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Edinburgh Napier University

Andrew Smith, Alasdair Reid, Mina Jowkar, Suha Jaradat (eds.)

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PREFACE

Welcome to the proceedings of the Fourth Transdisciplinary Research Network Conference (TWR 2024). This year's conference marks another milestone in our ongoing journey to foster collaboration and innovation to achieve our goal of contributing to the design and management of workplaces where people can work to their full potential and experience high levels of mental and physical wellbeing.

These proceedings present the latest findings of researchers, practitioners, and thought leaders from around the world who came together in Scotland's historic and vibrant capital city of Edinburgh to share their insights, discoveries, and visions for better workplaces from the 4th to the 7th of September 2024.

The Transdisciplinary Workplace Research (TWR) Network (www.twrnetwork.org) is a collaborative group of scholars and practitioners dedicated to enhancing workplace environments. Since its establishment in 2017, it has carried out its mission to disseminate groundbreaking workplace knowledge that enables organisations and individuals to reach their full potential, while maintaining high levels of mental and physical wellbeing. The network focuses on integrating various aspects of the workplace, including social, physical, technological, and managerial elements. This holistic approach ensures that workplaces support employee performance, satisfaction, health, and wellbeing. By bringing together experts from diverse fields, the TWR Network fosters interdisciplinary dialogue and collaboration. This approach helps translate academic research into practical solutions that can be implemented in real-world workplace settings.

The papers and presentations included in these proceedings represent the cutting edge of transdisciplinary workplace research. They span a rich range of topics including belonging, architecture and interior design, digitalisation and tools, wellbeing, educational and research workspaces, activity-based working, inclusion and diversity, engagement and culture, indoor environmental quality, workplace preferences, the evolving workplace, learning and education, corporate real estate, hybrid working, workplace experience and the human centred workplace. Each contribution underscores the importance of embracing a holistic perspective when it comes to workplace research and practice.

We would like to extend our thanks to all the authors and to the scientific committee, whose participation has made this publication possible. We must also thank the TWR Network and Board, in particular the Network Chair, Rianne Appel-Meulenbroek as well as the 2022 host, Chiara Tagliaro for the support that we have benefited from. We are also grateful to the School of Computing, Engineering and the Built Environment for making it possible to host the conference at Edinburgh Napier University. Thanks also to the university staff and volunteers who gave their energy to making the event a success, ultimately leading to these proceedings.

As you delve into these proceedings, we hope you find the research presented here as inspiring and enlightening as we do. Thank you for being a part of TWR 2024.

Andrew Smith, Alasdair Reid, Mina Jowkar, Suha Jaradat (eds.)
Edinburgh, September 2024

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SESSION 1

Session 1A: Workplace Sense of Belonging and Satisfaction

What affects sustainable coworking? A psychological ownership perspective

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ABSTRACT

Background: Previous research suggests that sustainability performance in any business depends on human behaviour. Building on this idea, sustainable coworking spaces depend on coworking members who behave sustainably. A sustainable coworking member is someone that simultaneously achieves the goals and objectives for the organization that they represent, benefits other individuals inside the coworking space, and responsibly shares the coworking space. To achieve sustainable coworking spaces, it becomes relevant to investigate what drives coworking members to display sustainable behaviours.

Purpose: This paper aims to explore the relationship between psychological ownership (PO) of a coworking space and sustainable coworking behaviours (SCB).

Theory: In psychology, ownership is the feeling that something is mine. You may not legally own it, but you feel like it is yours. Prior studies in other contexts have generally established a positive relationship between PO and behaviours that can be referred to as sustainable behaviours. Based on previous research, three hypotheses were formulated where PO of a coworking space acts as a driver for SCB.

Research design: This study uses a cross-sectional design to quantitatively test the hypothesized relationship between PO and SCB. Data were collected by conducting a survey that was sent to members of coworking spaces in Sweden. The data were then analysed with bifactor exploratory structural equation modelling (ESEM).

Results: The findings indicate that there is a statistically significant positive association between PO of a coworking space and SCB. Specifically, PO explains 24% of the variation in prosocial behaviours, 21% in responsible space sharing behaviours, and 11% in productive behaviours.

Originality: From a managerial perspective, this paper highlights how the feeling of ownership can help coworking members behave more sustainably and support coworking providers in their sustainability work. From an academic perspective, this study is among the first to incorporate psychological ownership theory in coworking spaces.

Keywords

Coworking spaces, psychological ownership, sustainable coworking behaviour, sustainability, structural equation modelling

1 INTRODUCTION

Coworking spaces are considered to be an activity falling under the umbrella of the sharing economy (Bouncken & Reuschl, 2018) and has become a widely popular workplace alternative during the last decades (Deskmag, 2019). As the popularity of coworking grows, it becomes more important to focus on sustainability in coworking spaces. According to Lülfs and Hahn (2013), the overall sustainability performance of any business depends on human behaviour. This idea suggests that in order to have sustainable coworking spaces, it is necessary to have coworking members who display sustainable behaviours.

In an exploratory study, Magnusson et al. (2023) contextualized sustainable behaviours (Juárez-Nájera et al., 2010; Corral-Verdugo et al., 2021) to a coworking space setting and coined the term sustainable coworking behaviour (SCB). With their contextualization, they mean that a sustainable coworking member is someone that simultaneously achieves the goals and objectives for the organization that they represent, benefits other individuals inside the coworking space, and responsibly shares the coworking space. To have more sustainable coworking spaces, it becomes interesting to know what drives coworking members to display sustainable behaviours.

Presumably it exists several drivers of SCB but this study solely focuses on psychological ownership (PO). PO is defined as "*the state in which an individual feels as though the target of ownership is theirs*" (Pierce et al., 2001, p. 299) and has been found to influence individual behaviour in traditional workplaces (Pierce et al., 2001; Van Dyne & Pierce, 2004) and third places

such as libraries and cafeterias (Joo, 2020). Morisson (2019) suggests that a coworking space is neither a traditional workplace nor a third place, but rather a hybrid "second-third place" intended for a new way of working and sharing knowledge.

In recent years, there has been an expansion of research linking PO with a range of desirable attitudes and behaviours (Dawkins et al., 2017). However, coworking spaces offer a unique setting and it is currently unknown how PO aimed towards the coworking space affects SCB. Therefore, the purpose of this study is to explore the relationship between PO and SCB.

2 RELATED LITERATURE AND HYPOTHESES FORMULATION

In psychology, ownership is the feeling that something is mine. You may not legally own it, but you feel like it is yours (Avey et al., 2009). For example, your favourite place in a café, you do not legally own it, but you feel like it is your place. This sense of ownership, known as PO, has important behavioural, emotional, and psychological consequences (Pierce et al., 2001). Van Dyne and Pierce (2004) propose that PO can positively influence individual attitudes and behaviour.

To investigate the relationship between PO and SCB, it is necessary to further describe what is referred to as SCB. Magnusson et al. (2023) found that SCB can be explained by three specific types of behaviours: prosocial behaviour, responsible space sharing behaviour, and productive behaviour. Prosocial behaviours are usually referred to as any action that benefits another (Pfattheicher et al., 2022), responsible space sharing behaviours include taking care of both the working environment and making conscious choices that are friendly to the natural environment (Magnusson et al., 2023), and productive behaviours comprise behaviours that positively contributes to achieving the individual or organizational goals and objectives (Park, 2020).

Empirical studies in other contexts than coworking spaces have generally established a positive relationship between PO and types of prosocial behaviours such as organizational citizenship behaviour, voice behaviour, and helping behaviour (e.g., Jami et al., 2021; Ramos et al., 2014; Van Dyne & Pierce, 2004; Vandewalle et al., 1995). For example, Jami et al. (2021) found that feelings of ownership lead to prosocial behaviour in the form of either helping others or making donations to charities, but also make people more generous toward others. Since a number of empirical studies show that PO has a positive influence on certain prosocial behaviours in different contexts than coworking spaces, it led to the following hypothesis being formulated:

H1: Psychological ownership of a coworking space is positively associated with coworking members' prosocial behaviours.

There are studies showing that enhancing the sense of ownership in people is accompanied by the feeling of responsibility (e.g., Li et al., 2021; Pierce et al. 2001; Preston & Gelman, 2020). For example, Pierce et al. (2001) stated that employees who feel like owners of their organization believe that they have the right to influence the direction taken by the organization and that they have a 'deeper responsibility' than those who do not feel ownership. Furthermore, Li et al. (2021, p. 4) state that: "*Customer psychological ownership can activate customers' sense of responsibility toward a hotel. Driven by this sense, customers are inclined to do something beyond transaction (e.g., convincing others to buy, providing feedback to firms, and helping develop new products/services) to benefit the hotel."* The literature seems to agree on a positive

relationship between PO and behaviours which are related to responsibility, but the studies are not set in a coworking context. Therefore, the following hypothesis was formulated:

H2: Psychological ownership of a coworking space is positively associated with coworking members' responsible space sharing behaviours.

Dawkins et al. (2017) state that relatively limited research has looked at whether organization and job-based psychological ownership leads to higher job performance or productivity. Two examples of studies that show a positive relationship are Brown et al. (2014) who reported a strong relationship between PO and sales performance, and Zhang et al. (2021) who found that PO was positively associated with organizational performance and creativity. Another example is Van Dyne and Pierce (2004) who identified a marginally positive relationship between organization-based PO and supervisor-rated productivity. Furthermore, Mayhew et al. (2007) found a positive relationship between job-based PO and productive behaviour, but it was not statistically significant. This led to the following hypothesis:

H3: Psychological ownership of a coworking space is positively associated with coworking members' productive behaviours.

In summary, previous research, theoretical and empirical, seems to suggest that PO should have a positive influence on behaviours associated with SCB i.e., prosocial behaviours, responsible space sharing behaviours, and productive behaviours (hereby referred to as PROS, RESP and PROD).

3 METHOD

3.1 Data collection

This study uses a cross-sectional design to quantitatively test the hypothesized relationship between PO and SCB. To collect data, a questionnaire was distributed to members of different coworking spaces located in Gothenburg, Sweden's second largest city. All coworking spaces included in the study are connected to the same coworking provider. The coworking provider was purposely selected since it is one of the largest providers of coworking spaces in the Gothenburg area and was willing to distribute the questionnaire.

The questionnaire was provided via e-mail and was divided into three sections. In the first part, respondents were asked to provide some demographic information. The second section in the survey was based on the conceptualization of sustainable coworking made by Magnusson et al. (2023). Based on the relevant literature, we included 45 items, where 19 items were used to assess PROS (e.g., Bettencourt 1997; Organ & Konovsky 1989; Podsakoff et al. 1990; Pommier et al. 2020; Williams & Anderson 1991; Zeithaml et al., 1996), 14 items for RESP (e.g., Avey et al. 2009; Bettencourt 1997; Robertson & Barling 2013; van Dyne & LePine 1998; Williams & Anderson 1991), and 12 items for PROD (e.g., Bueno et al. 2018; Joo 2020; Williams & Anderson 1991). The third section included measurements of PO. Van Dyne and Pierce (2004) have developed and validated a 7-item measure of psychological ownership and four were deemed fitting for the coworking space setting. All measurement items are available in the Appendix.

The respondents indicated their frequency or agreement with the items using a five-point Likert type scale ranging from Never/Fully disagree (1), Seldom/Disagree (2), Sometimes/ Neutral (3), Often/Agree (4), Always/Fully agree (5). An option to answer 'Don't know' was also included.

Before distributing the questionnaire, it was both pre-tested and pilot tested. The pre-test was conducted by interviewing six community managers in coworking spaces to ensure that the questions were reasonable and relevant for coworking members. The pilot survey was answered by 18 coworking members and helped making the main survey more rigorous before the official launch.

3.2. Data analysis

Historically, structural equation modelling (SEM) including confirmatory factor analysis (CFA) has been used to test hypotheses between latent variables such as PO and SCB. However, research has also shown that these analysis methods sometimes fail to meet standards of good measurements when analyzing multidimensional constructs (Marsh et al., 2014). To evade the restrictive assumptions, an alternative method known as exploratory structural equation modelling (ESEM) has emerged (Asparouhov & Muthén, 2009; Marsh et al., 2014; Morin et al., 2013). Basically, ESEM combines the advantages of exploratory factor analysis and CFA. More modern factor analytic techniques including bifactor models which hypothesize a general factor, onto which all items load, have also emerged (Howard et al., 2018; Morin et al., 2020). To ensure that the measurement model in this study provides a good fit, this study followed guidelines provided by Alamer (2022) and Swami et al. (2023) where four different models were tested: CFA, bifactor CFA, ESEM and bifactor ESEM.

All measurement models were developed in Mplus version 8.11. The models were based on a weighted least square estimator using a diagonal weight matrix (WLSMV) and a target rotation procedure as the rotation method which was recommended by Marsh et al. (2014) and Morin (2023).

To assess model fit, commonly applied goodness-of-fit indices were examined with their respective thresholds (Hu & Bentler, 1999): the comparative fit index (CFI; ≥ 0.95 for good, ≥ 0.90 for acceptable), the Tucker-Lewis index (TLI; ≥ 0.95 for good, ≥ 0.90 for acceptable), and the root mean square error of approximation (RMSEA; ≤ 0.06 for good, ≤ 0.08 for acceptable). Additionally, to ensure that the sample size provided adequate statistical power (≥ 0.8), RMSEA-based power calculations were performed where H0 = 0, H1 = 0.05 and α = 0.05 (Jak et al. 2021).

To ensure acceptable validity of the measurement model, the parameter estimates were closely inspected. For acceptable validity in CFA models, all items should have standardized factor loadings (λ) higher than 0.4 (preferably over 0.7) and be statistically significant (Hair et al. 2009). For ESEM, high loadings are often regarded as $\lambda \geq 0.5$ but values between 0.3 and 0.5 can be acceptable if previous research presents support for the item. For bifactor ESEM, $\lambda \geq 0.3$ to the targeted specific factor (i.e., PROS, RESP, and PROD) *or* the general factor (i.e., SCB) are needed to be considered satisfactory (Morin et al., 2020).

As a final part of the measurement model assessment, McDonald's omega test was applied to test internal consistencies. A common cut-off value is ω = 0.7 (Cheung, 2023). When the

measurement model was deemed fully acceptable, the structural model was developed, and the three hypotheses were tested.

4 RESULTS

4.1 Sample

In total, 77 questionnaires were fully completed and analysed. While coworking spaces are commonly associated with open-plan layouts and flexible workspaces (Bouncken et al., 2021; Spinuzzi, 2012), the sample deviates from this norm. The majority of coworking members (n = 43) work in private offices rather than in an open environment. Contrary to the general perception that coworking spaces primarily attract self-employed entrepreneurs and freelancers (Howell, 2022), the sample reveals a noteworthy margin (n = 43) of members employed by companies that cover their membership fees. Additionally, one space ('Space 3') has a prominent representation (n = 40), but this was anticipated as it is the largest coworking space out of the ones participating in this study. The data also indicate that many members are relatively new to coworking, with memberships spanning less than a year (n = 42) or between 1 and 2 years (n = 18). This aligns with the expectations, considering coworking is a relatively recent concept in Gothenburg and flexibility being one its main advantages (Howell, 2022). Efforts have been made to ensure representativeness of the sample by cross-checking the demographic profiles of the respondents with the owner of the coworking spaces. A summary of the demographic profiles is provided in Table 1.

Table 1. Summary of demographic profiles of the respondents

Characteristic	**n**	**(%)**	**Characteristic**	**n**	**(%)**
Coworking space			*Payment type*		
Space 1	7	9	My employer	62	80
Space 2	20	26	Myself	15	20
Space 3	40	52	*Workdays*		
Space 4	2	3	0-1 days per week	9	12
Space 5	8	10	2-3 days per week	29	37
Type of membership			4-5 days per week	39	51
Fixed space	27	35	*Age*		
Flexible space	6	8	18-24 years	5	6
Private office	43	56	25-34 years	29	38
Other	1	1	35-44 years	22	29
Time as member			45- 54 years	15	19
Less than 1 year	42	55	55-64 years	6	8
1-2 years	18	23	*Gender*		
2-3 years	11	14	Female	36	47
3-4 years	1	1	Male	41	53
More than 4 years	5	7			

4.2 Validity and reliability assessment of measurement model

Based on the first stage of the data analysis, commonly reported goodness-of-fit indices are shown in Table 2. The values show that the bifactor ESEM outperforms the other models indicating that it has the most satisfactory fit and the other models are thereby not retained. When conducting the power analysis based on 77 answers and 816 degrees of freedom, the statistical power was calculated to 0.97 indicating that the sample size is sufficient for further analysis.

Table 2. Goodness-of-fit indices for four measurement models

Model	c^2	***p***	***df***	**CFI**	**TLI**	**RMSEA**	**90 % CI for RMSEA**
CFA	1352	<.001	942	0.839	0.831	0.075	[0.066, 0.084]
ESEM	1028	<.001	858	0.933	0.923	0.051	[0.038, 0.062]
Bifactor CFA	1107	<.001	900	0.919	0.911	0.055	[0.043, 0.065]
Bifactor ESEM	934	.0025	816	0.954	0.944	0.043	[0.027, 0.056]

When assessing the validity by analysing the parameter estimates (see Table 3), some noteworthy observations can be made. First, it is possible to see that PROS18 has a low target loading (λ = 0.170) and a higher loading to the general factor (λ = 0.341). Also, PROS14 has a barely acceptable level of target loading (λ = 0.303) while having a low loading to the general factor (λ = -0.058). Based on the guidelines for bifactor ESEM, these loadings are acceptable, but they are clearly the weakest item for PROS. Second, similar things can be said about the loadings to the specific factor of RESP1 (λ = 0.337) and RESP11 (λ = 0.351) and their loading to the general factor (λ = 0.246; λ = 0.223) which also are relatively weak. However, they are still acceptable. Third, three items of PROD suffer from low target loadings: PROD10 (λ = 0.244), PROD11 (λ = 0.200), and PROD12 (λ = 0.130) but they are all still acceptable considering large loadings onto the general factor. These three items are phrased as "*I can create new ideas*", "*I can think outside the box*", and "*I can become inspired*" which are all related to the creative and problem-solving part of productivity rather than a traditional task-oriented point of view. Despite being acceptable, these three items can potentially be included in another construct currently not incorporated in the measurement model. Overall, the inspection of parameter estimates show that all loadings can be considered acceptable which acts as evidence that the measurement model can be deemed valid.

As a final part of the assessment, McDonald's omega test was applied, and all omega-coefficients are above 0.7 which indicate that the measurement model can be seen as reliable.

Table 3. Summary of statistics (mean, standard deviation, standardized factor loadings and reliability indices)

	n	Mean (SD)	PROS λ	RESP λ	PROD λ	SCB λ
Prosocial behaviour						
PROS1	76	2.03 (0.97)	**.415****	-.396**	-.011	-.286*
PROS2	75	2.81 (0.93)	**.525****	-.036	-.062	-.038
PROS3	74	2.49 (0.90)	**.716****	.004	-.062	-.038
PROS4	76	3.71 (0.99)	**.658****	.309**	-.096	.146
PROS5	74	3.18 (1.04)	**.643****	-.069	.139	.199
PROS6	77	3.23 (0.90)	**.758****	.143	-.003	-.018
PROS7	74	2.66 (1.14)	**.597****	.116	.062	.255*
PROS8	75	3.12 (1.01)	**.551****	-.205**	-.196*	.449**
PROS9	74	2.42 (1.17)	**.422****	-.335**	-.305**	.548**
PROS10	72	2.68 (1.23)	**.480****	-.462**	-.358**	.465**
PROS11	70	3.29 (1.25)	**.770****	-.032	-.042	.451**
PROS12	72	3.18 (1.09)	**.631****	.161	-.076	.523**
PROS13	75	3.17 (1.10)	**.786****	.017	.021	.291*
PROS14	76	2.01 (1.00)	**.303****	-.248*	-.059	-.058
PROS15	76	3.16 (0.88)	**.478****	-.126	-.121	.305**
PROS16	71	3.48 (1.12)	**.601****	.216*	.013	.039
PROS17	75	2.89 (1.05)	**.445****	.059	-.119	-.188
PROS18	76	3.49 (1.08)	**.170**	.475**	.130	.341**
PROS19	71	2.68 (0.95)	**.419****	.026	.275**	.149
ω			*.893*			
Responsible space sharing behaviour						
RESP1	77	4.34 (0.82)	-.092	**.337****	-.026	.246*
RESP2	77	4.38 (0.73)	.066	**.401****	-.134	.203
RESP3	77	4.44 (0.68)	.134	**.477****	.132	.148
RESP4	77	4.57 (0.64)	-.070	**.723****	.060	.432**
RESP5	77	4.16 (0.89)	.169	**.491****	.107	.063
RESP6	77	4.45 (0.74)	-.013	**.542****	-.154	.341**
RESP7	75	4.37 (0.80)	-.059	**.705****	.182**	.544**
RESP8	72	4.38 (0.86)	-.258**	**.362****	.081	.746**
RESP9	77	3.87 (0.95)	-.046	**.277***	.097	.654**
RESP10	77	4.27 (0.87)	-.045	**.311****	.155	.687**
RESP11	75	4.29 (0.80)	-.187	**.351****	-.143	.223
RESP12	74	4.42 (0.78)	-.182	**.499****	.093	.228
RESP13	63	3.49 (1.03)	.178	**.400****	-.011	.340**
RESP14	73	3.90 (1.04)	.074	**.615****	.233*	.342*
ω				*.797*		
Productive behaviour						
PROD1	77	3.75 (1.02)	-.238**	.205**	**.803****	.176
PROD2	77	3.71 (1.02)	-.186*	-.002	**.852****	.226
PROD3	77	4.01 (1.02)	-.111	.013	**.766****	.302*
PROD4	77	4.10 (0.93)	-.036	.045	**.524****	.536**
PROD5	76	4.01 (0.95)	-.052	.131	**.706****	.436**
PROD6	77	4.09 (0.86)	-.094	.234	**.679****	.446**
PROD7	74	3.80 (0.91)	-.145	-.009	**.570****	.615**
PROD8	72	3.79 (0.90)	-.024	-.056	**.391****	.718**
PROD9	75	3.88 (0.82)	-.005	-.041	**.511****	.733**
PROD10	74	3.66 (1.02)	.263**	-.057	**.244***	.726**
PROD11	76	3.75 (0.93)	.394**	-.116	**.200**	.742**
PROD12	77	3.70 (0.97)	.217**	.144	**.130**	.571**
ω					*.836*	

Note: **Bold** text: Target loadings for specific factors, grey text: -0.3 < λ < 0.3, *p < 0.05, **p < 0.01

4.3 Structural model testing

The results from the structural model testing are available in Figure 1. The data confirm that all three hypotheses are supported (see Table 4). PO of a coworking space seems to have a positive effect on the specific factors PROS (H1), RESP (H2), and PROD (H3). Overall, the calculations of R^2 signify that PO explains 24% of the variation in PROS, 21% in RESP, and 11% in PROD.

Figure 1. Results from structural model

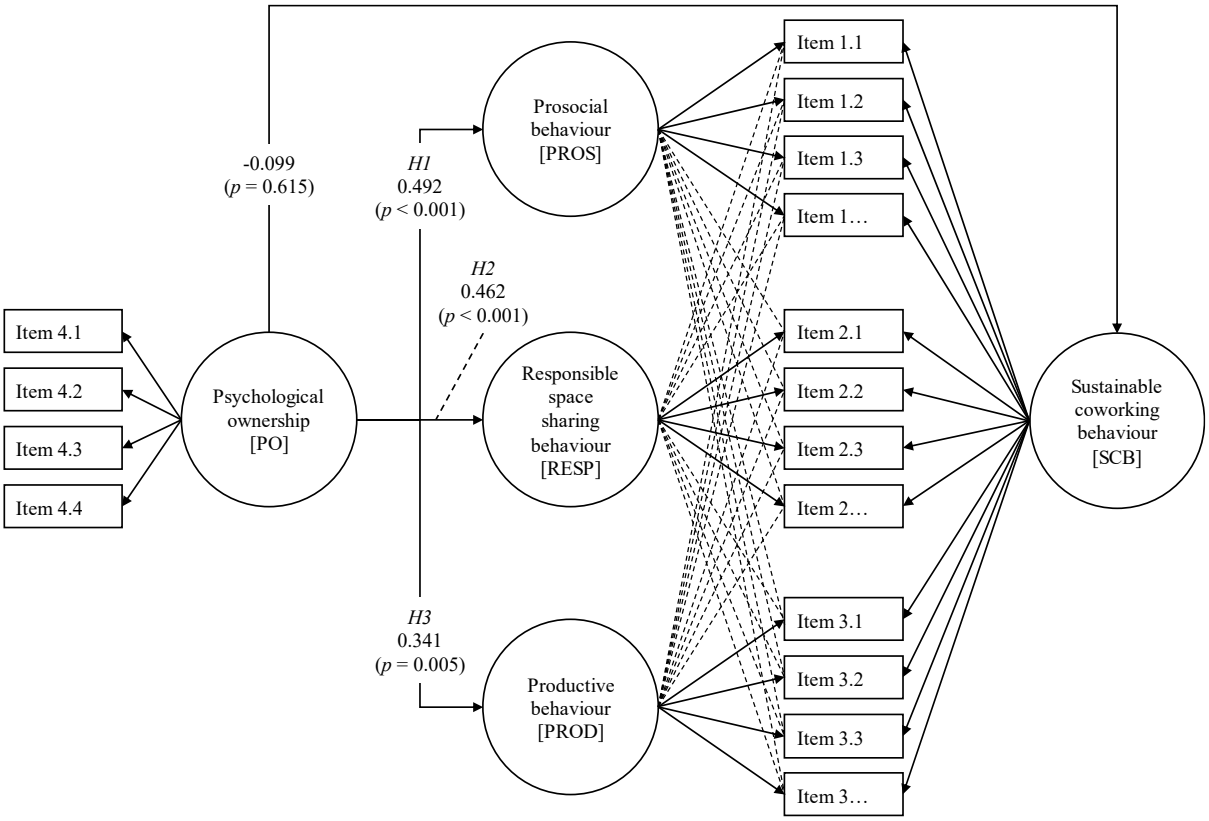

Table 4. Summary of hypotheses

	Hypothesis	Coefficients	*p*	R^2	Support
H1: PO → PROS	Psychological ownership of a coworking space is positively associated with coworking members' prosocial behaviours.	0.492	<0.001	0.242	Yes
H2: PO → RESP	Psychological ownership of a coworking space is positively associated with coworking members' responsible space sharing behaviours.	0.462	<0.001	0.214	Yes
H3: PO → PROD	Psychological ownership of a coworking space is positively associated with coworking members' productive behaviours.	0.341	0.005	0.116	Yes

5 CONCLUSION

The purpose of this study was to investigate the relationship between PO of a coworking space and SCB. To fulfil the purpose, this study tested three hypotheses regarding this relationship. The structural model show that all three hypotheses were supported. The findings demonstrate that it is highly likely that there is a positive relationship between psychological ownership of a coworking space and prosocial behaviour, responsible space sharing behaviour, and productive behaviour. The findings are consistent with prior studies that have analysed psychological ownership towards one's organization (e.g., Pierce et al., 2001; Van Dyne & Pierce, 2004).

Since this study found a positive relationship between psychological ownership and sustainable coworking behaviour (Magnusson et al., 2023), it comes with a number of implications. From an academic perspective, this study is one of the first to incorporate a psychological ownership point of view in a coworking space setting. It contributes to enhancing the understanding of psychological ownership in this unique setting. From a managerial perspective, this study highlights the importance of psychological ownership in creating sustainable coworking spaces. The findings give incentives for coworking providers to pursue how to increase coworking members' sense of psychological ownership.

We realize that the model that has been proposed has its limitations. One can assume that the specific factors may have causal relationships within themselves. For example, prior research has shown evidence that coworking members who engage socially with other entrepreneurs in a coworking space gain access to diverse pools of knowledge, expertise, and experiences. This enables them to gather valuable insights, exchange ideas, and receive feedback, ultimately enhancing their work efficiency and entrepreneurial productivity (Cabral, 2021).

Another limitation of the study is its sample size and generalizability. Although having sufficient statistical power, the results could presumably be more generalized with a larger sample size. Additionally, this study only collected data from a certain typology of coworking space. According to Kojo and Nenonen (2016) and Orel and Bennis (2021), there are several different typologies of coworking spaces, and the results might not be applicable to all of them. Furthermore, potential national bias may exist due to participant selection. Psychological ownership is, according to Pierce et al. (2003), affected by contextual factors, such as culture.

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APPENDIX

Items used for measuring sustainable coworking behavior (SCB)

	As a member of this coworking space…
PROS1	I share content with other members on the coworking space's online platforms
PROS2	I take a personal interest in other members
PROS3	I introduce new members to each other
PROS4	I orient new members
PROS5	I keep other members updated with important information
PROS6	I share experiences that may help other members avoid risks and trouble
PROS7	I share my possessions with other members
PROS8	I willingly help other members who have work-related problems
PROS9	I help other members who have heavy workloads
PROS10	I help other members who have been absent
PROS11	If I see another member going through a difficult time, I try to be caring towards that person
PROS12	I like to be there for other members in times of difficulty
PROS13	I take time to listen to other members' problems and worries
PROS14	I voluntarily arrange things not required for my work
PROS15	I attend functions not required for my work
PROS16	I say positive things about this coworking space to others
PROS17	I make constructive suggestions to this coworking space on how to improve its service
PROS18	If an employee of this coworking space gives me good service, I let them know
PROS19	I challenge other members if I think something is done wrong
	While working in this coworking space…
RESP1	I use the coworking space's utensils sparingly
RESP2	I recycle my trash
RESP3	I try to help keep this coworking space clean
RESP4	I conserve and protect the property of this coworking space
RESP5	I am aware of how much noise I make in this coworking space
RESP6	I am aware if I invade other members' workspace
RESP7	I obey this coworking space's rules and policies even when no one is watching
RESP8	I protect my sensitive information from being used by other members
RESP9	I carefully observe the rules and policies of this coworking space
RESP10	I am mindful of how my behavior affects other members' job
RESP11	I adhere to informal rules devised to maintain order
RESP12	I try to avoid creating problems for other members
RESP13	I speak up and encourage other members to get involved in issues that affect the community
RESP14	I tell the coworking host(s) if I see something that is done wrong
	While working in this coworking space…
PROD1	I can work without interruption
PROD2	I can work without being noticed
PROD3	I can concentrate

PROD4	I can perform work of high quality
PROD5	I can complete tasks efficiently
PROD6	I can focus on core activities
PROD7	I meet formal short-term targets at my job
PROD8	I meet formal long-term targets at my job
PROD9	I progress towards formal targets of my job
PROD10	I can create new ideas
PROD11	I can think outside the box
PROD12	I can become inspired

Items used for measuring psychological ownership (PO) (Van Dyne & Pierce, 2004)

PO1	This is MY coworking space
PO2	I feel a very high degree of personal ownership for this organization
PO3	This is OUR coworking space
PO4	It is hard for me to think about this coworking space as MINE *(Reversed)*

“Where’s my desk?”: A longitudinal investigation on personalization and psychological ownership at the workplace

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ABSTRACT

Modern workplaces are undergoing a significant transformation characterized by an increase in shared spaces and a decrease in the workstations-to-employees ratio. This shift towards flexible office arrangements has determined some challenges for the employee traditional experience of the workplace, particularly concerning phenomena such as personalization (i.e., a form of territorial behavior) and psychological ownership at the workplace. This study aimed to examine the relationship of workplace personalization, psychological ownership, and two work-related outcomes, namely preferable number of office days and affective organizational commitment. Drawing upon theory of psychological ownership (i.e., the feeling of possessives toward an object) and prior literature on territorial behaviors, we hypothesized that self-oriented personalization leads to higher preferable number of office days and higher affective organizational commitment, via desk-related psychological ownership. The study was designed longitudinally and consisted of two waves with a time-span of five

months in between. Data collection was carried out via online survey sent to the employees of a Belgian public agency. The final sample consisted of 301 employees and data were analyzed through structural equation modelling. We found evidence supporting the hypothesized relationship, yet with the reverse directionality. Specifically, preferable number of office days led to desk-related psychological ownership, which in turn led to self-oriented personalization. This study presented the first longitudinal test of the link between personalization (i.e., a type of territorial behavior) and psychological ownership at the workplace, and its findings contributed to shed light on the relationship between these two phenomena which are playing a relevant role in the modern debate on return-to-office and future office.

Keywords

Personalization, Psychological ownership, Territorial behaviors, Workplace, Longitudinal.

1 INTRODUCTION

Offices are getting flexible not just in the way they are used but also in their spatial features. In particular, the ratio between workstations and employees has decreased, implying that today's work environments include a rising number of shared spaces over the number of individual spaces (Engelen et al., 2019; Wohlers & Hertel, 2017). Accordingly, many offices host workspaces with no assigned workstations, where employees are provided with various workstations tailored to support concentration and collaboration in the various daily work tasks (Babapour Chafi & Rolfö, 2019; Kim et al., 2016; Millward et al., 2007).

However, the effects of this transformation are not limited to the office layout, as it requires employees to adjust their behavior according to the rules of desk-sharing and clean-desk policies (Appel-Meulenbroek et al., 2011; Davis et al., 2011). This has often come with some difficulties for the workforce: For instance, the shift towards the desk-sharing environment can impair the degree of familiarity and agreeableness of the workplace, as it decreases (or removes) the extent to which employees are allowed to use and personalize the space (Bodin Danielsson & Hoy, 2022; Brunia & Hartjes-Gosselink, 2009). In fact, workplace personalization is an important behavior, because it contributes to the comfort perceived at work, it is the expression of sense of ownership towards the workspace and it let people to "feel home" at the office (Elsbach & Pratt, 2007; Pierce et al., 2001; Wells & Thelen, 2002).

Personalization and psychological ownership are gaining momentum in the research on the physical work environment, since they are involved in the public debate on return-to-office and future workplaces (Epstein, 2023; Taskin et al., 2019). Specifically, given the habituation to the remote work that has been occurring for the latest years and the transformation that many workplaces have been undergoing, phenomena like personalization and psychological ownership at the workplace can help to explain why employees in the actual work context may prefer either go to the office or work remotely (e.g., Brunia & Hartjes-Gosselink, 2009). Yet, these two phenomena have not been examined with regards to the new challenges of flexible work environment. It can be argued that the sense of

ownership at the workplace may play a critical role in the understanding of the employee willingness to go to the office and that, in turn, the sense of ownership towards one's workplace depends to some extent to the familiarity and comfort perceived in the physical workspace.

This study aims at a twofold contribution. First, we empirically test the link between personalization (i.e., a category of territorial behavior) and psychological ownership. Second, we specifically design a longitudinal study, thus testing for the first time the directionality of the relationship between the two phenomena (cfr. Brown & Zhu, 2016).

2 Office environment: Flexibility versus familiarity?

The last decades have witnessed a higher awareness of the impact of corporate real estate and space maintenance on companies' expenses. The Covid-19 pandemic and the subsequent surge in telework have further prompted profound reflections and debates about the use and destiny of offices, the transformations needed in its setting, or even the alleged death of the office (Nixey, 2020; The Economist, 2020). As a result of mandatory telework, more companies have re-evaluated their physical premises and have made crucial decisions on the adaptation needed to foster higher space efficiency. Even those companies which had not previously contemplated office redesign had suddenly to make decisions on how to adapt to the new circumstances, with several of them opting to follow the trend of flexibility in the office space.

Basically, setting flexible offices allows to cut the costs associated with the (redundant) workspace, by maintaining approximately 60-70% of the space provided by a traditional office with individually assigned workstations (Engelen et al., 2019; Marzban et al., 2022). Thus, individual workstations as well as other communal spaces in the office, such as meeting rooms, touchdown areas, phone booths, kitchen and cafeterias, can be shared among the employees (Davis et al., 2011). Furthermore, when nonterritorial office arrangements are specifically adopted by companies (i.e., clean-desk policy) employees are prevented from claiming a space or leaving their belongings on any specific desk.

However, this kind of policy has presented challenges for both employees and employers, especially because employees often struggle to comply with the rules (Babapour Chafi & Rolfö, 2019; Brunia & Hartjes-Gosselink, 2009). They may tend to "nest", that is always use the same preferred space, even though activity-based working principles recommend changing workstation based on the nature of the task (Hirst, 2011; Rolfö et al., 2018). Or employees may tend to leave their belongings on the desk, thus acting in a territorial manner despite the clean-desk rules. Furthermore, employees may prefer teleworking from home or another location where they can enjoy an environment that suits them better, thus reducing their attendance of the physical office space (Epstein, 2023; Taskin et al., 2019).

Hence, the new features introduced in the work environment (i.e., flexible workspace, remote working, nonterritorial arrangements) have raise awareness on how "flexibility" affects the employee use of office and return-to-office. Despite the advantages of flexible workspaces for companies and employees (e.g., less commuting, more space and time autonomy), there is evidence of some criticalities of the employee experience of the workplace which has resulted in a lower attendance of office (Hampel & Hampel, 2023; Taskin et al., 2019). In fact, there are various jobs and companies which profoundly benefit from employees' presence at the office, working together in the same space

(Hill et al., 2003). Team outcomes, social relations with colleagues, organizational climate, and the workplace attachment relate—at least to some extent—to the spatial features of the workplace and employees' face-to-face interaction. This is the reason why the presence at the workplace is highly valued by employers, who are concerned about having their employees back in the company premises (Golden et al., 2008; Khazanchi et al., 2018; Rioux & Pignault, 2013).

In light of this emerging challenge, the comprehension of what influences the employees' attendance of office has become crucial. Aligning with a part of prior workplace research (Elsbach & Pratt, 2007; Wells & Thelen, 2002), we argue that examining the personalization behavior and sense of psychological ownership at the workplace can help to deepen the knowledge of the bond between employees and their workplace and understand what can foster their presence at the office.

3 Workplace personalization: Expressing identity at the office

Personalization is the action of modifying one's immediate environment, usually with objects that reflect individual personal characteristics and are related to social relations, hobbies, interests, which also signals to others that a particular space has been claimed (Elsbach, 2004). As such, it represents a type of territorial behaviors defined as "identity-oriented marking" (Brown et al., 2005) including behaviors like placing family photographs on the desk, sticking sport team logos on the laptop screen, displaying souvenirs of vacations on the wall, and drinking coffee from mugs featuring beloved quotes.

Importantly, these spatial modifications are believed to have a positive impact on the overall employee experience within the physical work environment, since they inject personal significance into the workspaces (Elsbach & Bechky, 2007). Also, since personalization enables people to create a more familiar environment around them, it is likely to counterbalance the adverse effects of low privacy on emotional well-being in the workplace, thereby safeguarding to a certain extent employees' psychological well-being (Laurence et al., 2013). Hence, personalization allows employees to satisfy the needs related to identity, security, and stimulation, and express a form of bond with a space that is meaningful to them (Brown et al., 2005; Elsbach, 2004; Wells & Thelen, 2002).

In the current study, we will specifically refer to *self-oriented personalization* to indicate any modifications or decorations applied to the physical workspace by using objects referring to employees' individual identity (Brown et al., 2005).

4 Psychological ownership towards the workplace

Territoriality is conceptually tied to the feeling of possession, that is the sense of ownership. Psychological ownership is a human experience characterized by the sense of possessing and forming a connection with specific "objects", whether they are people, material items, or abstract concepts. These objects raise in the individual feelings and thoughts relating to the idea "This is mine" (Pierce et al., 2001, 2003). Psychological ownership has three primary roots that elucidate the "why" behind this human feeling: efficacy and effectance, identity, and having a place (Belk, 1988; Dittmar, 1992; Pierce et al., 2003; Van Dyne & Pierce, 2004). Moreover, the sense of ownership evolves through the development of three key routes, which explain the "how" of psychological ownership: controlling the object, developing an intimate understanding of the object, and investing oneself in the object (Pierce et al., 2001, 2003).

Previous studies have found that the concept of psychological ownership can be considered a form of attachment to the workplace, close to organizational commitment and organizational identification but nevertheless distinct (Zhang et al., 2021), as it encompasses the unique dimension of sense of possessiveness towards the target object (Pierce et al., 2001; Van Dyne & Pierce, 2004). Zhang et al.'s (2021) recent meta-analysis reports that psychological ownership positively associates with job satisfaction, organization-based self-esteem, work engagement, and it negatively associates with negative affect and turnover intention. It potentially plays a beneficial role in fostering organizational performance and voice, and employees' creativity and knowledge sharing behavior.

However, psychological ownership has not yet been studied in specific relation to the physical work environment. While prior research has explored psychological ownership within the organizational context, studying concepts like organization-based and job-based psychological ownership (e.g., Brown & Zhu, 2016; Mayhew et al., 2007; Pierce et al., 1991), the focus of the current study addresses psychological ownership within the specific context of the physical work environment. Particularly, we will refer to *desk-based psychological ownership* to describe the sense of ownership that employees experience towards their individual workstations or the workstation they use most frequently at their office.

5 Personalization and psychological ownership: Territorial bonds with the work environment

Interestingly, when defining personalization and psychological ownership, a connection between the two phenomena emerges. However, up to now, little research has explored the association between psychological ownership and territorial behaviors, or personalization specifically, with studies addressing either the theoretical understanding or empirical testing of the two variables together (Brown et al., 2005; Brown, 2009; Brown, Crossley, et al., 2014; Khazanchi et al., 2018; Vischer, 2008). Research evidence supports the existence of the relationship between psychological ownership and identity-oriented marking (i.e., personalization, Brown, 2009; Brown, Crossley, et al., 2014). Arguably, this can be expected, because personalization involves acting behaviors and using objects directly related to individuals' self-identity (Brown, 2009). In addition, studies have found that both psychological ownership and territorial behaviors are associated with positive feelings towards the organization (Brown & Zhu, 2016).

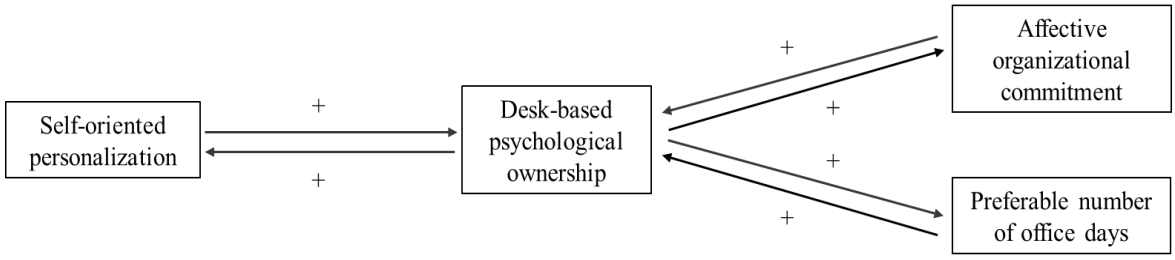
Notably, whereas the prior research has discussed the relationship between territorial behaviors and psychological ownership by always identifying the former as conceptual consequences of the latter, Brown and Zhu (2016) argued that both concepts can mutually reinforce each other. Moving from this stance and drawing upon the literature on territorial behaviors and psychological ownership, we want therefore to advance a different—reciprocal—perspective on this relationship. Specifically, we propose that perceiving oneself as owner of the workspace can lead to express the feeling of ownership through personalization, as well as personalizing one's workspace contributes to forming and strengthening the connection between employees and their workplace. This is because the changes introduced into the physical work environment allow employees to visibly demonstrate their control, intimacy, and investment in the workspace, all of which are key aspects of the psychological ownership experience (Pierce et al., 2003). In other words, personalization, as a form of territorial behavior, is likely to fuel all these three aspects (i.e., control, intimacy, and investment), as it represents a claim of ownership over

a space and fosters sense familiarity and a connection with it (Brown, 2009). Hence, personalization can be viewed as a supportive factor for psychological ownership as well as psychological ownership is seen as the feeling underlying personalizing behavior.

Thus, we posit that personalizing one's individual desk in a manner that reflects one's self-identity facilitates the development of feelings of ownership towards that specific workstation (desk). Furthermore, since psychological ownership encompasses thoughts and emotions related to possessing the workplace and can be described as a form of attachment to the workplace (Zhang et al., 2021), employees with a higher sense of ownership towards their workstation are more likely to feel satisfied and at ease in working in their workspace (Brunia & Hartjes-Gosselink, 2009), that is to have a stronger emotional connection with their organization and attend their office regularly. Symmetrically, we expect that the other way around also occurs. Employees who attend the office more frequently are more likely to use their (favorite) workstation. Since the habitual use of an object leads people to perceive more control over it and know it deeper (i.e., two routes of the sense of ownership), it contributes to the development of ownership towards that object (Pierce et al., 2003). Likewise, since affective organizational commitment implies an affective attachment to the company, employees with greater affective commitment to their organization are therefore more likely to feel higher ownership towards their workspace (see Figure 1). Accordingly, we hypothesize:

Hypothesis 1. *Self-oriented personalization is positively related to affective organizational commitment and preferable number of office days via desk-based psychological ownership, and, reciprocally, affective organizational commitment and preferable number of office days are positively related to self-oriented personalization via desk-based psychological ownership*.

Figure 1. The theoretical model of the study



6 METHODS

6.1 Participants and procedure

The study was carried out distributing an online survey among the employees of a Belgian government agency which has recently renovated its offices according to a flexible setting. The data collection consisted of two waves, with a time-lag of 5 months: Time 1 (T1) in December 2022, Time 2 (T2) in May 2023. The first survey was distributed as part of an annual assessment that employees were recommended to complete. The second survey was distributed among the respondents who gave

consent to be contacted again. At T1, 3740 responses were collected, out of which 3186 (85.2%) were valid based on the attention check. At T2, 382 participants were contacted, 332 respondents filled in the survey (response rate 86.9%) and 317 (95.5%) responses were retained as valid. After merging the data through the email of participants, our final dataset consisted of 301 respondents.

Most of the participants were women (76.8%), with the age ranging between 24 and 65 years (M = 45.7, SD = 10.5) and more than two thirds of the sample had a full-time contract (69.4%). Concerning the education, one half of the sample held a masters' degree (50.5%), another third held a bachelor's degree (35.5%), a smaller part completed the high secondary education (12%). Employees in the sample largely varied in term of organizational tenure (0 – 45 years, M = 14.2, SD = 11.00) and years spent in the same office (0 – 45 years, M = 7.1, SD = 7.2). Concerning the expected office attendance, 31.6% of the sample reported that their team agreed on coming to the office at least 1 day per week, 33% reported that they agreed on coming at least 2 days per week, 22% reported they do not have any team agreement on the minimum number of days to spend at the office.

6.2 Measures

Self-oriented personalization. We adapted the 6-item identity-oriented marking scale (Brown, 2009). Respondents were asked to what extent they engaged in individual personalizing behaviors relating to a workstation in their office. Answers were provided on a 5-point scale from 1=*Not at all* to 5=*As much as possible*. Cronbach's alphas were .79 (T1) and .77 (T2).

Desk-based psychological ownership. We adapted the 4-item scale used in Brown (2009). Respondents were asked the degree to which they agreed with the statements relating to the desk they use the most at their workplace. Answers were provided on a 5-point scale from 1=*Strongly disagree* to 5=*Strongly agree*. Cronbach's alphas at T1 and T2 were .97.

Affective organizational commitment. This variable was measured with the 8-item scale by Allen and Meyer (1990). Answers were provided on a 5-point scale from 1=*Strongly disagree* to 5=*Strongly agree*. Cronbach's alphas were .83 (T1) and .85 (T2).

Preferable number of office days. We asked participants how many days they would like to work at the office on an average working week. Answers were provided on a 6-point scale from 1=*None* to 6=*Five days*.

7 MAIN RESULTS

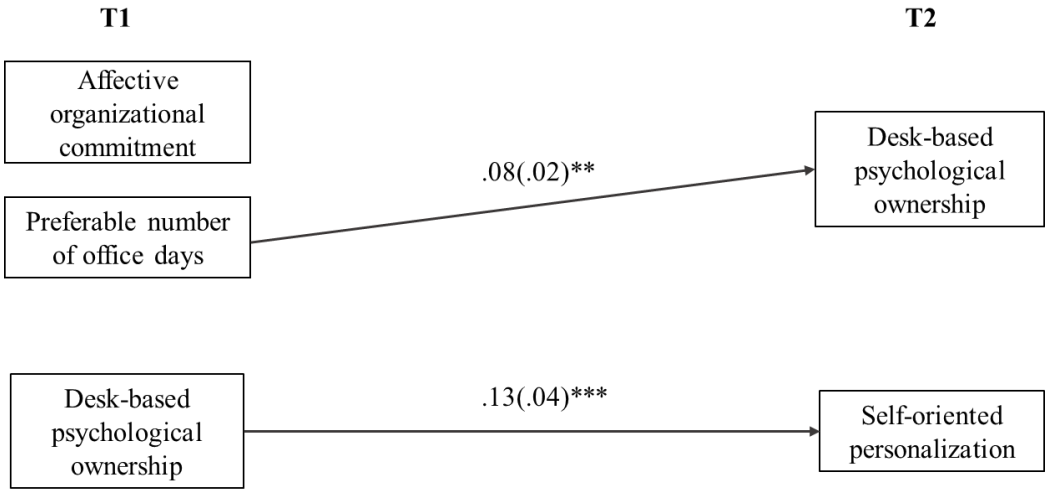
After the preliminary analysis on the hypothesized six-factor model (i.e., confirmatory factor analysis, factor loadings, longitudinal measurement invariance), we conducted structural equation modelling analysis to test and compare four models: Stability model (S1), causality model (S2), reversed model (S3), and reciprocal model (S4). No significant difference emerged between the model fit of S1 and S2, meaning that the causality model did not show better fit than the stability model. Model fit of S3 was significantly better than S1, showing that the reversed model performed better than the stability model. As shown in Table 1, no significant difference emerged between the model fit of S3 and S4, meaning that the reciprocal model did not perform significantly better than the reversed model (Hu & Bentler, 1999; Shi et al., 2022). Hence, overall S3 showed the best fit to the data. Thus, our hypothesis was not

supported. By contrast, the data lend support to the reversed directionality of the relationship between self-oriented personalization and desk-based psychological ownership. More in detail, we found that: The cross-lagged path from affective organizational commitment T1 to desk-based psychological ownership T2 was nonsignificant (β = 0.054, *SE* = 0.032, *p* = 0.089), while the cross-lagged path from preferable number of office days T1 to desk-based psychological ownership T2 was positive (β = 0.078, *SE* = 0.023, *p* = 0.001); the cross-lagged path from desk-based psychological ownership T1 to self-oriented personalization T2 was positive as well (β = 0.129, *SE* = 0.036, *p* = 0.000). These results are displayed in Figure 2.

Table 1. Goodness-of-fit indices of the structural models tested in the study.

Model	**χ^2**	***df***	***p***	**CFI**	**TLI**	**RMSEA**	**C.I. RMSEA**	**SRMR**	**AIC**	**BIC**
S1	73.301	12	0.000	0.971	0.933	0.127	0.100-0.155	0.050	4872.486	4961.456
S2	67.480	9	0.000	0.973	0.916	0.142	0.111-0.175	0.048	4871.979	4972.071
S3	39.734	9	0.000	0.987	0.959	0.099	0.069-0.132	0.029	4843.458	4943.550
S4	36.535	6	0.000	0.988	0.946	0.118	0.083-0.156	0.031	4844.867	4956.080

Figure 2. Significant cross-lagged paths from the reversed model.



8 MAIN DISCUSSION

We found that desk-based psychological ownership results from the preferable number of office days and leads to self-oriented personalization at the workplace. This finding did not support our alternative model advancing the reciprocal relationship between self-oriented personalization and the two outcomes (i.e., affective organizational commitment and preferable numbers of office days) via desk-based psychological ownership. With regard to the preferable number of office days, we found that it is an antecedent of psychological ownership, rather than its possible consequence. Interestingly, this might suggest an alternative interpretation of the role of preferable number of office days in our model: Although we expected that employees who feel greater ownership towards their workstation will be willing to go more often to the office, it appears that the other way around can occur, that is people who prefer going more often will also feel that their workplace is more their own. For example, preferable number of office days might be related to one of the three roots of psychological ownership (Pierce et al., 2003), that is efficacy and effectance (i.e., employees feel effective while working in the office and thus willing to work from the office). This sense of efficacy felt in relation to the office nurtures the corresponding feelings of ownership towards the office. Or, in alignment with Zhang et al.'s (2021) recent meta-analysis, the preferable number of days might be considered as a form of investment in the workplace and thus playing the role of antecedent of desk-based psychological ownership.

We also found that the study gave support to the current perspective in the literature on psychological ownership and territoriality, which considers psychological ownership as a theoretical antecedent of territorial behaviors (e.g., Brown, 2009; Brown et al., 2014). According to this perspective, personalizing behavior is the expression of the underlying sense of ownership felt by the individual, and this sense of ownership, in turn, reflects a natural human tendency to develop an emotional tie with objects and spaces they use (Brown, 2009; Pierce et al., 2003).

8 Conclusion

Our study made a step forward in the investigation of the relationship between personalization and psychological ownership at the workplace, presenting for the first time a longitudinal test of the directionality of their relationship. Findings provided support to the existing perspective in literature, according to which workplace personalization is the behavioral expression resulting from the feeling of psychological ownership towards a specific workstation at the office. Also, the preferred number of office days predicted employees' sense of ownership. This can inform employers on two aspects of the presence at the office: First, the time spent at the office is relevant to foster employees' attachment towards the workplace; second, personalizing a workspace is the sign that the employees have developed this bond with the workplace. Although there is certainly need for more research to further validate these findings, our study contributed to bringing more clarity on the topics of personalization and ownership which are interestingly intertwined with todays' changing work environment.

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How do workplace features at the office and at home determine workplace choice during a flexible workday?

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ABSTRACT

Hybrid work has emerged as a prominent trend, especially after the COVID-19 pandemic, providing employees with the flexibility to work either from home or in the office. Even though this work arrangement has seen a notable increase in adoption and attention in workplace studies, it remains

unclear what workplace designs employees prefer when choosing between home and the office on a 'flexible' day. A stated choice experiment was conducted with 1,495 employees from two Dutch municipalities between 15 August and 01 October 2023. The data was analysed with a multinomial logit model to identify the perceived utilities of workplace attributes, including seven office-based and two home-based attributes. The findings show that all workplace attributes, except aesthetics at the office, have a significant impact on workplace choice decisions on a flexible workday. Regardless of the type of workplace design offered at the office or home, home-workplace is somewhat preferred over the office-workplace alternative. The presence of direct colleagues at the office and the absence of others at home are found as the most influential factors favouring each workplace alternative. Smart technology implementations, gaming amenities, socializing events, and a single office room with one glass wall in the office-workplace can impact decision making in favour of the office. The results provide new insights into the workplace preferences of civil servants when choosing between working in the office or at home. Organisations and facility managers can use the results in decision-making in workplace policies and design for hybrid work settings.

Keywords

Workplace Preferences, Flexible Work, Hybrid Work, Smart Workplaces.

1 INTRODUCTION

Hybrid work became prevalent during and soon after the COVID-19 pandemic. Despite a growing number of workplace studies on preferences for hybrid work, it remains unclear what type of workplace employees would prefer when given the choice to work either at home or at different office design qualities. Understanding workplace preferences within hybrid work settings is vital for organisations to provisde optimal workplace environments to support their employees. Therefore, this study aims to understand the impact of workplace features on choice behaviour during a flexible workday where employees can choose between their home workplace and different office workplace scenarios. A stated choice experiment is conducted with office employees from the Dutch Municipalities Almere and Amsterdam.

1.1 Literature Review

The definition of hybrid work refers to the work setting where employees have some level of autonomy and flexibility in choosing the location where they perform their work tasks (Halford, 2005). The term relatively blends the traditional 'in-office' work with remote work, where employees can choose to work from an office or any other remote location (e.g., home, cafe, coworking place) outside their employers' premises.

Since a great number of employees experienced this work setting during the aftermath of the COVID-19 pandemic where it gained its popularity, several workplace studies on preferences for hybrid work were conducted. Some focused on experiences with working from home and showed its positive influences on individuals with improved work efficiency, work-life balance, and spending more time with their families (Hopkins & Bardoel, 2023; Ipsen et al., 2021). Conversely, other studies have underlined the potential disadvantages of working outside the employers' premises, such as the

gradual loss of corporate identity, a feeling of loneliness, work-home conflict, work intensification and other downsides (Bentley et al., 2016; Eddleston & Mulki, 2017; Oppong Peprah, 2024). To avoid the downsides of working from home, one recent study conducted a stated choice experiment to examine the factors that may attract employees back to the office. They showed the preferences for workplace features at the office may differ based on age, gender, type of employment, and administrative roles (Appel-Meulenbroek et al., 2022). However, they did not include any workplace features at home compared to those in the office alternatives.

Existing studies show that workplace features at home also impact individuals' work experiences and, thus, their preferences. For example, layout of the apartment (Kleeman & Foster, 2023), the size of the workspace (Cuerdo-Vilches et al., 2021), having a separate room for work (Ng, 2010), presence of household members (Sridhar & Bhattacharya, 2021) and having an ergonomic chair or external monitors (Gerding et al., 2021; Janneck et al., 2018) can influence individuals' work experience at home negatively or positively. So far, it still remains unclear how home-based workplace features are experienced and preferred by individuals compared to workplace features in an office within the hybrid work setting.

Regarding the office environment, studies have highlighted that the office-workplace enhances the overall workplace experience for individuals, especially through interaction with colleagues (Yang et al., 2022). Break-out spaces have been identified as crucial within office environments that support and facilitate such interactions (Tuzcuoğlu et al., 2021). Similarly, an open plan layout is also considered to improve communication and interactions; however, there can be potential negative effects like distraction and stress on users (Danielsson et al., 2015; Kim et al., 2016). To promote the enhancement of such interactions, organising socialising and wellness events in the office environment can facilitate office experience. In particular, these office events in hybrid work settings may help home-based workers to build relationships with others by informal communication (D'Oliveira, 2023; Goetzel, 2020). In terms of physical office feature, the appearance can influence office experiences and preferences. In particular, studies have shown potential psychological aspects of indoor green plants (Elsadek & Liu, 2021) and the use of colours (Elliot & Maier, 2014), and the presence of art may also evoke positive emotional output, or affect mood and well-being (Mastandrea et al., 2019). However, it is not yet clear how these office features influence individuals' workplace choice behaviour in hybrid work setting.

Technological advancements at home or at the office workplace can impact user preferences in terms of workplace use and experiences. Technology implementations in office-workplaces can improve office experience by offering new ways of workplace use with such applications as location-based user applications, booking possibilities and monitoring space use (Buckman et al., 2014; Jackowska & Lauring, 2021; Sinopoli, 2010). Individuals also prefer the state-of-the-art technology and design in their office environments (Tuzcuoglu et al., 2022). In the home-workplace, technology can help alleviate the possible downsides of remote work, such as social isolation and challenges in communication and collaboration (Green, 2020). Yet, it remains unclear what technology preferences employees have for their home workplace and how this would impact their choice for a workplace at home or at the office.

Overall, existing studies investigate workplace preferences; however, they lack insights on preferences for workplaces at the office compared to at home. Thus, this study aims to explore workplace preferences for home and office environments by identifying the trade-offs employees make when choosing their work location on a flexible workday.

2 Methodology

2.1 Experiment Design (Stated Choice Experiment)

A stated choice experiment (SCE) was designed and conducted on an online platform (LimeSurvey). SCE is chosen as it allows for systematic analysis of participants' preferences by presenting them with a series of hypothetical workplace scenarios and asking them to choose their preferred option. This method thus can reveal the relative importance of different attributes (workplace features) and the trade-offs that participants are willing to make. The online survey consisted of stated choice experiment and additional questions. In the choice experiment section, participants were instructed that they had two workday options: a flexible and an in-office workday. This paper focuses only on stated preferences during a flexible workday, where employees can choose where they want to work, either at home or in an office environment.

In the experiment, participants were randomly shown six choice questions for such a flexible workday and were asked to make a choice between the presented workplace alternatives. In each choice question, a hypothetical office workplace and their own home workplace (with two additional attributes) and a 'no preference' option were presented. Participants were asked to select 'no preference option' if they did not favour one workplace alternative over the other. A total of nine workplace attributes were selected for the choice experiment: seven for the office and two for the home (see Table 1). Only two attributes were selected to be presented in the home workplace (i.e., the presence of other people and innovative technology enhancements). For the workplace design at home, participants were asked to imagine their current physical workplace at their own home with these two attributes mentioned above to prevent the cognitive burden of respondents from imagining both the office environment and a new home workplace. The relevant information about their current workplace at home is gathered in the additional questions section.

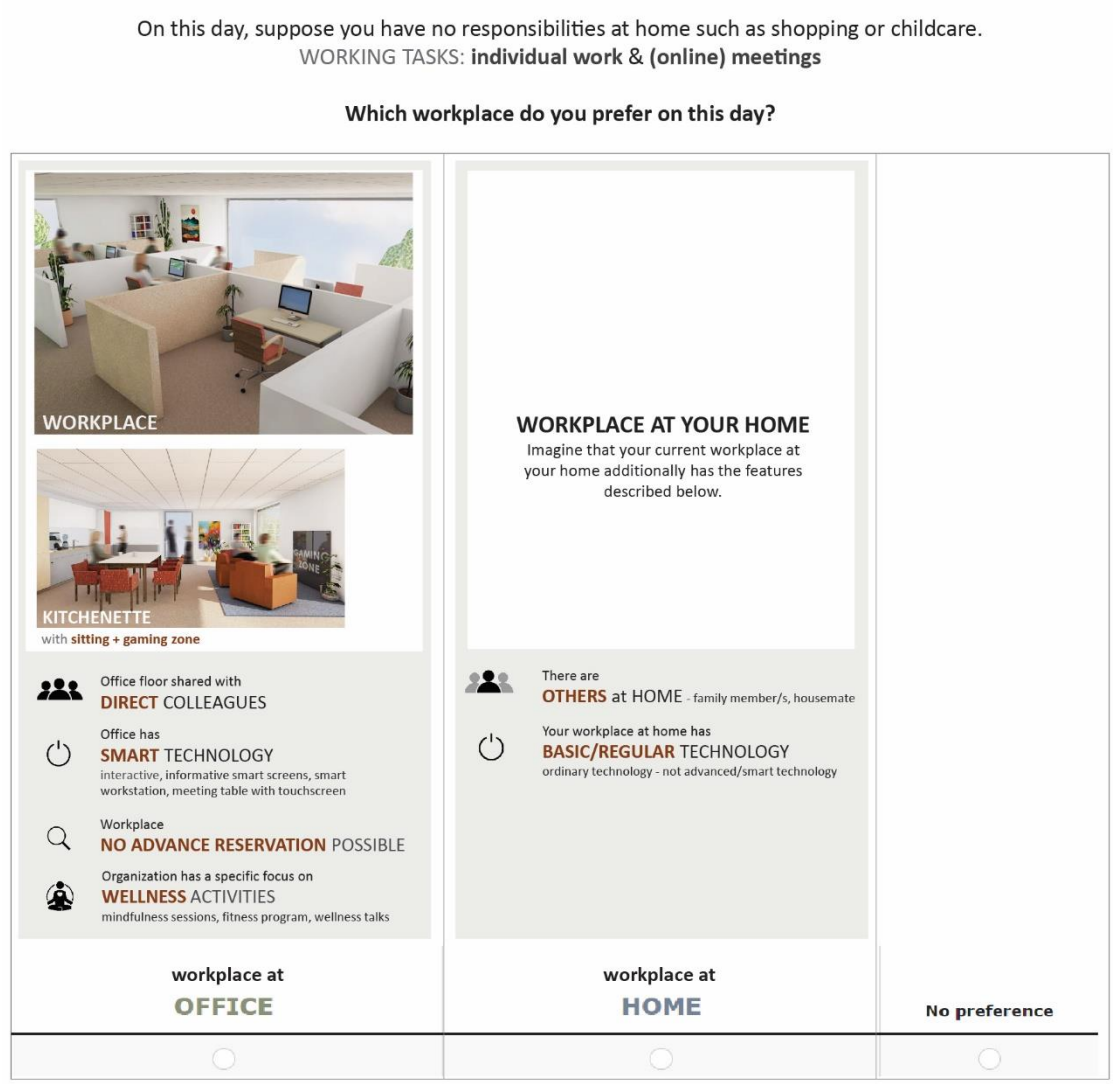
Table 1. Attribute selection

	Workplace Attributes	Level ID	Attribute Levels
	at the office		
1	Workspace type	1	Single-office with non-transparent walls
		2	Single-office with one glass wall
		3	Open office with half-wall separation
		4	Open office with no separation
2	Workspace access	1	(online) reservation is required
		2	Reservation is not possible
3	Aesthetic (comb. 3)	1	Plants, warm colours, art objects
		2	No plants, cool colours, no art objects
4	Other people	1	Direct colleagues
		2	Others
5	Break-out spaces	1	Kitchenette with standing tables
		2	Kitchenette with sitting area
		3	Kitchenette with sitting and gaming area
		4	Only kitchenette
6	Events	1	No-events
		2	Socialising focused
		3	Wellness focused
7	Innovative properties	1	Smart technology
		2	Basic technology
	at home		
1	Innovative properties	1	Smart technology
		2	Basic technology
2	Presence of others	1	Presence of others
		2	No presence of others

Three workplace attributes at the office (physical arrangement, aesthetic and break-out spaces) were depicted and presented as images to enhance the comprehension of the workplace alternatives with the other attributes presented as texts (see Figure 1). Additional definitions were provided for some attributes to improve clarity. For instance, smart technology at home was defined in the questionnaire, as employer supplies of equipment, such as digital tools, meeting equipment, and a fast internet connection, and smart technology at the office was explained as interactive, informative, smart screens, smart workstations, and meeting tables with a touchscreen.

Considering the selected workplace attributes and their respective levels (at the office and at home), there are $2^6 x 4^2 x 3^1 = 3072$ different possible combinations. To lower the number of combinations to be used in this study, a small fraction of 16 alternatives was generated using an orthogonal fractional factorial design using SPSS software. In this orthogonal design, the attributes systematically vary independently of each other; thus, the unique effect of each attribute can be measured.

Figure 1. Example choice set



2.2 Data Collection

Employees were invited to this research with an online link to the survey by their respective employers: the Municipality of Almere between 03 August and 16 October 2023 and the Municipality of Amsterdam between 11 September and 9 October 2023. The survey was provided in Dutch and took approximately 17 minutes. Responses were received from 1495 employees from both municipalities: 1258 responses from Amsterdam (out of approximately 20,000 employees) and 237 from Almere (out of approximately 2,000 employees). Overall, 58.7% were women and 39.4% were men; 29.8% were aged above 55, 26.6% between 46-55, and 22.5% between 36-45, while 21.1% were aged less than 35 (see Table 2).

Table 2. Demographics

	Sample (N = 1495)	Sample (%)
Municipality		
Almere	237	
Amsterdam	1258	
Gender		
Female	878	58.7 %
Male	589	39.4 %
Other / no answer	28	1.9 %
Age		
18-35	315	21.1 %
36-45	337	22.5 %
46-55	398	26.6 %
55+	445	29.8 %

2.3 Multinomial logit model (MNL)

A multinomial logit model (MNL) is used to identify the preferences and to investigate which attributes affect these preferences and to what extent. The model assumes all parameters are the same for all employees. Based on the workplace choices made by the employees in the experimental choice situations, the utility of each alternative was estimated using Nlogit6 software (Econometric Software, 2016):

$$V_{office} = \beta_1^{office} X_1^{office} + \beta_2^{office} X_2^{office} + \cdots + \beta_7^{office} X_7^{office}$$

$$V_{home} = \beta_0 + \beta_1^{home} X_1^{home} + \beta_2^{home} X_2^{home}$$

$$V_{none} = \alpha_0$$

X_k^{office} represents the k^{th} workplace attribute at the office and X_k^{home} represents the k^{th} workplace attribute at home. Parameters β_k^{office} and β_k^{home} measure the contribution of attribute *k* to the utility of the relevant alternative. β_0 refers to the base utility of the home alternative (without taking its attributes into account). Finally, α_0 represents the utility of the no-preference option.

Effect coding is used in the data analysis as it facilitates the comparison of the utilities to the overall mean. Therefore, the analysis provides insights into the relative importance of different attribute levels in driving workplace choice behaviour. In the case of three attribute levels, two indicator variables are needed. The first indicator is equal to 1 if the first level applies; similarly, the second indicator is equal to 1 if the second level applies. Two indicators are -1 in the case of the third level. If an attribute has two

levels, only one indicator variable is needed, with 1 for the first level and -1 for the second level. βs are estimated for each indicator variable of each attribute. The value of a βrepresents the part-worth utility of the corresponding attribute level. The part-worth utility of the last level is equal to the negative of the sum of the part-worth utilities of attributes' other levels.

3 FINDINGS

The MNL analysis revealed that respondents place great importance on workplace features both at home and in the office when choosing their work location. Almost all selected attributes for the office and home (except the aesthetic attribute at the office) have a significant role in choice decision of a workplace during a flexible workday (Table 2). The parameters (β**)** of the workplace attributes represent how they influence respondents' choice behaviour and, consequently, their workplace preferences. The attributes and levels are depicted based on their preferences (β) for workplace attributes at home and at the office (see Figure 2).

Regardless of specific workplace characteristics, respondents were more likely to select the home-workplace alternative over other alternatives, with the utility level of choosing the home-workplace being positive (β_0=0.573) and statistically significant at the 1% level. The utility of choosing "no preference" was negative (α_0=-2.445) and statistically significant at the 1% level, referring to that respondents were more likely to select one of the workplace alternatives, either at home or at the office, over the "no preference" option.

3.1 The utility of workplace attributes at the office

The analysis revealed that sharing an office floor with direct colleagues was the most influential factor in choosing the office alternative. Unlike other attributes, only the aesthetics attribute (plants, colours, art) at the office did not significantly influence decision regarding workplace selection.

Regarding the workspace type, respondents significantly preferred the single office with one glass wall (enabling visual interaction) and disliked the open office with half-wall separation. The single office option with non-transparent walls and the open office option without separation did not influence their workplace choice decision. Respondents preferred office workplaces equipped with smart technology, which significantly influenced their decision-making in favour of the office alternative. The type of workspace access was also an influential factor in decision-making. They disliked the workplace alternative requiring advanced booking. Lastly, respondents did not prefer the workplace alternative without any organised events. They preferred socialising and wellness events, with a slight preference for socialising over wellness. In the experiment, different types of kitchenettes referring to break-out spaces are examined. While either a "sitting area" or "standing tables" adjacent to the kitchenette did not significantly affect workplace choices, a “gaming area” adjacent to the kitchenette (with a sitting area) emerged as an appealing feature that positively influenced decision-making towards an office alternative.

Table 2. Output of MNL model

Attributes	Levels	β	Significance
At office			
Workspace type	Single office with non-transparent walls	0.028	
	Single office with one side glass wall	0.066	*
	Open office with half-wall separation	-0.076	*
	Open office with no separation	-0.018	
Workspace access	Advance reservation is required	-0.049	**
	No advance reservation is required	0.049	
Aesthetic (comb. 3)	Plants, warm colours, art objects	-0.025	n.s.
	No plants, cool colours, no art objects	0.025	
Other people	Direct colleagues	0.343	***
	Others	-0.343	
Break-out spaces	Kitchenette with standing tables	-0.017	
	Kitchenette with sitting area	0.060	
	Kitchenette with sitting and gaming area	0.082	**
	Only kitchenette	-0.124	
Events	No-events	-0.202	***
	Socialising focused	0.138	***
	Wellness focused	0.064	
Innovative Properties	Smart technology	0.076	***
	Basic technology	-0.076	
At home			
β_0	Constant of the home alternative	0.573	***
Innovative Properties	Smart technology	0.060	***
	Basic technology	-0.060	
Presence of others	Presence of others	-0.139	***
	No presence of others	0.139	
α_0	No preference option	-2.445	***
*Significance *** p < 0.01, **p < 0.05, *p < 0.1, n.s. = not significant*			

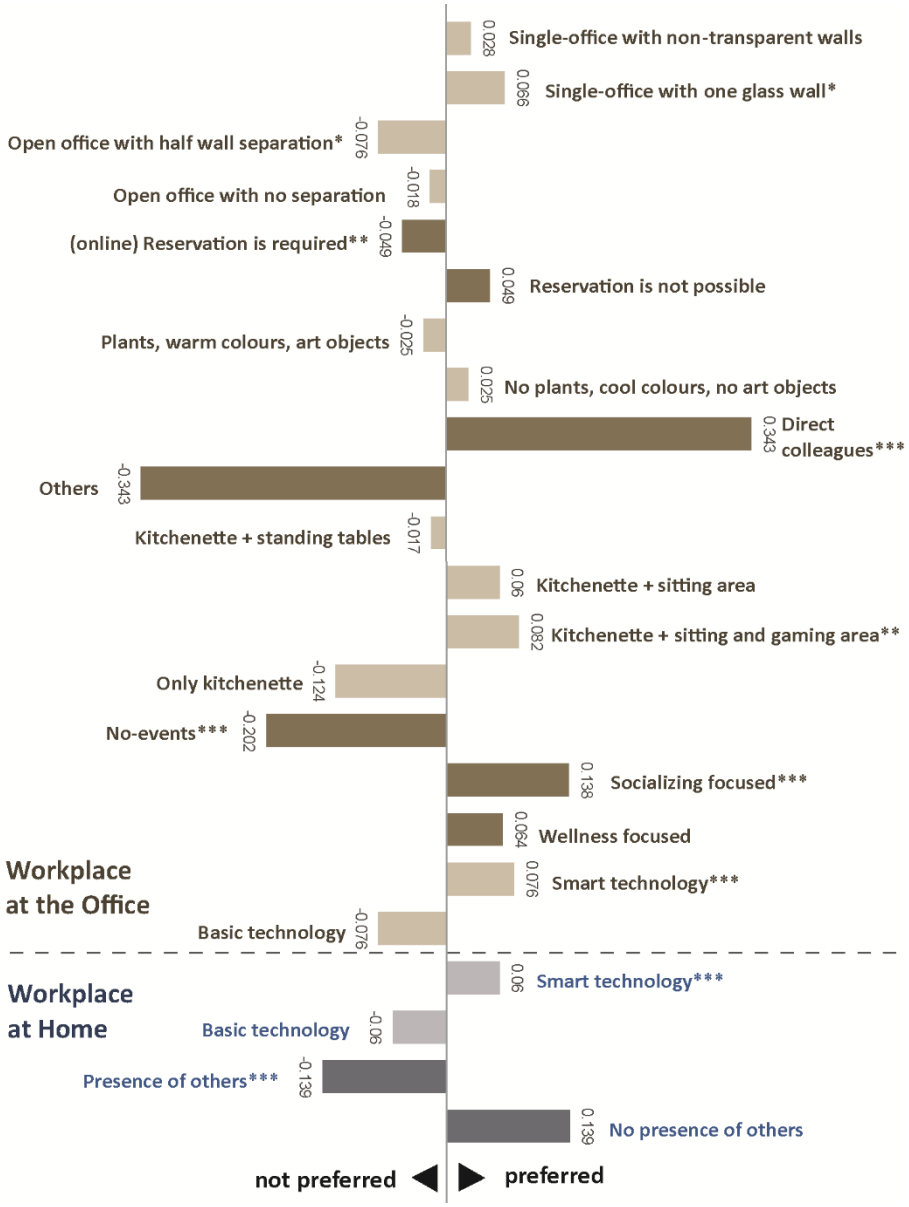
3.2 The utility of workplace attributes at home

This study examined two home-based attributes, both which were significant in influencing workplace choice behaviour. The findings indicate that having other household members present significantly discouraged respondents from choosing to work at home, suggesting that a solitary home environment increased the appeal of the home-workplace alternative.

Regarding the innovative properties at home-workplace, findings show that respondents preferred smart technology enhancements in their home workplace, which significantly influenced their decision-making in favour of working at home. This suggests that having basic technology in the home

workplace made the alternative less appealing. Furthermore, the innovation properties in the home alternatives had a comparable influence on decision-making as those in an office alternatives

Figure 2. Preferences (β) for workplace attributes



4 DISCUSSION, limitations and implications

This study aimed to explore how individuals choose a work location and how workplace features influence this choice during a flexible workday. The results revealed workplace features at home and at the office both had a significant influence on workplace choices. In this study, respondents were asked to consider a mix of tasks (individual work and meetings) when making their workplace choice. The

findings show that the home-workplace was somewhat more likely to be selected than the office workplace alternatives, regardless of specific workplace characteristics. This finding contributes to new insights into mixed-work-task-based preferences. Particularly, it is worthwhile to compare with a recent hybrid workplace study (Appel-Meulenbroek et al., 2022), which found that employees with individual-work tasks tend to prefer the home alternative, whereas those with meeting-based tasks prefer office alternative.

The findings indicate a favour towards choosing to work from home when other members of the household are absent. This preference could be linked to findings from a different study, which suggests that having family members present at home reduces work efficiency (Sridhar & Bhattacharya, 2021). In this study, respondents were presented with a scenario that excluded home responsibilities (e.g., childcare, post-delivery) to avoid assumptions about home-related obligations related to their personal circumstances. However, future studies can further explore the preference for the home alternative over the office alternative across different demographics, such as varying ages of children and other household members.

Regarding the office environment, the presence of direct colleagues is the strongest factor influencing the preference for working in the office over the home alternative, overshadowing all other workplace features examined in this research. This finding confirms the importance of social interaction and collaboration with direct colleagues in shaping individuals' preferences for office-based workplaces, aligning with current literature on socializing in office-environments (Tuzcuoğlu et al., 2021; D'Oliveira, 2023). The findings further suggest that having a gaming area in breakout spaces has a positive influence favouring the choice of the office alternative. This finding can be related to the desire for restorative and relaxation areas in the workplace, aligning with previous studies (Korpela et al., 2015).

In terms of workspace type in office environments, the findings show a strong preference for a single office with a transparent (glass) wall, which may imply a preference for a focused workplace while still maintaining a visual connection with colleagues. In contrast, open workplaces with half-wall separation were not preferred, which may be attributed to the negative experiences with noise in open office environments (Jahncke et al., 2011; Kim & de Dear, 2013). Future hybrid workplace research can further investigate preferences for open office environments, including factors such as noise levels, layout variations, and privacy considerations, in comparison with employees' home workplace environment. Furthermore, respondents strongly preferred workplaces equipped with smart technology both at home and in the office. This finding aligns with previous study where users prefer advance technology in office environments (Papagiannidis & Marikyan, 2020). On the other hand, concerning the use of technology for workplace booking, the findings revealed that individuals strongly dislike the necessity to book workplaces in advance (online). However, current studies have rarely explored preferences for workplace booking within a hybrid setting and the reasons behind them. Further research is needed to shed light on the factors influencing employees' preferences for booking options for the office workplace alternative. Additionally, further research into the psychological and social factors that contribute to workplace choice can provide a more comprehensive understanding of preferences in a hybrid work setting.

5 CONCLUSION

This study provides new insights into the workplace preferences of civil servants when choosing between working at the office or at home during a flexible workday. All workplace attributes significantly impact the decision-making process, except for the aesthetic features of the office. Regardless of workplace features, the home-workplace alternative has a clear preference over the office alternative. The presence of direct colleagues at the office and the absence of others at home are the most influential factors favoring each workplace alternative. Furthermore, this study shows that smart technology implementations, gaming amenities, socializing events, single office room with one glass wall in the office may attract employees to choose the office alternative. Overall, organizations and facility managers can utilize the insights from this study in shaping workplace policies and design for hybrid work settings. By understanding the trade-offs employees are willing to make, employers can create successful hybrid workplace environments.

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How office workers adapt their workplace – a social practice perspective

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Abstract

This study aims to understand how what office workers do in the accomplishment of work influences the arrangement of their workspaces. More particularly, the study examines the role of the office in the enactment of office work, the adaptability of the setup and adjustments made by office workers as office work unfolds. With office workers seeking flexibility on where and when work is to be done, there is a need to continually add to the existing knowledge of office setups by examining how setups accommodate work practices and the emerging roles the office fulfils during the accomplishment of day-to-day office work.

The study uses data collected from a situated case using ethnographic methodology to draw from the experiences of office workers in the office environment. The observed episodes of office work were analysed using social practice theory concepts of materiality and meaning to interpret the actions of office workers and the spatial-temporal adjustments to the office setup during the accomplishment of work.

The results show that though office work may appear to involve similar kinds of activities as it unfolds, it is dynamic in terms of the changing intentions of office workers, the objects used and the place and time of work. Additionally, although the setup where office work is accomplished seems static and ready for anticipated office work practices, as office work unfolds, office workers make adjustments to the office setup to support their intentions and preferences.

Keywords:

Office setup, office work practices, social practice theory, adaptability, ethnographic methodology

1. Introduction

Studies on the office environment show that office workers are more satisfied with an environment that they can control as well as the flexibility to choose the time and place of work (Haynes *et al* 2019, Appel-Meulenbroek *et al* 2018). The preferences of office workers for flexibility of time and place of work are observed both within and away from the office (Göçer *et al*, 2018, Chadburn *et al* 2019, Haynes *et al* 2019). Flexibility within the office viewed as a 'fixed-flexible work style' with the provision of unassigned and shared desks (hot-desking) as well as reduced use of fixed desks that in turn reduce the cost of occupancy as workers share desks (Göçer *et al* 2018, Endrissat and Leclerq-Vandelannoitte 2021). While office workers have been observed to value flexibility above other attributes such as ambience, indoor air quality and layout (Chadburn *et al* 2019, Haynes *et al* 2019), little is known about what office workers actually do in the office and the how the preferences they exercise in the quest for flexibility shape the office setup. Understanding the intentions of office workers and their preferences potentially gives facilities managers insights into the flexibility sought by office workers in the accomplishment of work and how they adapt the office setup.

The examination of what goes on in the office can provide insights to the everyday practices of office workers and the actions and rearrangements that take place as office workers carry out their tasks. To increase our understanding of how office workers adapt the office setup supports the adjustments made by office workers, this paper examines:

i. The emerging roles of the office setup as office work unfolds.

ii. How the emerging roles of the office are enabled and constrained by the office setup.

iii. How spatial-temporal rearrangements of the office setup support these emerging roles.

2. The role of the office

Various studies have observed that the physical setting of office work fulfils a wide range of roles that shape how work is accomplished (Endrissat and Leclerq-Vandelannoitte 2021, Skogland and Hansen 2017). These roles include providing corporate identity, supporting organisational culture and the differentiation of hierarchy, providing the physical address for the place of office work as well as an input to the process of production of office work (Harris, 2019; Kallio *et al* 2015, Khanna et al 2013). In addition to the office being used for the accomplishment of office work, office setups have been used as brand identifiers to differentiate one organisation from another and provide a venue for administrative and managerial control of the organisation's activities (Zhang *et al* 2008; Harris 2019, Halford 2004). Additionally, office spaces are set up as a venue for interaction, to aid monitoring and supervision and to provide amenities that support office work (Harris 2016, Sage and Dainty 2016, Halford 2004) while providing a place for association, identity, belonging and community to the office worker (Lu and Roto 2016, Tagliaro and Migliore 2022). Though offices are arranged to fulfil multiple roles, the traditional roles of the office may change as organisations and office workers exercise their preferences.

While various aspects of the office setup including office layout, provision of amenities, and indoor environment have been used to assess the suitability of the office setup (Rasheed and Bryd 2017,

Raskams and Haynes 2019), the perceived suitability of the setup for the roles it fulfils requires an understanding of the roles the office fulfils for different people. For instance, for managers, the office spatial arrangements enable surveillance aimed at supervising, monitoring and enforcing work regulations (Laclerq-Vandelannointte 2021) while for other office workers, the office may demonstrate norms such as hierarchy and regulations as well as expected interaction between office workers (Miller *et al* 2014, Skogland and Hansen 2017). Noting that office workers attach different meanings to office arrangements (Skolgland and Hansen 2017, Duffy *et al* 2011) the understanding of the office setup would be incomplete without incorporating the office worker's perspective of the role of the office setup and how they exercise their preferences.

3. Theoretical framework

Noting that social practices are connected to human life, are carried out using materials such as the human body and physical non-human objects, involve people as individual agents and have agency, structure and routines (Nicolini 2012, Schatzki 2010, Reckwitz 2002), this study views office work as a social practice that is part of the everyday life of office workers. Using social practice theory as a lens, elements of the theory are employed to conceptualise and interpret (Schatzki 2010, Shove *et al* 2012) what office workers are doing in the office and the setup in which office work is accomplished. By applying the social practice perspective that space is socially constructed and given meaning by the practices that are enacted in it and physically constructed by the material objects that enable those practices (Schatzki 2010), the research considered the office as the site of office work constructed by the practices enacted by office workers. Since space and how it is arranged is expected to change as practices change (Merriman et al 2012, Shortt 2015), the study observed in-depth office work practices, the objects used and the spatial-temporal arrangement of the objects that support those practices.

Noting that social practices are sets of spatial-temporal actions of ‘doings’ and ‘sayings’ that are organised by an array of understandings, rules and teleo-affective structures (Schatzki 2016) and are interconnected by other practices and material arrangement (Schatzki 2010), the study considers that office work practices do not stand alone but are interrelated with other practices of the office worker’s everyday life. Though elements of social practice comprise of materials, competence and meaning (Shove *et al* 2012), this study focuses on two elements namely; materials and meaning. Considering materials to be both human and non-human entities (Schatzki 2010), the material arrangements observed include the arrangement of objects in the office setup as well as the bodily movements of office workers. Further, since the meaning of different actions that constitute work and the significance of different times and places in a workday are socially constructed and understood in the context of the worker (Rosengren 2015), the study considers that those who carry out social practices know the actions they carry out, materials used, time and place, and the understanding of their ‘world’ and context of the practices.

4. Methodology

A wide range of methodologies including experiments, surveys, interviews and recording of physiological data of office workers have been used to examine the contribution of various aspects the office environment in the accomplishment of office work (Appel-Meulenbroek *et al* 2018). However, there is need to investigate in depth how office work is accomplished and how office workers interact

with the physical setup in a real-life setting to examine how office workers actions and the adjustments they make to the office setup. This study takes a qualitative approach that examines what office workers are doing in the office as their work unfolds and changes made to the office setup that supports it from the everyday experiences of the office workers who perform the practices. An ethnographic methodology based around a situated case was adopted. The data collection methods used included participant observation, structured discussions with office workers, semi-structured interviews and document analysis to investigate what office workers do on a day-to-day basis, drawing on their experiences. The qualitative approach allowed for observing and listening to the participants to gain an understanding of their everyday working lives and the purpose of what they were doing to interpret the meanings they attach to the social practices being observed (Bryman 2016; Silverman 2013). Though studying the everyday practices may not be representative of all practitioners and cannot be generalised, the findings from real-life context are useful in increasing understanding of relationships and explaining social life (Miettinen et al 2009; Feldman and Orlikowski 2011). This approach therefore provided means of obtaining explanations from office workers on their preferences and how they used spaces and objects to exercise their preferences.

To reduce the variations in organisational norms and work procedures that affect how office workers conduct their work, the participants for this study were selected from a situated case. The situated case is a power utility company based in Nairobi, Kenya,. with approximately 600 office workers in its head office. The head office occupies building A and B. The selected 10 participants from a situated case are office workers of different ranks are based in different floors of the two buildings. The situated case is where the first author works and was selected due to its accessibility of the field for participant observation. Though a single case can be used in a holistic research design that covers the whole organisation (Yin 2018), this study focused on a small number of participants providing a greater focus on the office work practices they enact. The in-depth observation focused on what office workers were doing to accomplish work, and observed the setting of work, the objects used and the spatial rearrangements that took place as work unfolded. The data from participant observations was captured in field notes and photographs. The field notes were further enhanced using data from informal discussions to develop a rich text of the setting and what office workers were doing. The semi-structured interviews were recorded and transcribed for analysis. The accounts given by participants were used to give context to the purpose of the work and the roles fulfilled by the objects and spaces used.

Themes were developed and relationships were drawn between the spatial-temporal arrangement of practices and the spatial-temporal arrangement of objects. The social practice concept of meaning and materiality was used to interpret the relationship between the roles fulfilled by the objects and the spatial-temporal re-arrangement of those objects. Noting that the site of the organization of practices is comprised of physical materials and meanings from the norms, purpose and understanding of the practices (Schatzki 2005 and 2017), the topic themes developed considered the material arrangements of the workspace and the meanings arising from the intentions and context of the work. Connections between meaning and material arrangements were further interrogated to identify linkages between what was going on, the objects used and the spatial-temporal arrangements of those objects.

5. Results

5.1. Emerging roles of the office setup

An observation of the setting shows that the office setup is prefigured with fixed and movable objects as detailed in the field notes hereunder.

The setting

14th floor of Building A is divided by a central corridor that forms two wings. The external walls are half glazed masonry walls with aluminium sliding windows covered by window blinds. Both sides of the central corridor open office setup arranged in cubicles of a maximum of 6 desks per cubicle arranged in 2 rows of 3 desks and a 1.5meter walkway between two rows running from the central corridor to the windows. The walkway provides access to the 6 desks and divides the space between the rows. The cubicles are marked with 1200mm high particle board desk divider that are covered in blue fabric that are sandwiched between adjoining desks. The desks on the same row are divided by half glazed 1200mm high desk dividers. All the desks on that floor are arranged facing the central corridor with the workers backs to the window. Participant 1 seats in an open office at the beginning of the southern side of the floor.

Participant 1 shares a cubicle with 3 other staff (CW1, CW2 and CW3). The cubicle only has 5 desks, his desk, an unoccupied spare desk that is front of him, and 3 occupied desks arranged in row across the walkway from him. His desk is a free standing 1600mm L-shaped desk with a right return and drawers. The right edge of the desk is along a full height partition that separates the open office with the room that precedes it. On his desk is a desktop computer, a telephone extension, folders and diaries and notebook. The computer central processing unit is on the edge of the desk and the screen and keyboard are near the centre of the desk's work surface. The computer cables have been passes through the desk grommet and others are passed along the edge of the desk near the wall.

Participant 2 sits in an enclosed office on the 4th floor of building B while Participant 3 sits in an open office on the same floor. The office is partitioned with full height double glazed partition. The double glaze is infilled with horizontal metallic blinds giving partial visual privacy. His office is the second room on the western side of the floor. The first room at is a meeting room and after his office is an open plan office accommodating his team and another department. Participant 2 sits with this back to the window. His seats on a 2meter long 800mm deep L-shaped solid wooden desk. The desk has a continuous 1600mm long 600mm wide left return, an under-desk fixed pedestal with 3 drawers and meeting module. This is not a typical desk but one that used to be allocated by senior managers as they are more prestigious. The material for the desk matches with full height half glazed cabinet. This by with the left edge seating along the full height glazed partition. Behind him is a pedestal with tea accessories and a whiteboard that is not mounted but leans on the wall below the window board. In front of him are two leather visitors' chairs. Leather visitors chairs are used in manager's offices. The researcher observed the participant from one of the visitor's chair.

Image 5.1: Extract of field notes describing the setting.

The fixed and movable objects are used to distinguish, amongst others, enclosed and open offices, the space allocated an individual workstation and shared spaces using attributes such as partition heights, distance between workstations. Since the fixed objects such as partitions are spatially static, during day-to-day use of the space they remain in the background playing the pre-assigned roles of

demarcating and defining spaces while concurrently supporting movable objects including desks, chairs, computers and telephones to perform their functional roles.

Through physical attributes such as their arrangement, shape, finish, size and type, certain objects such as desks and chairs differentiate the ranks of the office worker and uses of space. Objects such as partitions were used to communicate the access granted and visual and acoustic privacy to spaces. The arrangement of spaces guided office workers on their expected uses. For example, spaces assigned for supervisory roles had authority symbolised in physical attributes such as the spatial arrangement of objects, including their perceived quality and finishes. The data shows that the prefigured setup was arranged to fulfil the role of supporting the performance of office work and enforcing the rules under which the work is performed by enabling and constraining actions that take place in those spaces. These rules include how the spaces are to be used, the type of work to be carried out and the rank of office workers meant to occupy the spaces. The findings show that the prefigured setup not only provides spaces and objects for accomplishment of office work, but it also communicates, interprets and enforces rules under which such work is expected to be performed.

The study found that though the office setup serves to enable or constrain interaction between office workers in accordance with organisational rules, as the work unfolds the setup is assigned additional roles in support of office workers preference. For instance, office workers interviewed considered the partition as providing visual privacy between neighbouring co-workers and shielding the documents on their desk from spreading to neighbouring desks. However, office workers also considered the partitions as enabling interaction between themselves as the half-height partition allowed them to converse across the partition without leaving their desks lending the half-height partitions temporal meanings associated with collaboration and interaction in addition to the meanings associated with marking boundaries between spaces. Similarly, filing cabinets lined along the corridor were used not only for document storage and to define spaces but were also assigned additional roles of shielding office workers from shared spaces thus lending additional meanings associated with privacy.

While objects such as filing cabinets and desks within the workspace are assigned the prefigured roles of storage of documents and work surfaces, as work unfolded they were also used to reinforce the hierarchy of the occupant of the office as they served to differentiate workstations of office workers from those of their superiors. These additional roles assigned to the physical attributes of objects are not limited to enabling the accomplishment of work but also include the enabling of privacy and interaction preferences of office workers. Since the roles assigned were based on the meanings lent to the object, the study found that the physical attributes of objects must be ready to take on the meanings associated with the emerging roles they are assigned.

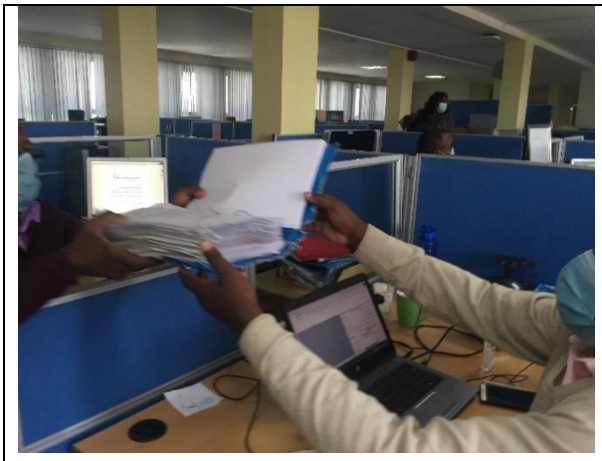	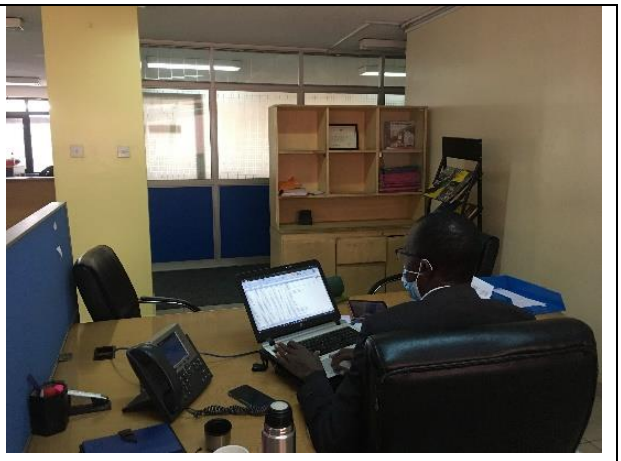
Image 5.2: office workers interacting over the half-height partition	*Image 5.3: Cabinet partially shielding office worker from the corridor.*

5.2. Temporal roles and spatial-temporal arrangement of objects

An in-depth observation of office work showed that the roles that the objects were assigned different roles as office worker's used objects to fulfil different intentions. For instance, while many office workers were working computers, they were doing different things: some were preparing documents; others were retrieving information and transmitting it to others; while their supervisors were checking or approving information.

A supervisor (Participant 1) was observed working on a computer with a co-worker standing next to him.

10.29am. Participant 1 pulls out the manager's folder and opens it. There are items for signature. A co-worker comes to clarify one of the memos. Participant 1 sees an error in it and gives it back to the co-worker. 10.43am. The co-worker (CW1) returns and standing at Participant 1 desk pointing at Participant 1's computer screen using his pen. Participant 1 uses his computer mouse to click on some buttons on the screen that CW1 is showing him. CW1 leaves.

Image 5.4: Extract of description of office work practices at participant's desk

Participant 1 explains what they were doing:

The memo [I was working on] is a confirmation that the estimate is ok and has been reviewed. They [subordinates] expect me to sign the memo and countercheck the printed copies of the estimates. Sometimes you check the soft copy and then they print and old version. So, I still have to check read through review and sign. It there is no issue then it's a short meeting (Interview with Particant1 March 2021).

The intentions of office workers assigned different temporal roles to the computer, and in turn the office desk as it served roles of being a place of supervision and document verification. While the actions and objects used did not change, the meaning of the practices being enacted were temporal and shaped by

the temporal roles being fulfilled. The desk used for concentration work becomes a venue for collaboration work while supporting supervision role as the office worker checks work that has been submitted by the coworker. Additionally, the computer used for solo work is used as a shared object used concurrently by CW1 and Participant 1.

In addition to temporal roles of objects being attributed to the temporal meaning lent by the practices being enacted, the results showed that practices shaped the material re-arrangements on and around the desk impacting spatial arrangement office setup. This was demonstrated in the rearrangement of additional chairs around Participant 2's desk as the desk is assigned the temporal role of a meeting area to support meeting practices that are enacted as office work unfolds.

8.28 a.m. A call comes through on Participant 2's mobile phone. He speaks on it as he motions CW4 seated in the waiting area, to come into his office. The partition of his office is glazed, and CW4 can see through the partition. Participant 2 uses his telephone extension to call Participant 3 to come to his office.
8.30 a.m. CW4 and Participant 3 enter the Participant 2's office. There is one available chair. One seats on the available chair and the other goes out and gets a fabric visitors' chair from the waiting area and beings it into office. They sit down and start the meeting.
8.35 a.m. A third coworker (CW5) joins the meeting and brings into the office a fabric visitor's chair from the waiting area.

Image 5.5: Extract of description of office work practices at participant's desk

The change of role of the desk from supporting concentration work and to supporting collaborative work is enabled by ease in which new roles can be assigned to objects based on their readiness to accept them thus enabling their spatial-temporal rearrangement to suit the unfolding work practices.

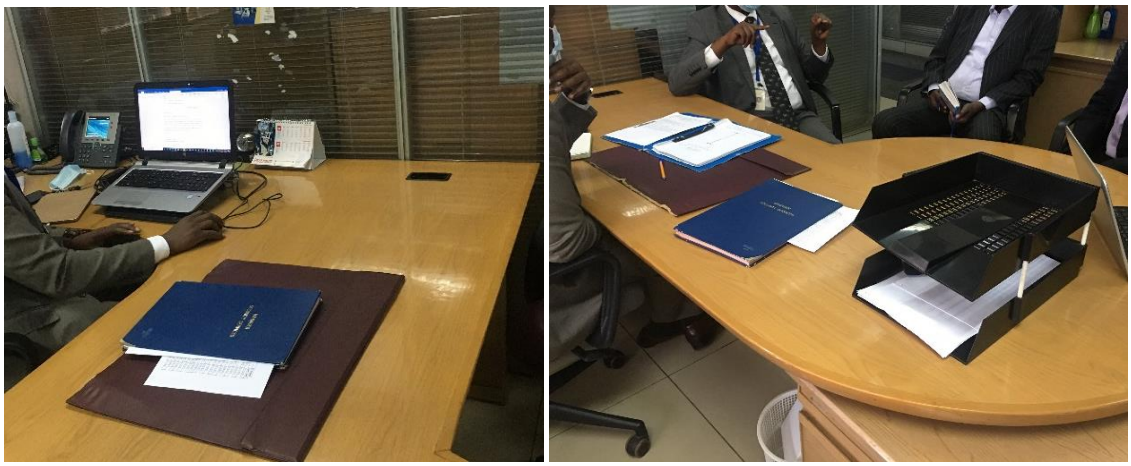

Image 5.6: different spatial arrangements of Participant 2's workstation before the meeting and during the meeting.

The data showed that office work is ever-changing and office workers assign roles to objects to fulfil the purpose of the work and their own preferences. By preferring to hold the meeting in his office,

Participant 2 assigned his office the role of a meeting venue. Participant 2 explained that *'This [office] is quite spacious, and I can have a meeting of 3 or more people..., and I don't need to book a meeting room so it's convenient for me'*. This illustrates that upon rearrangement to the office was able to take up the meanings lent by the meaning thus enabling it to fulfil the roles assigned by the meeting practice and in turn supporting the preferences of the office worker.

6. Discussion and Conclusion

From casual observation office workers may seem to be doing much the same things during the working day with their use of objects made apparent in the work that they do. However, when viewed more closely and through a social practice lens, the study shows that office workers with different purposes customised the office setup to suit their intentions that prioritised exercising convenience and preferences. While office workers seek to realise their preferences and rank highly the ability to make changes to their prefigured set-ups to suit them (Chadburn *et al* 2017, De Been and Beijer 2014), individual preferences vary from one office worker to the next (Hills and Levy 2014). The findings show that objects in the office setup support a wide range of roles and are lent temporal meanings associated with the intention of the office worker and the suitability of customisation is determined by its ability to take on the meanings lent by the practices being enacted. We take the view that spatial rearrangements of offices are made possible by the readiness of the objects in the setup to take new meanings that they are lent by practices as they unfold.

While the prefigured setup provides spatial arrangements that communicate and enforce work rules (Beyes and Holt 2020, Skogland and Hansen 2017), the findings show that office workers seek to incorporate their individual preferences by assigning additional roles to objects in the setup. Since the symbolic roles of objects include communicating the role of the space and the authority and supervisory role of the office worker (Sage and Dainty 2011, Hopwood 2014, Fahy *et al*. 2014) it can be argued that office workers are continuously customising their spaces to accommodate the prefigured roles while exercising their preferences. Noting Skogland and Hansen (2017) finding that designs and objects evoke certain responses based on how office workers interpret them, the study demonstrates that roles assigned to the setup are subject to the interpretation of the office worker. A closer look at office work practices shows that the office setup is prefigured to support various functional and symbolic roles but also enables or constrains the fulfilment of emerging roles that arise from office worker intentions and preferences. Since the roles assigned to the office setup are subject to the interpretation of the office worker, the office setup needs to be adaptable to accommodate customisation that supports a wide range of emerging roles that arise as work unfolds.

With new ways of working having potential to influence the role of the office, there is need for facilities and corporate real estate managers to continually examine what office workers use the office for. There is also need to continually examine what office workers value when working from the office and adjust to fast changing trends to keep the office relevant to the office worker. This will guide policymakers and managers of workspaces who seek to enhance to experience and productivity of office workers when working in the office.

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Session 1B: Architecture and Interior Design

Exploring the Link Between Office Workstation Design and Physiological Stress - A PRISMA Systematic Review

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ABSTRACT

While psychological stress in relation to the physical workplace environment is well-researched, physiological stress is relatively underexplored. This systematic literature review explores the relationship between workstation design and biomarkers of physiological stress among office workers. Since physiological stress biomarkers overlap with cardiometabolic health, this paper reevaluates current research on how workstation design influences cardiometabolic health and evaluates findings through the lens of physiological stress. Using PRISMA guidelines, papers were sourced from Scopus, PubMed, PsycINFO, and Web of Science databases, focusing on primary research. 54 papers were highlighted as relevant during phase one *screening for title and abstract review,* reduced to 20 papers included for analysis following *full review*. Research findings suggest that workstation design characterised by poor ergonomics, promoting sedentary behaviour or inactivity, is associated with a decline in cardiometabolic health and potentially an increase in physiological stress. These effects are evidenced by deterioration in cardiometabolic fitness, increased muscle tension, suboptimal posture, and heightened activity within the sympathetic nervous system. Findings suggest that deterioration of cardiometabolic health may increase acute stress reactivity, promote the activation of chronic stress

and diminish overall resilience against physiological stress. Conversely, active or ergonomic workstations, such as sit-stand desks and active chairs, promote improved cardiometabolic health, posture, muscle activation, physical activity, and may potentially indicate reductions in physiological stress. These findings suggest that workstations that can reduce sedentary behaviours, promote physical activity, and improve posture may reduce the immediate effects of physiological stress and enhance long-term resilience. However, studies are generally constrained by heterogeneity and unsuitable study designs to comprehensively assess the impacts of physiological stress. Despite promising indications that active workstations may mitigate physiological stress, further research is imperative to elucidate these observations. This review offers insights that may help workplace designers create environments that better support employee health and well-being.

Keywords

Systematic literature review, workstation design, physiological stress, cardiometabolic health, biomarkers.

Abbreviations

BMI	Body Mass Index
BP	Blood Pressure
EDA	Electrodermal Activity
EE	Energy Expenditure
HR	Heart Rate
HRR	Heart Rate Reserve
HRV	Heart Rate Variability
RHR	Resting Heart Rate
SAA	Salivary Alpha-Amylase

1 INTRODUCTION

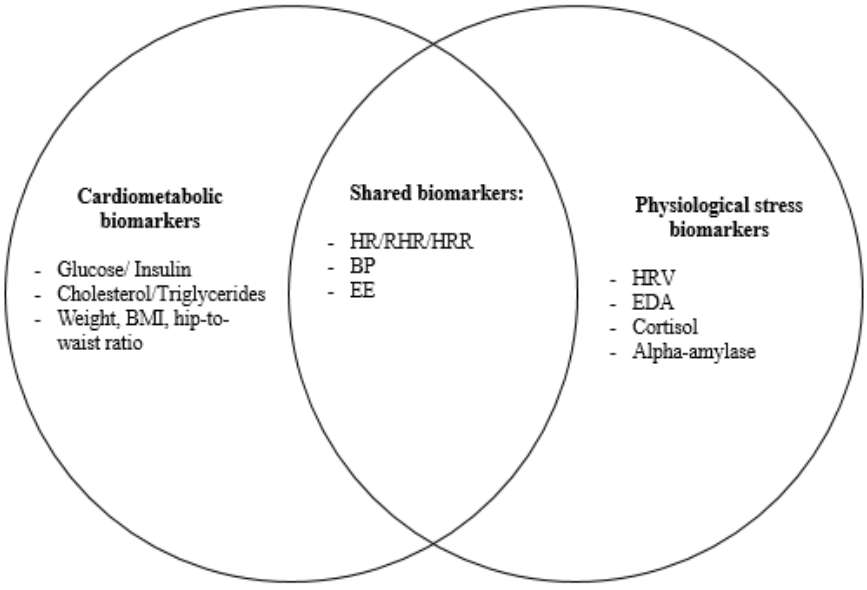
Working adults spend between 50% and 86% of their day sitting at their workstations (Katzmarzyk et al., 2009; Toomingas et al., 2012). The design of workstations can influence sedentary behaviour, poor posture and muscle tension (Dinar et al., 2018), which have been shown to contribute towards cardiovascular disease (Katzmarzyk et al., 2009), obesity (Silveira et al., 2022) and diabetes (Hamilton et al., 2014). In addition, there is an established body of research demonstrating that workstation design may also influence psychological stress (Huang et al., 2004; Sliter & Yuan, 2015). However, there is a scarcity of literature evaluating the influence of workstation design on physiological stress.

(Lindberg et al., 2018), despite indications that physiological stress is also linked to the onset of several health-related diseases (James et al., 2023).

Typical workstation designs often include a desk, chair, and computer screen designed for seated use. However, to address increased attention on sedentary behaviour at work, more active workstation options have emerged (Zhou et al., 2023a), such as sit-stand desks, which allow users to alternate between sitting and standing; standing desks, which are used exclusively for standing; and desks, which encourage continuous movement, like walking or cycling through built-in apparatus under a typical desk.

An existing body of research has demonstrated that traditional seated workstations with a static desk and chair drive sedentary behaviour and a lack of physical activity (Michalchuk et al., 2022), which has been shown to have a deleterious effect on several biomarkers of cardiometabolic health, such as heart rate (HR), blood pressure (BP), energy expenditure (EE) (Dupont et al., 2019b), as well as muscle activation and poor posture. Importantly, these biomarkers share underlying biological mechanisms with the stress cascade and, as a result, are shared biomarkers of physiological stress (Allen et al., 2014) (please refer to Fig 1). This means that workstation-related physical activity may also influence mechanisms of physiological stress. However, the link between workstation design and these biomarkers is predominantly examined through the lens of cardiometabolic health only, overlooking their significance as shared markers of physiological stress. Therefore, this paper will systematically explore how workstation design may influence physiological stress by investigating existing literature on workstation design and its impact on biomarkers of physiological stress.

Figure 1. Shared cardiometabolic and physiological stress biomarkers



1.1 Physiological stress and its biomarkers

Physical activity leads to increases in HR, EE and BP during periods of exercise (Chauntry et al., 2022). However, acute physiological stress relies on the same cardiometabolic system to fuel the body to

meet external demands, as indicated in the well-known mnemonic "fight or flight" (Tonello et al., 2014). In the case of both physical activity and acute physiological stress, the body will 'fuel' to respond to immediate threats or challenges, such that running for fun or running from a threat will initially elicit the same physiological response (Deuster & Silverman, 2013).

In the case of chronic physiological stress, this alarm system does not turn off, sending continuous signals to the body demanding 'fuel' when it is not required. As a result, chronic physiological stress is associated with elevated biomarkers that indicate 'fueling' the body, such as high HR, high BP, and dysregulated EE, as well as elevated rates of neuroendocrine biomarkers, such as cortisol (the 'stress hormone') and alpha-amylase (an enzyme that marks stress-reactive bodily changes) (McEwen, 2017). Chronically elevated levels of biomarkers can increase the tension and strain on the cardiometabolic system, causing an increased risk of cardiovascular disease (Gerber et al., 2016) and metabolic diseases such as diabetes (Sharma et al., 2022), as well as heightening reactivity to stress and reducing overall stress resilience (McEwen, 2017). On the other hand, increased rates of physical activity over the long term improve cardiometabolic health (Chauntry et al., 2022), resulting in lower HR, BP and more efficient EE. Guidelines demonstrate the necessity for physical activity to come from a combination of moderate-to-intense exercises (measured in EE of > 3 MET), such as from sports and leisure activities, as well as daily low-to-moderate exercise (measured in EE of 1.5> 3 MET) such as using active workstations (Dupont et al., 2019b). Use of active workstations can thus improve cardiometabolic health (Dupont et al., 2019b; Oye-Somefun et al., 2021), contributing to improved cardiovascular tone, which improves resilience and responsiveness to physiological stress (Zhou et al., 2023a). Together, this outlines the shared underlying biological mechanism between physical activity and physiological stress.

1.2 Rationale

As workplace-related stress rates rise, as indicated by EU-OSHA in 2013, there is a clear understanding of the correlation between workstation design and psychological stress. However, research on the connection between workstation design and physiological stress is lacking, revealing a gap in existing literature. This gap underscores the need for further exploration into how workstation design impacts physiological stress levels, including the potential benefits of active workstation design. This paper, therefore, aims to review existing literature regarding the impact of workstation design on biomarkers of physiological stress. In doing so, literature on the relationship between workstation design and cardiometabolic health will partially be revisited insofar as this concerns shared biomarkers of physiological stress and cardiometabolic health.

2 METHODS

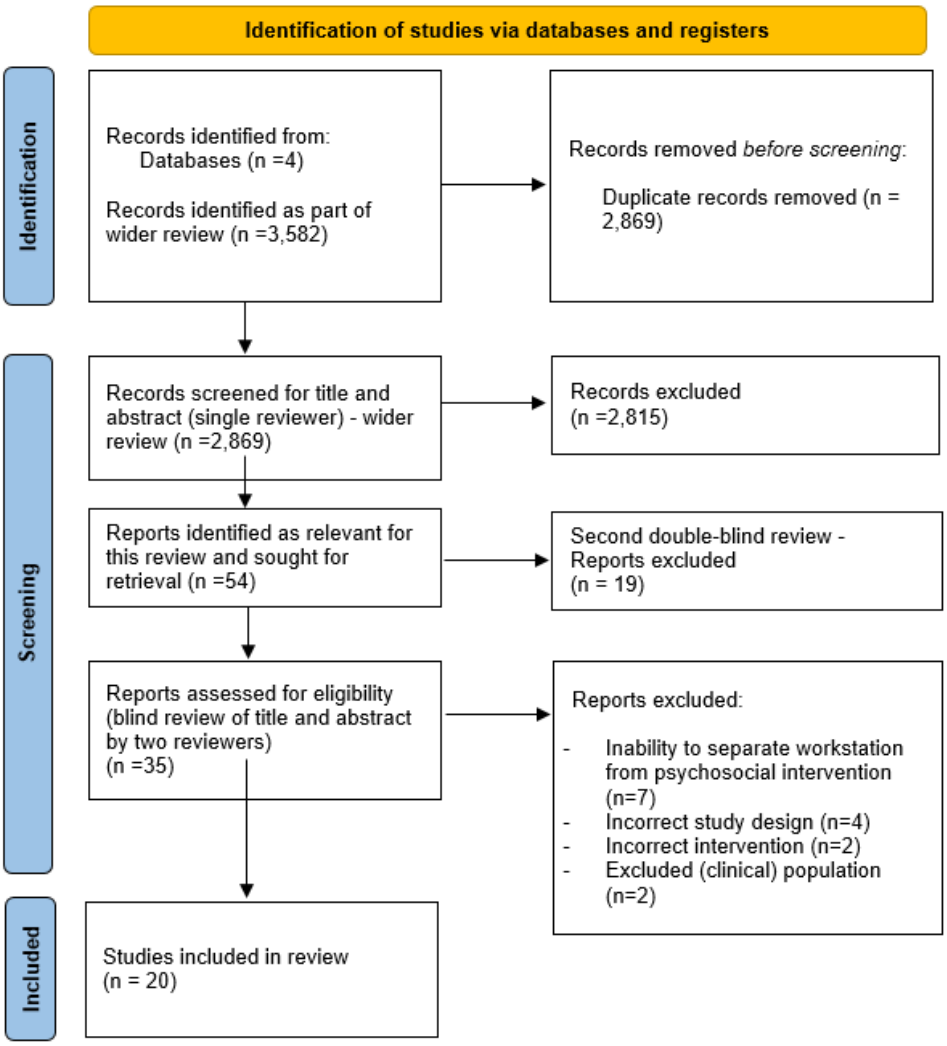
For this systematic literature review, the PRISMA (Preferred Reporting items for Systematic Reviews and Meta-Analyses) guidelines were used (Page et al., 2021).

2.1 Search strategy

Reviewed papers were extracted from Scopus, PubMed, PsycINFO and Web of Science databases between June 2023 and October 2023. Papers were chosen based on the inclusion of a comparative workstation design intervention and the inclusion of at least one biomarker of physiological stress,

including those shared with markers of cardiometabolic health. Biomarkers included within search terms are summarised in Figure 1 and are based on acknowledged indicators of physiological stress (Allen et al., 2014) and cardiometabolic health (Rykov et al., 2020). Studies with biomarkers were included even if they did not explicitly mention stress. Papers were limited to primary research, published between 1980 and 2023 in English. This review forms part of a larger systematic review, which found 3582 papers, reduced to 2869 after duplication removal. Phase one *screening for title and abstract review* reduced papers to 118, of which 54 were relevant to this review's search terms. The second phase, *blind screening by two reviewers*, reduced papers for *full-text review* to 35 papers, of which 20 were included for analysis, as summarised in Figure 2. Please see Table 1 For a summary of the reviewed literature.

Figure 2. PRISMA Flowchart of the selection process



2.2 Data synthetisation

Findings from papers were aggregated into Rayyan to allow for blind screening and synthesised via Microsoft Excel based on extraction fields such as (1) general information on the paper, its authors and publications, including country, journal and date of publication; (2) study design and duration; (3) sample size and population summary, (4) field or lab study; (5) characteristics of specific workstation design (6) biomarker of physiological stress, including whether stress was specifically mentioned.

Table 1. Summary of included papers by workstation intervention and biomarker

Authors	**Workstation Intervention**	**Biomarkers measured**	**Mention Stress**
Léger et al., (2022)	4 conditions: Sitting (control); two active chairs; stand	HR, EDA	Yes
Alyan et al. (2021)	Ergonomic vs non-ergonomic workstation	SAA, (Pre-frontal cortex (de) activation)	Yes
Brusaca et al., (2021)	6 conditions: sitting (control); computer work sit; computer work stand; non-computer work sit; non-computer work stand; walking work; walking non-work	HRR, heart rate variability (HRV)	Yes (nervous system activation)
Hervieux et al., (2021)	Sitting (control) vs cycle desk	HR, HR (max)	Yes (perceived stress)
Schwartz et al., (2019)	Sitting (control) vs stand-sit desk	HR, Salivary cortisol	Yes
Weston et al., (2017)	Ergonomic vs non-ergonomic workstation	HRV, (Muscle activation, posture, spinal compression)	Yes (nervous system activation)
Tang et al., (2020)	5 conditions: Sitting (control); bike low speed/intensity; bike high speed/low intensity; bike high speed/intensity; bike low speed/high intensity	HR, EE	No
Altenburg et al. (2019)	Standing desk vs stability ball	HR, BP, Cortisol, (Muscle activity)	No
Snarr et al., (2019)	3 conditions: standard chair (control), active ball; active balance chair	HR, EE	No

Nelson et al. (2018)	Three conditions: Sitting (control), stand; active ball	HR, EE	No
Schellewald et al., (2018)	3 conditions: Sitting (control); seated cycle; upright cycle	HR, EE	No
Caljouw et al., (2017)	Sloped surfaces; 6 conditions: sitting; standing; curled up; lean back; front low; front high	HR, EE	No
Gao et al., (2017)	Sitting (control) vs stand-sit desk	HR, EE, Cortisol	No
Gibbs et al. (2017)	Sitting (control) vs stand-sit desk	HR, EE	No
Botter et al., (2016)	6 conditions: sitting (control); stand; slow walk; fast walk; slow cycle; fast cycle	HR, resting HR (RHR), HR reserve (HRR), EE	No
Carr et al. (2016)	Traditional chair (control) vs Active chair	RHR, BP,	No
Koren et al. (2016)	3 conditions: Sitting (control); cycle low intensity; cycle high intensity	HR, EE	No
Graves et al. (2015)	Sitting (control) vs stand-sit desk	BP	No
Buckley et al. (2014)	Sitting (control) vs standing desk	HR, EE	No
Carr et al. (2014)	Sitting (control) vs stand-sit desk	HR, BP, EE	No

3 results

The analysis of 20 papers reveals a concentration in ergonomic-related journals (n=10), followed by sports medicine (n=6) and health management (n=4). The methodological approach favoured crossover studies (n=16). 14 papers were conducted in lab environments, five within field environments. One study used a lab and field environment (Schwartz et al., 2019). Variation existed in study duration with five studies with exposures of < 60 mins; nine studies of >60 mins but < 24 hours; one study had an exposure of between 24 hours and one week; two studies between one week to one month; and three studies of more than one month. The participant demographics were diverse, incorporating studies focusing on single genders (n=3 female-only; n=2 male-only) but mainly featured

mixed genders (n=15). The age of participants varied between 18 and 49.4 years. As weight and body mass index (BMI) influence cardiometabolic function (Díez-Fernández et al., 2015), the BMI of participants was often recorded and ranged from normal weight (BMI <25, n=7) to a mix of normal and overweight (BMI 25-30, n=9). Four studies did not specify participants' BMI. Confounding health conditions were controlled for in 16 studies, including a combination of musculoskeletal disorders (n=8), cardiovascular disorders (n=9), pregnancy (n=4), and metabolic disorders (n=5). Only three studies considered the potential influence of medication use, which may also confound cardiometabolic activity (Abosi et al., 2018).

Most workstation interventions focused on comparing traditional seated workstations to stand-sit desks (n=4), sitting versus cycling desks (n=4), and ergonomic versus non-ergonomic workstations (n=2). Additional workstation interventions included a combination of active chairs, such as balance boards, balls, and sloping surfaces (n=6), standing desks (n=12), and walking desks (n=2). The study designs had high levels of heterogeneity, encompassing 13 different intervention conditions, which resulted in a limited ability to compare findings across studies.

The studies predominantly focused on physical activity, reporting the effects of workstation design on HR and BP (n=20), EE (n=14), and biomarkers of physiological stress such as heart rate variability (HRV) (n=2) and levels of cortisol and salivary alpha-amylase (SAA) (n=4). A unique study by Alyan et al. (2021) paired near-infrared spectroscopy to analyse prefrontal cortex activation. However, recognising functional brain imaging as a stress biomarker remains contentious (Cordoner et al., 2023).

3.1 Effects of workstation design on cardiometabolic biomarkers

Results of cardiometabolic biomarkers reinforced existing findings relating to the positive cardiometabolic benefits of active workstations and physical activity (Dupont et al., 2019b) and are summarised in Figure 2. Most studies indicated that compared to traditional seated workstations, standing or active workstations increased cardiometabolic markers of EE, HR and BP through increased physical activity (n=18). Five studies found that standing or stand-sit desks increase cardiometabolic function versus sitting, but effects did not increase with more active workstations (Caljouw et al., 2017; Nelson et al., 2018; Schellewald et al., 2018; Snarr et al., 2018; Tang et al., 2020). Only two studies saw no significant change in cardiometabolic markers compared to traditional seated workstations (Carr et al., 2016; Graves et al., 2015). However, these studies were limited to overweight populations and short exposure times, which have been shown to confound measurements of cardiometabolic effects (Battista et al., 2021). Two papers found that increases in metabolic markers were positively correlated with an increase in greater muscle tension, suggesting that increases in metabolic activity result from increased use of the muscles in static positions and during exercise (Gao et al., 2017; Tang et al., 2020).

3.2 Effects of workstation design on biomarkers of physiological stress

Measurements of HRV, electrodermal activity (EDA), cortisol and SAA are well-established biomarkers of physiological stress (Dhama et al., 2019; Jambhale et al., 2022; Kim et al., 2018). Five papers reviewed these biomarkers and mentioned stress or activation of the nervous system, the underlying physiological mechanism of stress. Posture, muscle tension and spinal compression linked to non-

ergonomic workstations correlated with deterioration of HRV and increased activation of the sympathetic "fight or flight" nervous system (Brusaca et al., 2021; Weston et al., 2017), increased EDA and SAA (Alyan et al., 2021; Léger et al., 2022), all indicating increases in physiological stress when using traditional seated workstations. No increases in cortisol were found following an active workstation intervention (Gao et al., 2017). However, authors did not control for stress testing paradigm or activity, which may mean that the threshold was not met for activation of cortisol secretion (Hill et al., 2008).

4 Discussion

4.1 Enhanced muscle activation and cardiometabolic conditioning may decrease acute stress responses and boost stress resilience

Overall, this review demonstrates that active workstations, compared to traditional seated workstations, promote cardiometabolic fitness through increased physical activity, improved posture and muscle use, as evidenced by increased HR, BP and EE. Improvements in cardiometabolic fitness contribute to enhanced cardiovascular tone, which increases resilience to stress (Deuster & Silverman, 2013). This suggests that active workstations may also enhance long-term resilience to psychological stress. However, the lack of longitudinal studies on the impact of active workstations on long-term stress resilience indicates a gap in the research.

Two papers highlighted that a significant part of the increase in EE comes from switching between standing and sitting rather than continuous movement (Gibbs et al., 2017; Tang et al., 2020). This suggests that stand-sit desks may be highly effective for increasing EE and positively impacting cardiometabolic health and physiological stress. Many papers report no significant differences in cardiometabolic outcomes between active workstations, indicating that the shift between sitting and standing provides sufficient physical activity to improve cardiovascular tone. However, for the cardiometabolic system to enhance long-term stress resilience, EE needs to reach light-to-moderate (>1.5 METs) or moderate-to-intense exercise (>3 METs) or burn an additional 100 Kcal per day (Garber et al., 2011; Hill et al., 2009). Seven studies measured EE and found that active workstations met these MET or calorie thresholds during the experimental period. However, three papers either did not report this threshold or found that it was not met, suggesting that active workstations may not always promote cardiovascular tone and its associated benefits.

Physical activity is correlated with reductions in acute physiological stress response (Zschucke et al., 2015). Hervieux (2020) found that lower perceived stress was positively correlated with decreased HR during a 60-minute cycling meeting, with stress remaining low for up to four hours after the activity. Ergonomic workstations were associated with improved nervous system activity (Weston et al., 2017). These findings suggest that active workstations may provide immediate stress reduction effects that last beyond initial use. However, the short study durations (60 to 240 minutes) may not capture long-term strain that could lead to stress (Kar & Hedge, 2020). Additionally, perceived stress and physiological stress do not always align (Ginty et al., 2017), highlighting the need for both objective and subjective measures of stress, along with a post-activity period, to separate the cardiometabolic effects of physical activity from physiological stress.

Table 2. Sustained effects from traditional and active workstations

Biomarkers	Sustain effects from traditional workstations	Sustain effects from active workstations
Cardiometabolic biomarkers	↑ RHR, HR ↑ BP ↓ EE	↓ RHR, HR ↓ BP ↑ EE
Musculoskeletal (including posture)	↓ Muscle activity ↓ Muscle strength ↓ Muscle efficiency/tone ↑ Static posture ↑ Slouched, slumped ↑ Vascular constriction	↑ Muscle activity ↑ Muscle strength ↑ Muscle efficiency/tone ↓ Static posture ↓ Slouched, slumped ↓ Vascular constriction
Cardiovascular system	↓ Cardiovascular fitness/tone ↑ Vascular dysfunction ↓ Resilience to physiological stress	↑ Cardiovascular fitness/tone ↓ Vascular dysfunction ↑ Resilience to physiological stress
Physiological stress biomarkers:	↓ HRV ↑ EDA ↑ Cortisol secretion, dysregulation ↑ SAA secretion, dysregulation	↑ HRV ↓ EDA ↓ Cortisol secretion, dysregulation ↓ SAA secretion, dysregulation

4.2 Workstation-mediated posture may influence physiological stress

Research shows that posture can influence nervous system activation through changes in cardiometabolic markers (Altenburg et al., 2019; Alyan et al., 2021; Weston et al., 2017). The angle of the hips in a seated position can cause vascular constriction, reducing blood flow efficiency and increasing BP (Parry et al., 2019). A slouched posture is particularly harmful due to spinal compression, which restricts vascular and nervous system activity and may disrupt stress-related nervous system processes (Momen et al., 2009). Alyan (2021) and Weston (2017) found that traditional seated

workstations increased stress hormone SAA and showed poor HRV compared to ergonomic workstations, suggesting that improved posture can enhance nervous system activation and reduce physiological stress.

The wider literature reviewing the embodied psychophysiological effects of poor posture provides a further explanation of how posture may influence physiological stress: Participants identify their mood as worse in slumped, slouched postures (Nair et al., 2015). However, as no studies investigated the psychophysiological effects of stress and poor posture from workstation design, the findings remain to be proven.

4.3 Limitations and implications for practice

The findings suggest that increased physical activity and improved cardiometabolic biomarkers from active workstations can lessen acute physiological stress and enhance long-term resilience by improving cardiovascular tone. However, existing studies did not control for the shared effects of physical activity and stress response, so it is unclear if increases in markers like HR and BP are due to stress or activity. Future studies should assess physiological stress biomarkers after physical activity to distinguish these effects. Longitudinal studies are needed to evaluate the impact of chronic stress. Additionally, examining muscle activation and posture in traditional and active workstations will clarify their effects on physiological stress and potential negative impacts, like posture strain, over time. Finally, it is acknowledged that stress can be both physiological and psychological, and these constructs interact in a complex manner (James et al., 2023). Including evaluations of both could have provided additional insights not presented in these findings.

Despite these limitations, findings highlight the deleterious effects of traditional seated workstations on cardiometabolic health and the suggested impact on physiological stress. There are several implications for workplace design practice. While the findings suggest that the universal adoption of active workstations could be beneficial, studies report mixed experiences. Some studies indicate increased satisfaction (Hervieux et al., 2021), cognitive gains (Alyan et al., 2021), and uninfluenced productivity levels (Caljouw et al., 2017; Gibbs et al., 2017; Graves et al., 2015; Nelson et al., 2018). Conversely, other studies report decreased satisfaction, productivity loss (Koren et al., 2016; Léger et al., 2022), diminished fine motor skills (Carr et al., 2013), and issues such as excessive sweating from cycling desks (Koren et al., 2016). These findings highlight that the adoption of active workstations is likely to be influenced by individual preferences and specific tasks, which may limit their acceptance. Despite these conflicting results, the potential of active workstations to improve biomarkers of physiological stress and cardiometabolic health remains a critical consideration.

5 Conclusion

Further research is necessary to identify the optimal design of active workstations that balance physiological health with employee satisfaction and productivity. Workplace professionals should consider the long-term health implications of traditional seated workstations and actively participate in research and discourse to determine the most effective strategies for balancing employee health with organisational productivity through the implementation of active workstations.

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Knowledge Management between Service Design and Architectural Design in Workplace Development

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ABSTRACT

Purpose. This research explores the operational environment that facilitates interdisciplinary interactions between architects and service designers during user-centred development of physical work environments. It aims to analyse diverse project scenarios where service design is applied in real estate development and to deepen the understanding of the knowledge management challenges in these contexts.

Theory. The changing landscape of workplace development is increasingly using user-centred design methods, such as service design, to better understand the evolving needs of knowledge workers and improve the overall user experience in the workplace. Incorporating service design into workplace development has shown significant advantages, including enhancing core business value, supporting new work methodologies, achieving economies of scale, and promoting sustainable work environments. However, integrating a service design phase into an established workplace development process also presents a knowledge management challenge that has not been thoroughly explored.

Design/methodology/approach. The findings are based on 18 in-depth interviews of architects, interior architects, and service designers who practice service design in the real estate development context. These interviews were analysed using the open-ended Grounded Theory Method. Findings. Design projects employing service design are typically structured as a series of non- overlapping design phases or as concurrent design processes. Knowledge management is a significant concern, resulting in discontinuities in interdisciplinary interactions. The transfer of knowledge between service and

architectural design is influenced by the overall duration of the design process, the duration of each design task, and the temporal sequence of design tasks. The crucial role of temporal overlap in facilitating interdisciplinary collaboration between service designers and architects is underscored, thereby enhancing knowledge management. Originality/value. This research takes a practitioner-driven approach, leveraging comprehensive overviews of the field and various cases in facilities management. It provides a comprehensive understanding of the relationship between service design and architectural design in facilities development.

KEYWORDS

Architectural design, Service design, Facilities management, Knowledge management

1. INTRODUCTION

The COVID-19 pandemic has profoundly altered the landscape of work. Recent technological advancements have made remote work and collaboration more feasible, leading many knowledge workers to question returning to traditional office spaces (Kniffin et al., 2021). This shift has prompted facilities managers worldwide to reconsider the purpose and design of the workplace to make it more appealing. Researchers and practitioners are currently examining the evolving needs of workers in the post-pandemic environment, the new role of the office, and the future of the Facilities Management profession (Fiorentino et al., 2022; Nenonen et al., 2023; Tagliaro and Migliore, 2022).

However, amidst these discussions, the practical implementation of user-centred workplace concepts remains paramount. A longstanding challenge in real estate development, successful knowledge management is crucial for translating new visions into reality and sustaining them throughout the project lifecycle (Barrett and Stanley, 1999; Hudson et al., 1991; Jensen, 2009). The pandemic has underscored the significance and urgency of addressing this issue, highlighting the need for robust knowledge management practices in workplace planning and design.

The collection of crucial knowledge begins well before the design team is involved, typically led by facilities managers. The project inception process addresses the client's strategic and organisational issues, needs, and requirements (Smith and Love, 2011). Stakeholder participation, such as workshops, is a common feature of these early stages, helping to create a clear understanding of the project requirements, which both the client and user groups commit to (Heywood and Smith, 2006; Smith, 2005). In recent years, facilities managers have embraced various collaborative and user-centred design methodologies to better address user needs in architectural projects, such as Lean-Led, Evidence-Based, and Integrated Design (Forgues et al., 2018). Service Design (SD) has emerged as a key practice in shaping workplace development in Finland. For instance, it has been crucial in formulating and implementing innovative workplace concepts across Finnish government offices. These initiatives aim to enhance core business value, support new work methodologies, achieve economies of scale, and promote sustainable work environments (Rasila et al., 2014). While SD shows

considerable promise in this context, it may be challenging to integrate the specialised SD knowledge with the Architectural Design (AD) phase of workplace development (Trebilcock et al., 2006).

Previous studies have discussed the implications of integrating SD and AD in participatory design research and practices (De Rosa, 2022) through the lens of individual case studies. In contrast, our research is situated in the domain of facilities management. It takes a practitioner-driven approach, leveraging their comprehensive overview of the field and the various cases they have engaged with. Motivated by our central research question, "*How can collaboration between Service Design and Architectural Design be optimised to overcome knowledge management challenges and ensure their seamless interdisciplinary interactions in workplace development?"* we aim to explore the operational environment that facilitates interdisciplinary interactions between architects and service designers in participatory real estate projects. Our study has two main objectives: 1) analysing diverse project scenarios where SD is applied in real estate development, and 2) deepening our understanding of the knowledge management challenges in these contexts.

1. USER EXPERIENCE IN WORKPLACE DEVELOPMENT

The late 1990s marked a transformative moment in the field of workplace development with the introduction of the Experience Economy by Pine and Gilmore (Pine and Gilmore, 1999). Their groundbreaking concept revolutionised our understanding of customer value. It enlightened us about the potential for businesses to gain a competitive edge and achieve growth by offering experiences instead of just traditional goods and services. This idea quickly spread to the field of AD, which began to see cities as 'brandscapes' and buildings as destinations (Klingmann, 2010). In the field of Built Environment, researchers argued for a user-centred theory of the built environment to emphasise the influence of users' experiences, expectations, and emotions alongside the environment itself (Vischer, 2008). Workplace design also embraced this approach, moving away from spaces that solely supported work processes to creating employee experiences that fostered innovation, inspiration, creativity, and productivity (Nenonen et al., 2009). As a result, user experience has become a vital consideration in modern workplace design, shaping how we think about and plan our workspaces.

Introduced by Vargo and Lusch in 2004, service-dominant logic presents a novel theoretical framework in behavioural economics, emphasising the processes, patterns, and benefits of exchange over traditional outputs like goods (Vargo and Lusch, 2004). This shift has also profoundly influenced workplace development, reconceptualising offices as services rather than physical spaces. In 2018, Petrulaitiene et al. introduced the term 'servitization' to describe this evolution, highlighting a move from focusing solely on the physical attributes of workplaces to prioritising service-oriented experiences. Embracing ‘servitization’ can empower service providers and client organisations to deliver more adaptable, user-centric services, necessitating innovative workplace design and planning (Petrulaitiene et al., 2018). The COVID-19 pandemic has accelerated changes in workplace expectations, reinforcing the importance of adaptability and resilience in response to such disruptions. Despite these shifts, the principles of servitization continue to shape modern workplace strategies.

In Finland, SD has become a widespread tool in workplace design. SD is an approach that enables the simultaneous consideration of user experience and business requirements in workplace development (Mager, 2004). In this context, SD refers to designing or improving business services and processes to

make them more efficient, effective, and user-friendly for employees. Applying SD involves thoroughly understanding user and business requirements and creating an environment that facilitates a smooth workflow (Stickdorn et al., 2018; Stickdorn and Schneider, 2011). In the workplace context, SD can significantly enhance employee experiences, service delivery, and overall organisational performance. Studies have shown that integrating SD into workplace development can offer numerous advantages, including improving the user experience and promoting well-being at work (Rasila et al., 2009). By improving efficiency, fostering innovation, and improving service quality, SD can drive positive change and enhance organisational performance, instilling a sense of optimism in workplace development projects (Larsen et al., 2007).

However, previous research has shown that integrating new specialist knowledge into AD poses significant challenges. A noteworthy 2006 study by Trebilcock et al. conducted during the early stages of introducing sustainability to architecture, provides valuable insights into integrating SD and AD. The study explores sustainability knowledge integration, noting that design teams often preferred clear roles: architects focused on design while engineers (sustainability experts) conducted specialised analyses and provided guidance. Despite this structured approach, close teamwork facilitated effective collaboration, benefiting from established professional relationships among the experts studied. SD and AD collaboration resembles that of architects and engineers, each emphasising different aspects: SD on service delivery and user experience and AD on spatial and structural design. However, unlike architects and engineers with established relationships, SD and AD professionals still lack this rapport, potentially hindering seamless collaboration. Understanding these dynamics is crucial for optimising outcomes and managing the risks of introducing SD in workplace development.

1. METHODOLOGY

This research is based on a comprehensive series of interviews conducted with leading practitioners in SD in Finland's real estate development field. From November 2019 to March 2020, we conducted 18 interviews involving 19 participants, including one as a pair interview. Initially, prominent industry experts from Finland were selected based on their recognised stature and subsequently asked to recommend additional participants. Recruitment concluded upon achieving data saturation, indicated by no further names being suggested by participants.

Interview sessions typically lasted one to two hours. During these sessions, participants were extensively questioned about their utilisation of SD in real estate development, the intricacies of the design processes, the roles assumed by designers, their professional identities, prevailing attitudes, and the challenges encountered in their professional practice. All interviews were transcribed, and Table 1 summarises participants' educational backgrounds, professional roles, and the duration of their respective interviews.

Table 1. Interview data on participants' education, working roles, and interview lengths

Interview #	Education	Working Role	Interview Length
1	Interior Architecture	Service Designer	03:00:12
2	Graphic Design	Service Designer	02:17:06
3	Architecture	Service Designer	04:24:33
4	Architecture	Service Designer	02:16:37
5	Architecture	Service Designer	02:44:30
6	Architecture	Service Designer	01:30:58
7	Architecture	Service Designer	01:18:29
8	Interior Architecture	Service Designer	01:14:10
9	Interior Architecture	Client	01:57:12
10	Landscape Architecture	Service Designer	01:50:23
11	Urban Studies	Service Designer	02:16:46
12	Engineering	Service Designer	01:50:11
13	Economics	Service Designer	01:39:50
14	Architecture	Client	01:46:41
15	Interior Architecture	Client	02:10:07
16	Interior Architecture	Service Designer	01:46:04
17	Design	Service Designer	01:55:39
18 (double)	Architecture, Interior Architecture	Service Designer, Service Designer	02:09:24

It is important to note that the interviews were conducted before the COVID-19 epidemic. However, we are confident that the results are still highly relevant as real estate development and AD practices continue evolving and core principles of SD remain constant. This research provides valuable insights directly applicable to the industry's current state, making it a compelling read for professionals and academics alike.

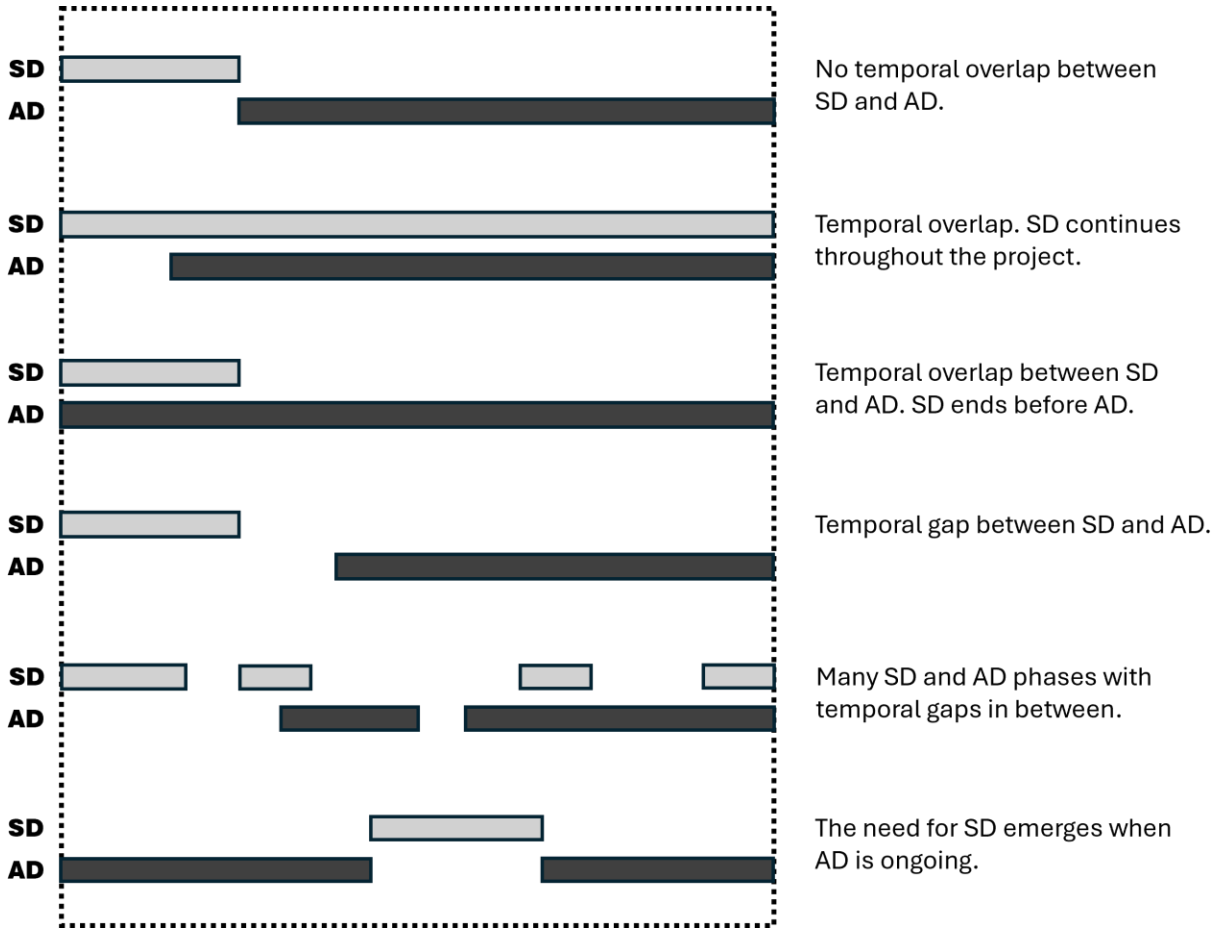
The material collected during the study was analysed using the open-ended Grounded Theory Method (GTM) developed by Strauss and Corbin in 1990. This method aims to generate a theory from the data itself. In our analysis, we focused on identifying the main concerns of the study participants, specifically regarding 'knowledge transfer' (in their words) between service designers and architects and the strategies they used to address those concerns. Our findings offer new insights into the field and significantly contribute to developing a more comprehensive theory, inspiring further research and exploration.

2. FINDINGS

Our research shows that knowledge management poses a significant challenge for service and architectural designers due to discontinuities in interdisciplinary interactions. These discontinuities are, in turn, defined by the organisation of the SD and AD tasks. We identified two primary organisational scenarios for the design projects under investigation. The first scenario involves a linear progression of design phases, where each phase ends before the next one starts (usually, the SD phase finishes before the AD begins). The second scenario involves concurrent design phases, fostering a dynamic and collaborative process with participation from different design teams. This approach can manifest in various ways, such as the AD phase overlapping with the SD phase without any time gap or the SD phase continuing throughout the project with varying intensity

levels. Figure 1 illustrates various ways to organise the SD and AD phases in interdisciplinary design processes.

Figure 1. The organisation of AD and SD phases in interdisciplinary design processes.



According to our findings, three factors determine the effectiveness of knowledge transfer from SD to AD: the overall duration of the design process, the duration of each design task, and the chronological order of these tasks.

The overall duration of the design process significantly affects knowledge transfer. In long processes, accumulated knowledge is at risk of being forgotten, dispersed, or lost due to personnel changes. Additionally, some knowledge may become outdated as project requirements and objectives change. On the other hand, rushing the process could impede effective knowledge transfer due to insufficient time. However, adjusting the timeline of design processes in built environment development can be difficult. Therefore, issues related to the overall duration must be addressed through alternative strategies outlined in our framework.

It is equally important to consider *the duration of each design task*. When the timeline is too short or too long, it can be challenging to retain knowledge. In tight timelines, basic AD tasks take priority over knowledge transfer activities, which may cause important insights to be overlooked.

Conversely, essential facts may be forgotten during extended processes, and documentation may become disorganised. *The chronological order of design tasks* has a direct impact on knowledge transfer. Both SD and AD tasks can benefit from being scheduled optimally to ensure that knowledge remains relevant and timely. While SD can be used at different stages of built environment development, specific task configurations have drawbacks; for example, integrating SD knowledge into an almost finalised AD is challenging.

Excessive time gaps within and between the SD and AD tasks hinder knowledge management. Tasks may be divided for various reasons, such as the need to comply with competitive tendering laws that require multiple contractors or to employ different consultancies with complementary expertise for larger tasks, financial or other reasons. However, task fragmentation increases the complexity of knowledge transfer operations and leads to knowledge loss.

The temporal sequence of design tasks, or the specific order in which tasks are carried out, directly affects knowledge transfer. A well-synced sequence can benefit both the SD and AD tasks, ensuring the relevance and timeliness of knowledge. However, it is crucial to provide no significant temporal gaps between project stages for optimal knowledge transfer, as these gaps can hinder the process.

Our research has shown that overlapping the SD and AD tasks can significantly enhance interdisciplinary collaboration between service designers and architects. This approach fosters a dynamic and collaborative process and improves the efficiency of knowledge management, offering a promising solution to the challenges we have identified. Typically, the volume of SD tasks is higher initially, while AD tasks become more intensive during later project stages. Overlapping SD and AD allows architects to participate in the SD tasks, gaining firsthand knowledge about user requirements. Service designers can periodically contribute during the AD phase, ensuring knowledge retention and supporting design decisions based on actual user insights. This process helps verify whether the design meets user needs through interaction, prototyping, and other design practic

3. DISCUSSION

In recent decades, workplace design has experienced a considerable transformation. The advent of the Experience Economy (Pine and Gilmore, 1999) initiated a paradigm shift in all industries, emphasising the significance of crafting memorable experiences. Service-dominant logic (Vargo and Lusch, 2004) reframed workspaces as services framed by a physical space. Consequently, workplace development has pivoted towards a model known as 'servitization' (Petrulaitiene et al. 2018), characterised by a service-centric, experience-driven approach that better caters to the needs of contemporary knowledge workers. This evolution necessitated innovative tools that reconcile user experiences with business requirements, thereby shaping workspaces that balance efficiency and user-friendliness. SD has emerged as a powerful tool to streamline workplace development (Rasila et al., 2014).

However, SD presents a new stage in workplace and facilities development. This stage is closely interconnected with AD, presenting opportunities for interdisciplinary collaboration. However, the practice and implications of introducing a new stage to an established design process have not been studied. Our investigation underlines the potential impacts and challenges of integrating SD and AD in real estate development.

Our research has identified knowledge management as a significant challenge in the collaboration between service and architectural designers. This finding is in line with previous observations about integrating specialised expertise (e.g. sustainability) in architectural practice (Trebilcock et al., 2006). Our research demonstrates that the knowledge management challenge arises due to the discontinuities in interdisciplinary interactions. We found that the successful transfer of knowledge from the SD phase to the AD phase depends on three factors: 1) the duration of the entire design process, 2) the duration of each design task, and 3) the sequence of tasks.

Upon analysing our data, we concluded that collaboration between service designers and architects is most effective when there is a temporal overlap between their tasks. This overlap enhances the overall efficiency of knowledge management. Our findings underscore the critical importance of interdisciplinarity and collaboration in effectively managing knowledge throughout the design process.

Building on our findings, we suggest that the optimal design organisation strategy would involve overlapping design processes. Such a strategy allows knowledge to be readily shared and transferred between the teams involved, enhancing overall project outcomes. It also addresses concerns regarding potential knowledge loss during the development process. It helps mitigate any discontinuity risk between the needs initially identified by users and the ultimate service experience.

While further research is needed to refine the application of SD in real estate development projects and to develop a more comprehensive theory on this topic, our study presents an important step in understanding the nuances of deploying SD in workplace development. The insights gained through our research contribute towards providing a smoother, more synchronised workplace development process, thus ensuring a more user-centred and gratifying result.

4. CONCLUSION

The rapid evolution towards a more service-centric, experience-driven model in workplace design has created a need for innovative tools that successfully integrate user experiences with business requirements. Our research emphasises the potential of Service Design as a significant instrument, especially when skillfully incorporated into the process from its inception to post-occupancy and integrated with Architectural Design. However, these observations also bring forth challenges, the most notable being knowledge management, particularly in interdisciplinary collaboration. Effective knowledge transfer requires careful navigation of the design process and its duration. Our findings suggest that a more prolonged process duration may risk knowledge loss, while a process that is too rushed may not allow time for efficient knowledge transfer. The issue of temporal sequence also stands out; significant gaps between stages can obstruct effective knowledge transfer.

We propose an optimal design strategy that involves temporal overlap of SD and AD tasks. This strategy can provide a platform for ongoing interaction and collaboration, fostering a smooth knowledge transfer and ensuring the design fully meets the user's needs. By doing so, not only is there a continuous dialogue with users encouraging them to participate in the design process, but it is also a safeguard against the potential loss of pivotal insights in the later stages of architectural planning.

In essence, the implications of a service-centric approach in workplace design call for strategies that maximise user experience and ensure the successful knowledge transition in an increasingly interdisciplinary field. Our findings actively engage these aspects and advocate for the seamless integration of Service Design throughout workplace development projects.

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Exploring the Decision-making of IAQ Interventions in post-covid Australia

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ABSTRACT

The COVID-19 pandemic posed a significant challenge for facilities managers to manage the workplace with Facilities Management Interventions (FMI) for infection control. This paper explores the decision-making of FMI implemented for infection control in post-COVID Australia. Through 41 semi-structured interviews with facilities managers, health and safety managers, and infection control experts, we examined the decision-making process and factors related to indoor air quality (IAQ) interventions. Thematic analysis identified six main factors determining FMI decision-making: compliance, occupant impact, organisational characteristics, financial characteristics, building characteristics, and environmental impacts. This research reveals the challenges for FMs in adapting existing workplaces to meet occupant health and energy efficiency goals. It contributes to workplace research and benefits scholars and practitioners who design and manage workplaces in the post-pandemic era.

Keywords

Facilities Management, COVID-19, occupant health, IAQ, compliance

1 INTRODUCTION

Healthy indoor air has been acknowledged as a human right by the United Nations since 2022(Andorra et al., 2022). However, before the COVID-19 pandemic, respiratory infection prevention was significantly overlooked in building design and operation(Morawska et al., 2021), and research on indoor air and ventilation primarily focused on occupant thermal comfort, cost control, and energy performance. The pandemic reveals that many existing public buildings are unsafe shelters for occupants regarding respiratory infection control. In response, Facilities Management Interventions (FMIs) have been implemented to control indoor respiratory transmissions through airborne, contact, and fomite routes. These interventions include air-related measures, cleaning and disinfection, and occupant density controls to reduce contact transmission(Zhang et al., 2022). However, the decision-making drivers for organisations to implement these interventions remain unclear. This paper evaluates the decision-making factors for air-related interventions to mitigate respiratory airborne transmission in existing office and educational buildings. It focuses on three primary practices implemented in Victoria: (1) CO2 monitoring, (2) air ventilation, and (3) air filtration (Zhang et al., 2024).

Previous studies on FMI decision-making have mainly focused on building maintenance. For instance, Besiktepe et al. (2020) investigated the decision-making process for building maintenance with a survey study in the US, identifying and ranking eleven factors: (1) code compliance, (2) condition, (3) cost, (4) duration, (5) funding availability, (6) health and safety, (7) impact of failure, (8) occupancy, (9) scheduling, (10) sustainability, and (11) strategic business planning. The study revealed that "past experience and expert opinion" was the primary decision-making approach in building maintenance, with "visual inspection" being the most common facility condition assessment method (Besiktepe et al., 2020). Additionally, Cooke et al. (2021) classified decision-making variables into four groups: (1) decision variables (alternatives), (2) situational variables (external factors), (3) attribute variables (consequences of the decision), and (4) benefits associated with the attributes from the decision (Cooke et al., 2021). Despite these studies, evidence-based research on FMI decision-making remains limited. This paper utilises qualitative data collected in post-pandemic Australia regarding IAQ interventions, providing a real-world example of FMI decision-making.

2 Methods

2.1 Study context and ethics approval

The data used in this paper was part of a project focused on managing indoor respiratory infections with FMIs. The study includes an online survey distributed to building occupants and interviews with key stakeholders. All procedures in this study were approved by the University of Melbourne Human Research Ethics Committee (ID: 24664). This paper presents findings from the interview data. The interviews were conducted from Dec 2022 to Mar 2023, one year after the last lockdown in Melbourne. While COVID-19 has had a worldwide effect, Victoria has a unique setting regarding government interventions and guidelines during the pandemic. The State of Victoria witnessed six lockdowns spanning two years, implementing commercial building closures and stay-at-home orders. Since Dec 2021, the Victoria government has issued Pandemic Open Premises Orders (Department of Health, 2021) to facilitate office employees

returning to the workplace. Victoria government issued COVID-19 ventilation advice to recommend that building operators improve ventilation(Department of Health. Victoria, 2022).

2.2 Semi-structured interviews

This paper reports data from the qualitative investigation, in which key stakeholders working with office and education buildings were interviewed about how they have implemented FMI for respiratory infection control and improved occupant experience. All interviews were semi-structured following a protocol. A purposive sampling technique was adopted to reach out to potential participants for the study. 155 industry practitioners and experts in infection control were invited to participate in the research, and 41 individuals from 13 organisations finally consented to participate in the interview. All the interviews were conducted through Zoom. All interviews were audio recorded and then transcribed for subsequent analysis. The average interview duration was 45 minutes. The interviewees are asked about their current position and their years of experience. The participants include 25 FMs, 6 Health and Safety Managers, 4 business stakeholders, and 6 infection control experts (N=6). 80% of the participants have more than ten years of related experience.

2.3 Data analysis

The interview transcriptions were imported into NVivo for thematic analysis following the guidelines given by Braun and Clarke(Braun & Clarke, 2006). First, the first author repeated the data reading for immersion to achieve a thorough understanding of the data. Second, themes and sub-themes were developed based on the data to reflect the research questions. Third, the authors reviewed and refined the themes to ensure they were clear and distinctive.

3 Findings

3.1 Air filtering decision-making

- **Occupant request**

Many participants have discussed that air purifiers were installed in 2022 on occupants' requests. For instance, participant 4 shared the experience as follows:

"They (occupants) often just request a purifier. "Could you supply me with an air purifier?" we're happy to do that and support that request, but it did not always mean it was an engineering decision. It could sometimes be psychological support, or you know that people feel like there is something there to help protect them. "

Many interviewees spoke of the "psychological effect" of air purifiers on reducing occupant "perceived risk". For instance, participants 19 and 24 shared the following:

"If people see an air purifier in a room, it might make them feel more comfortable. Realistically, when there's one in a lecture theatre, it's not actually serving the purpose. It's not actually helping. It's not suitable for that volume. But the individuals might feel better just because it's there." (019)

"It really is about that psychological mindset and creating a safe environment that's in line with what people would expect about our brand and reputation, like making ethical choices, if that makes sense. That was really the driver. "(024)

The interviews show that FM also considered mental health, such as “anxiety” and “stress”. For example, participant 31 reflected as follows:

“Of implementing throughout the outcomes all the installations we’ve done, all the systems we’ve done. It’s a healthier building. We’ve found that occupants of these buildings have a greater level of being comfortable within these buildings. So, there’s less anxiety and less stress involved.

- **Funding availability**

Other participants spoke of installing PACs based on available funding. For example, participant 33 shared that air purifiers were installed because of the change in space use and funding available as follows:

“With (building name), the Department of Education supplied three purifier units with HEPA filters for the teaching space down in the basement of (gallery name). And recently, one was deployed here to the (building name) because it’s now being used as a teaching space.”

- **Energy concerns**

Participants also discussed the environmental concerns regarding additional PACs, which did not affect the decisions made to install PACs. For instance, Participant 8 had the reflection below:

“All of a sudden, you have got thousands of those devices (air purifiers). They all have to be plugged into a power supply so they will consume energy. They are portable devices, so once you have them to be tested and tagged as electric devices and made it to make sure that they are safe. They’ve all got a filter, which arguably might have to be replaced twice or three times a year, so somebody’s got to replace it. The filter is effectively a contaminated item. It has to be disposed of. That comes with both the labour and supply costs, along with environmental costs that go to landfills. “

3.2 CO2 monitoring decision-making

- **Not a compulsory requirement**

Based on the interviews, FMs perceive CO2 monitoring as neither required by the current building code nor acknowledged by the government bodies as an effective measurement of ventilation. For instance, participant 25 shared the experience as follows:

“...none of them(codes) have ever prescribed any requirements for environmental monitoring. We’ve just been required to consider health and safety to reduce the risk of transmission. There’s never been any in Victoria that we have already prescriptive requirements around ventilation to say you had to achieve this standard. “

Similarly, participant 4 shared an experience in handling IAQ complaints made to the Victorian Government Workplace Safety Authority, which shows that the focus of the authority was to check whether the mechanical ventilation systems can deliver air exchange of 10 meters per second per person.

“We did have an experience where there was a complaint (about IAQ safety of the workplace) and made to the WORK SAFE, which is, you know, the Victorian Government Workplace Safety Authority. They (inspectors) were only interested in the engineering capacity of the ventilation

systems in these spaces. So, all this great work we were doing around IAQ monitoring and CO2 levels, they weren't interested in any of that. They just wanted to know what was against the official standards of 10 meters per second per person. They wanted evidence that our systems would deliver that... I suppose it was quite a legal perspective, but it was also an engineering requirement. They just wanted to satisfy that. "(004)

- **Building characteristics**

Based on the interview, the main driver for CO2 monitoring was to identify poorly ventilated areas quickly to meet the ventilation code requirement. Thus, CO2 monitoring technology was adopted as a fast solution for risk assessment since ventilation measurement with experiments was time-consuming. Therefore, the building portfolio's complexity and the buildings' age contributed greatly to the decisions on CO2 monitoring. As explained by Participant 022, "They (CO2 monitors) are to identify the higher risk, and then trigger a further response or a localised, you know, assessment and response. "Participant 007 shared the experience as follows:

"We started rolling out CO2 as a proxy for ventilation because we realised it would probably take us a couple of years to physically measure (ventilation) in every space".

Some participants spoke about CO2 monitoring as a practice to reassure occupants in old buildings. For instance, Participant 25 shared the comments as follows:

"We made a commitment to put CO2 monitors into all teaching spaces. The goal was to provide some confidence that we were just relying upon a standard that was built some time ago, but we were also going to monitor its actual operation. "

- **Funding**

For some organisations, the CO2 monitoring project was funded by the pandemic response funding. For example, participant 24 compared the cost of the CO2 monitoring project with the massive investment in consumables during the pandemic to procure rapid test kits, facial masks, sanitisers, etc., to make the point on the cost-effectiveness of CO2 monitoring as follows:

"Backing January 2022, when you couldn't get them (rapid test kits, facial masks, and sanitisers, etc.) anywhere, we invested two and a half million dollars in that, to get again reducing barriers for people to be able to access and test. So when we're looking at what the options were, you know, (experts) certainly came into meeting conversations around air quality, and you know, expertise presenting to the decision makers saying that this (CO2 monitoring) is what actually we need to do. And then, if I can even call it a business case. And I remember there being quite an interest in realising that it wasn't that much of an expensive intervention it could, compared with what people were thinking to make that sort of investment."

By contrast, for organisations considering CO2 monitoring as part of the ventilation system O&M project, the justification for the project investment appeared to be challenging. For instance, participant 7 reflected:

"That (CO2 monitoring) is an expensive thing to just to start, to identify where the need (ventilation improvement) was. So, do you spend money on identifying where the need is? What do you just simply jump in and do something which is okay but not great? And so, you know, if you put that

back into a budget context, you say, “I know I’ve got 2 million dollars. Do I spend my 2 million dollars working where I can best spend my money?”

- Organisational characteristics

Educational organisations were more likely to implement CO2 monitoring to align with their value proposition for students and educators. For instance, participant 5 shared the following:

“if you can tie it back to the value proposition, you know, where a university, if CO2 levels are above 800, your ability to make a strategic decision is very impaired.”

Moreover, FM educational institutions tended to be more influenced by expert advice and were willing to implement best practices. For instance, participant 10 shared the comments as follows,

“We were very proactive, rolling out a large number of CO2 sensors that connect to our smart campus infrastructure so we can monitor CO2 levels, which is a sign of poor air quality. You know the air exchange is not enough. So, we’ve probably got one of the largest CO2 monitoring infrastructures and the whole state, if not Australia.”

3.3 Air ventilation decision-making

- **Compliance requirements on ventilation**

Based on the interviews, FMs perceived it was easy to comply with the building code on ventilation rate requirements without any interventions. However, it was time-consuming to collect the ventilation rate data as evidence. For instance, Participant 11 shared the experience as follows:

“My team responded to that by first understanding the design and what the maximum we can do with the design is, something and nothing else, so that that stops there, and then we check against the design standards. Are we complying legally? Then, you look at the health advice/recommendations. Remember, the recommendation is different from a building code or regulation; the recommendation is someone else’s opinion. You know, it’s a kind of guideline. You can do it if you want to, or if you can, you know you don’t have to do it. If the system doesn’t allow you to do it kind of thing. “

- **Occupant sentiment**

Occupant sentiments and organisation characteristics were the main drivers for providing more fresh air exchange by window openings or reducing air recirculation in buildings ventilated with mechanical systems. Participant 8 shared the following:

“One of the ones we first started talking about was occupant sentiment. One of the great fears is that people wouldn’t come back to buildings, or people needed to have confidence that buildings would be well-ventilated and well-managed. We certainly work with a number of our clients to help them communicate with their tenants. Their systems were good if you like, so some of the high-end clients that we would be some of the very high-profile building owner organisations have very good buildings with very good ventilation.”

- **Organisational characteristics**

Although the healthy recommendation from the government is not a legal requirement, the decisions on ventilation improvement were mainly driven by the organisation's priority. Some participants reflected on the employer's duties on employee health and safety as the main driver in implementing ventilation improvements, such as 100% fresh air intake, window openings, etc. For instance, Participant 26 reflected as follows:

"Employer always has the responsibility for the health and safety of their employees. Organisations do have a responsibility for the buildings that they conduct their business in, and we know that better ventilation actually leads to less infection."

- **Energy concerns**

Many participants discussed the trade-off between the ventilation improvements and building energy consumption, which did not affect the decision since energy saving was not a priority during the building reopening stage. For instance, participant 9 shared,

"As soon as you increase fresh air into a building. If you set that at 100%, you are conditioning more air rather than recirculating existing. A. So, it naturally increases energy consumption in the building. There were no decisions made that, you know, prioritise energy over indoor air quality. "(004)

Similarly, Participant 11 also reflected on the sentiment change regarding energy goals in building re-openings but expressed concerns about balancing the energy-saving target and the ventilation improvements.

"More fresh air means more energy consumption, particularly on a hot day or even cool day, around 30, 40% more energy (for air conditioning). And it's funny that before the pandemic, energy saving was on everyone's (FM) agenda. But in the pandemic. Everyone forgot it. And now it's coming back."

4 Discussions

This study aims to identify the drivers for IAQ intervention decision-making from the building manager's perspective. Semi-structured interviews were conducted with 41 professionals with first-hand experience in managing office or occupant safety in space for buildings in post-pandemic workplaces in Victoria. By exploring the voices of experienced staff, we seek to shed light on the FMI decision-making process and identify lessons for future development. As shown in Fig.1., this study shows that the main factors determining IAQ invention decisions include compliance, institutional characteristics, building characteristics, financial characteristics, occupant impacts, and environmental impacts.

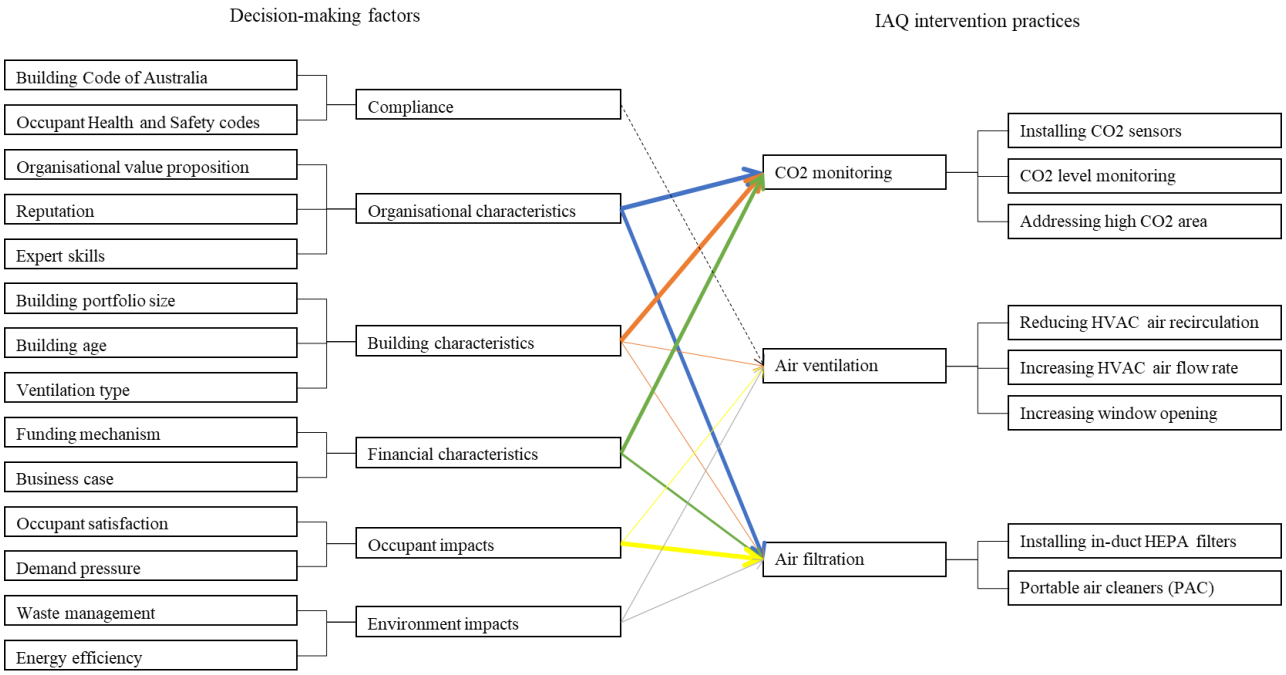

Fig.1. Decision-making factors for IAQ interventions

While building code compliance was evidenced as the most critical decision factor for FM (Besiktepe et al., 2020; Medal et al., 2021), this study shows that the influence of building code on IAQ inventions was limited. In the literature, the CO2 level has been used to determine the outcome of air dilution based on the well-mixed air assumption(Gammaitoni & Nucci, 1997). The interviews show that government guidelines and the building code have also prompted organisations to measure the indoor air exchange rate in the buildings; however, the building code compliance was not the main driver for the IAQ interventions, given that the related building code includes limited requirements for space with operable windows and air recirculation degrees. From this study, FMs perceive that CO2 monitoring is neither required nor acknowledged by government bodies as evidence of sufficient ventilation. The current Australian building code requires “a space in a building used by occupants must be provided with means of ventilation with outdoor air which will maintain adequate air quality”, which refers to criteria on acceptable IAQ that specifies 850 ppm for CO2 level as a maximum(NCC, 2022a). However, CO2 monitoring is not yet required by the building code. Moreover, for buildings with natural ventilation, the building code requires the inclusion of openings with a certain percentage of the floor area (NCC, 2022b), but the ventilation outcomes rely on window operations, which is out of the scope of the current code compliance.

The interviews show that the funding mechanism is a primary consideration for all IAQ inventions, which echoes with decision-making factors for health-related intervention decision-making(Mason et al., 2018; Moberg et al., 2018; Wang et al., 2021). For example, organisations who considered those investments as part of the COVID-19 response and have extensive pandemic response fundings implemented ventilation improvement projects as “Emergency Response”, where cost factors were a secondary consideration. The pandemic response funding from the Department of Education played a significant role in rolling out PACs in educational buildings. By contrast, for those considered ventilation improvement as FM projects, the cost-

benefit analysis was challenging for organisations, indicating the need for practical tools to quantify the benefits of the IAQ interventions.

Organisational, building characteristics and occupant impacts are the primary drivers for organisations that want to implement IAQ interventions. For instance, educational organisations tended to invest more in CO2 monitoring due to the awareness of the impacts of CO2 levels on educational outcomes (Rajagopalan et al., 2022). Additionally, building characteristics, especially building portfolio, complexity, and building age, also contributed significantly to the decisions on CO2 monitoring. For example, for organisations with an extensive portfolio of buildings or older buildings, CO2 monitoring was adopted to quickly identify poorly ventilated areas to address compliance requirements. Occupant impacts appeared to be a key determinant for all three IAQ interventions. For instance, installing PACs in office buildings was mainly driven by occupant requests. On the other hand, environmental impacts did not play a significant role in IAQ invention decision-making in the context of building reopening. However, given Australia's long-term emission reduction plan (Australian government, 2021) and the trade-off between more fresh air intake and HVAC energy consumption(J. Zhang et al., 2024), environmental impacts will be a critical factor for ventilation decisions in the long term.

5. Limitations

This research has some limitations. Most participants (39/41) in our study resided in a single city and experienced the exact implementation of lockdown measures during the pandemic. Future work with other samples should be conducted to confirm and extend our findings. It is worth mentioning that our study relied on self-reported information from interviewees. This study might have unavoidable social desirability biases (SDB) (Bergen & Labonté, 2020).

6. Conclusions

This paper presented a qualitative study to explore FMI decision-making in post-COVID Australia, including CO2 monitoring, air ventilation, and air filtration. We found that the decisions were primarily driven by qualitative risk assessment and outcomes. However, a quantitative evaluation of the cost and benefits of those interventions was lacking, which reveals the need for developing quantitative decision-making aid tools in the industry. Additionally, the study shows that IAQ intervention factors include compliance, occupant impact, organisational characteristics, funding mechanism, building characteristics, and environmental impacts. Furthermore, the study reveals the challenges for FMs in balancing building energy-saving goals and IAQ controls in post-pandemic workplaces. This paper contributes to the knowledge of facilities management and indoor respiratory infection control.

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Burnout in Context: Studying Real World Workplaces

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ABSTRACT

Burnout degrades quality-of-life and professional performance. Maslach (2017) recommends that organizations battle burnout by carefully managing employee workloads and community spirit as well as workers' perceptions of situational control, organizational fairness, rewards, and group values. Design can generate conditions inconsistent with burnout by focusing on these six burnout predictors/risk factors. The unique value of the study reported here is that multiple design features linked by previous separate studies to employee burnout were investigated concurrently in real-world settings to identify their potential relationships to burnout levels. In this initial study in a planned series, participants first answered the questions on the Schaufeli et al. (2019) burnout scale. Then they categorized/described the physical environment at their work site (e.g., soundscapes experienced) by answering additional closed-end multiple choice survey questions. Findings confirmed many hypothesized relationships between aspects of the physical environment previously linked to burnout and participant burnout levels. For example, the study participants that were the least burned out were significantly more likely to describe their mood as positive when sitting where they were most likely to work than to describe it as negative (chi-squared value 41.179, p = .041); many environmental factors influence mood-in-space. Among the participants scoring most burned out, an overwhelming majority were able to hear other people talking as they worked; this group was also significantly more likely to have a view mainly of buildings or other manufactured things as they worked (as opposed to views mainly of nature). Of the participants who were least burned out, 66% felt that the space where they were most likely to sit and work helped them do mental work, while for those who were most burned out this value was 50%. Environmental psychology-based audits of work areas revealed meaningful differences in physical work conditions experienced by workers with different burnout levels.

Keywords

burnout, workplace design, professional performance, mood, sensory experience

1 INTRODUCTION

Employee burnout reduces both quality-of-life and professional performance (Appel-Meulenbroek, Le Blanc, & de Kort, 2020).

Maslach (2017) reports that the three primary components of burnout are emotional exhaustion, cynicism, and degraded professional effectiveness/performance. Those who are burned out have difficulty coping with workplace challenges, feeling overwhelmed, and are unmotivated. Maslach and Leiter (2017) share that "The exhaustion dimension was also described as wearing out, loss of energy, depletion, debilitation, and fatigue. The cynicism dimension was . . . also described as negative or inappropriate attitudes, detached concern, irritability, loss of idealism, and withdrawal. The inefficacy dimension was originally called reduced personal accomplishment and was also described as reduced productivity or capability, low morale, and an inability to cope."

Albrecht (2015) also links higher burnout levels to compromised physical health, as well as to lower wellbeing and professional performance, with additional negative effects on employee turnover and absenteeism.

Conversely, work engagement is a more positive mental state distinguished by feelings of vigour, dedication, and absorption; it "is not the opposite of burnout (although it is negatively related to it)" (Maslach, 2017).

Maslach (2017) recommends that organizations battle burnout by carefully managing employee workloads and community spirit as well as workers' perceptions of situational control, organizational fairness, rewards, and group values. Design can generate conditions inconsistent with burnout by focusing on these six burnout predictors/risk factors (e.g., Al Horr, et al., 2016; Appel-Meulenbroek, Le Blanc, & de Kort, 2020; Newsham, et al., 2009; Veitch, 2012). Veitch (2018) ties more positive moods generated by workplace design to higher levels of employee engagement.

Designing to make burnout less likely is consistent with supporting the fundamental human motivations outlined by self-determination theory (SDT). Deci, Olafsen, and Ryan (2017) indicate that these core human drives are for competence, autonomy, and relatedness. The Deci-lead team reports that when workplace experiences support achievement of these objectives, positive psychological situations that are inconsistent with burnout but aligned with engagement are more probable. When these core needs are more fully satisfied via design, employee engagement becomes more likely (Appel-Meulenbroek, Le Blanc, and de Kort, 2020).

Designing to Minimize Work Overload

Positive workload-related experiences are more likely when the design of the workplace supports the activities-at-hand (Appel-Meulenbroek, Le Blanc, & de Kort, 2020), for example, and when opportunities for cognitive refreshment are available (Veitch, 2012). Workplace support for professional activities has been directly tied to lower levels of burnout (Barnes, Wineman, & Adler, 2020) while possibilities for cognitive restoration have been linked to lower employee burnout levels (Thompson & Bruk-Lee, 2019). In addition, Hoendervanger, Ernst, Albers, Mobab, and van Yperen (2018) have identified a relationship between environmental satisfaction, and the ensuing more positive moods, and elevated employee engagement while Nieuwenhuis, Knight, Postmes, and Haslam (2014), for example, link the presence of green plants in workplaces to greater employee engagement.

An extensive range of research findings indicates how workplace design can support achievement of at-work goals, which makes workload overload less likely. For instance, seeing the colour green can boost creative performance (Lichtenfeld, et al., 2012; Studente, Seppala, & Sadowska, 2016) as can being in warm light (Weitbrecht, Barwolff, Lischke, & Junger, 2015). Another example: enhanced workplace ventilation and augmented professional performance have been linked by MacNaughton, Pegues, Satish, Santanam, Spengler, and Allen (2015); the

same association has been found between natural light and professional performance (Edwards and Torcellini, 2002). Visual clutter has been tied to risk for work-related burnout by Ferrari and colleagues (2021) and clutter can also degrade performance.

Support for mental refreshment has been associated with lower burnout levels. Thompson and Bruk-Lee (2019) found a tie between cognitive restoration via nature exposure and lower burnout scores, for instance. Ward and Parker (2020) also found a relationship between restorative experiences being present and greater employee engagement and less burnout as well as a link between support for the task at hand, elevated engagement, and reduced burnout levels.

Providing Control Via Design

Comfortable levels of environmental control optimize user comfort, wellbeing, and performance (Iyengar & Lepper, 2000; O'Neill, 2010; Veitch, 2012). They have also been directly tied to lower burnout levels (e.g., Laurence, Fried, & Slowik, 2013). Scrima and colleagues (2021) found that work area personalization can lessen burnout since it allows the worker to establish a "psychological home" at the office, which in turn can elevate satisfaction with workplace design. Laurence, Fried, and Slowik (2013) link inadequate workplace privacy to emotional exhaustion and report that greater workplace personalization can reduce the amount of exhaustion experienced. The Laurence-lead research team also discusses environmental control as a counter to burnout.

At work environmental control can be supplied, for instance, via activity-based work environments (e.g., Spivack & Milosevic, 2018).

Signalling Nonverbally

Workplaces can send nonverbal messages that support positive moods inconsistent with burnout (e.g., Commission for Architecture and the Built Environment & the British Council for Offices, 2006; Vischer, 2007). They can signal that employment-related decisions and rewards are fair (e.g., Vischer, 2005) and present organizational values (e.g., Becker & Steele, 1995). Burnout is less likely when appropriate rewards, values, etc., are in place, and workers must read nonverbal messages from the work environment that confirm their contributions to organizational success are respected (Maslach, 2017). Pearce and Hinds (2018) define place identity as "whether employees feel the space aligns with their self-image and enhances their sense of belonging." They found that stronger place identity is tied to greater engagement. To build place identity, Pearce and Hinds recommend, for example, that employees be allowed to customize their work environments to convey desired messages to others.

Supporting Community Development

Workplace design supports the growth of employee communities, via, for example spatial layout (Allen & Henn, 2007) and tactile experiences (Ackerman, Nocera, & Bargh, 2010). Spreitzer, Bacevice, and Garrett (2020) link at-work options to pleasantly socialize with colleagues and to collaborate effectively to higher levels of engagement.

Multi-Factor Considerations

Appel-Meulenbroek, Aussems, LeBlanc, and Arentze (2020), using survey data gathered in activity-based offices (ABO), identified 3 psychological continuums underlying burnout/engagement (levels of energy/exhaustion, cynicism, and perceptions of efficacy), and used them to better understand burnout in ABOs The research team found that higher levels of interaction or desk switching could be tied to enhanced perceptions of professional efficacy and that noise distractions and inability to separate from colleagues as desired were linked to reduced energy levels and feelings of involvement. The investigators conclude that "Disturbance by noise, privacy and concentration issues are proven negative effects of ABOs in several studies

. . . . [this study] show[s] that [ABOs] can also increase the likelihood of burnout symptoms. . . . When striving towards engaged and healthy employees, workplace managers should aim at maximising interaction and desk switching, whilst at same time minimising distraction for other colleagues by noise. . . . workers should be given the opportunity to isolate themselves from colleagues by providing various types of workplaces."

Appel-Meulenbroek van der Voordt, Aussems, Arentze, and Le Blanc (2020) also link activity-based workplace attributes and burnout: "Distraction has a direct and indirect (through overload) negative relation with the individual strain (meaning increased exhaustion). Office comfort has indirect positive relations (through recognition and appreciation) with the interpersonal strain (meaning increased involvement). The possibility for teleworking has an indirect positive relation (through control) on the self-evaluation strain (meaning increased efficacy). . . . Workers should have the opportunity (and the organisational culture, Babapour, 2019) to isolate themselves from distraction when necessary, by providing various types of workplaces that support concentration (e.g. cell-offices, quiet areas, private spaces) and/or clear use-protocols in more open environments."

2 METHODS

For the study reported here, multiple design features linked by previous research studies to employee burnout were investigated concurrently in real-world settings to identify their potential relationships to burnout levels.

In this initial study in a planned series, participants first answered the questions on the Schaufeli et al. (2019) burnout scale. Then they categorized/described the physical environment at their workplace (a coworking site; e.g., soundscapes experienced) by answering additional closed-end multiple choice survey questions.

Photographs of locations where burnout data were collected were also analysed via human experience audits. A human experience audit (HEA) applies neuroscience to support the development of places that foster desired emotional, cognitive, and physical outcomes/experiences; it integrates environmental psychology and design practice (Augustin, 2009).

Human experience audits focus on approximately 150 design-related criteria, which can be customized to investigate issues pertinent to individual projects (Augustin, 2009). The core set of evaluation criteria were selected after a review of relevant neuroscience research and have been refined through 20 years of HEA use. The HEA's components were chosen because they are:

- Physiologically tied to experience (for example, saturation and brightness of surface colours in view, visual complexity, sound levels and types, light levels and colours, etc.)

- Universal components of effective places (consistent with, for example, biophilic design principles, achieving optimal stimulation levels, presenting appropriate personal/group identity, and similar factors)

- Society specific design issues (such as cultural associations to particular hues, focal sensory experiences, personal spacing, etc.)

- Individual user and user group specific design parameters (which include personality-linked concerns, task appropriateness, and other similar factors)

The HEA criteria are used to structure observations. Useful data can be collected during a single walkthrough of an area. Data have also been gathered effectively via photographs and videos of spaces to be assessed and, in the case of prospective assessments, through reviews of potential

floor plans and similar materials. The HEA is a straightforward way to quickly obtain important information about a space and the experiences people have in it; HEAs can be productively integrated with other research methodologies, such as surveys or discussion groups.

HEAs have been used in a variety of applications including workplace, health care, academic, hospitality, retail, spa, and residential (single and multifamily) ones. HEA-based recommendations have supported the development of environments that enhanced both user and management team wellbeing and performance.

3 RESULTS

Completed surveys were received from 57 individuals, working at 8 different locations in the United States. All data were collected in 2023.

- When asked how they felt about their job, considering all aspects of their jobs (response scale ranging from 1, extremely dissatisfied to 7, extremely satisfied) the median and mode response among participants was 6.
- When asked how many days a week they spent working at their employers' office, 70% of participants indicated 0 days a week and 5% said one day a week. 13% of participants spent 1 day a week working at a coworking site, 11% spent 2 days, 41% spent 3 days, 18% spent 4 days, and 18% spent 5 days a week working at a coworking site.
- 46% of respondents reported that their role at their company was "professional," 22% indicate their role was business owner, 11% reported being a manager, and 3% each indicated that their role was consultant or executive.
- Of those who reported how many years they had been working at coworking sites, 24% reported less than 1 year, 45% 1 to 3 years, 20% over 5 years, and 11% 4 to 5 years; no responses were registered for other time periods.

Findings confirmed many hypothesized relationships between aspects of the physical environment previously linked to burnout and participant burnout levels. For example, when participants were divided into three groups based on burnout scale scores, the set that was the least burned out was significantly more likely to describe their mood when sitting where they were most likely to work as positive than to describe it as negative (chi-squared value 41.179, $p = .041$); many environmental factors influence mood-in-space.

Among the third of the participants with the highest burnout scores, an overwhelming majority (100%) were able to hear other people talking as they worked; this group was also much more likely to have a view mainly of buildings or other manufactured objects as they worked (as opposed to views mainly of nature, 100% had a view mainly of buildings and other manufactured objects).

Of those participants in the group that was least burned out, 66% felt that the space where they were most likely to sit and work helped them do mental work, while in the group with the highest burnout scores this value was 50%.

Burnout levels and number of days per week usually worked onsite at the coworking location were not associated in a statistically significant way (chi-squared value 4.600, $p = .319$).

Burnout and job satisfaction ($r = -.3905$, $p = .003$) and burnout and engagement ($r = -.5151$, $p < .001$) were significantly and negatively correlated. This was also true of burnout and likelihood of recommending current employer as a place to work ($r = -.4207$, $p = .003$). As job satisfaction increases so does professional performance and people are less likely to leave jobs; customer satisfaction also generally increases (Harter, Schmidt, and Hayes, 2002).

Environmental psychology-based audits (HEAs) of work areas reveal meaningful differences in physical work conditions experienced by workers with different levels of burnout. Photographs of workplaces were analysed for the study reported here.

HEAs of a location at which 62% of users scored in the top third group for burnout levels (i.e., with the highest burnout levels, called Location A, below) and of a site where 30% of users had the same high burnout level scores (called Location B, below) revealed that:

- At both sites there were locations where more than 15 people were visible to each other as they worked and many people worked with others seated behind them, both of these situations have been shown to degrade professional performance and have negative effects on teamwork (Brunia, de Been, and van der Voordt, 2016; Sailer, Koutsolampros, and Pachilova, 2021). The research conducted by Sailer and colleagues supports design alternatives that visually separate workers from each other, via screens, seat orientations, and/or other means.
- Some wood grain was also visible in both locations. Seeing wood grain has been linked to lower stress levels (e.g., Fell, 2010).
- Light levels were generally much lower in Location A.
- Plants were present in both spaces but in Location A they were much smaller and more difficult to see while in Location B a comfortable number of plants (2 or 3) of moderate size (approximately two to three feet tall) were generally in view of people working.
- At Location B there were a variety of work locations and work postures available to workers. Only one, a seat at a non-sit-stand desk, was available to those at Location A. The variety of work locations is associated with perceived control of environmental stimuli. There were more, but a still comfortable number, of ways for people at Location B to control their physical stimuli than were present in Location A (although people at Location A could raise and lower window blinds).
- Ceilings were usually much higher in Location B than in Location A.
- Nonverbal signals at Location B conveyed respect for employees and indicated the value of the contributions that employees make to organizational success (via materials, furnishings, onsite amenities, etc.) while this was not the case at Location A.
- In Location B there was more support for cognitive refreshment (via views, natural lighting, materials, etc.) than in Location A.
- There was also more support for the task at hand (via work activity zoning, workspace configurations, etc.) at Location B than at Location A.

4 DISCUSSION

Workplace design can support minimization of burnout and greater employee engagement. Design decisions must be made in the context of an organization's cultures (organizational, group, national), competitive environment, etc., as desired outcomes can be made more likely but not guaranteed via design (see, for example, Albrecht, 2015).

Data collected indicate that workplace design that reduces the likelihood of burnout:

- Elevates positive moods
- Supports the activities planned by users

- Provides opportunities for cognitive refreshment
- Reduces at-work stressors
- Is biophilic
- Sends nonverbal messages that users are respected and their contribution to organizational success are valued.

Design that reduces the probability of employee burnout and enhances that of engagement is an important consideration in the development of workplaces. For example, Ayoko and Ashkanasy (2020) report that Google and similar firms are integrating retreat/refreshment/meditation spaces into workplaces to reduce the likelihood of burnout. Applying design-related research to manage burnout and engagement is thus timely as well as critical for employee wellbeing and performance.

5 CONCLUSION

The unique value of the study reported here is that it investigated multiple design features linked by previous separate studies to employee burnout concurrently in real-world settings to identify their potential relationships to burnout levels. In this initial study in a planned series, data collected indicate that workplace design can make burnout less likely when it boosts positive moods, supports planned activities and cognitive refreshment, slashes at-work stressors, sends positive nonverbal messages to users, and adheres to biophilic design principles.

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Session 1C: Digitalisation

The Influence of Video Communication on the Informal Interactions Between Dispersed Workers: The Role of Space

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ABSTRACT

The number of globally dispersed workers is growing across the world. Globally dispersed teams (GDTs) bring advantages to organizations, but also face coordination and social cohesion challenges due to the geographical distance and lack of overlapping work hours between team members. Informal interactions can alleviate these challenges. However, informal interactions are challenging to achieve within GDTs as team interactions tend to happen in a formal, scheduled virtual format, for example via formal video communication (VC). This research seeks to understand how spatial qualities can impact informal, unscheduled VC solutions support for informal interactions between globally dispersed workers. This is conducted through two studies across three globally dispersed office sites of an architecture firm. The first study adopted behaviour mapping of participants to understand how spatial characteristics affect the frequency of informal interactions between globally dispersed workers (n=103). The second study conducted focus groups to understand how individual perceptions of VC affect the use of this technology for informal interactions between globally dispersed workers (n=16). Findings from the behaviour mapping and focus groups indicated that informal interactions across VC can be affected by the amount of space available for the interactions to occur, a balance between openness and privacy, and potentially by how close VC connections are to kitchen amenities. Spatial designs techniques responding to these aspects are suggested, to support informal interactions across VC between dispersed workers. The research findings are relevant to organizations working in office buildings, science campuses and academic institutions, as they tend to strive for serendipitous interactions, to drive collaboration, camaraderie, and research investment.

Keywords

Unscheduled video communication, Computer-mediated communication, Informal interactions, Globally dispersed teams, Dispersed offices.

1 INTRODUCTION

Many organisations recognise the advantages of globally dispersed teams (GDTs) (Martins et al., 2004; Rosen et al., 2006). These are teams that work together but are not collocated in the same office (Hinds & Bailey, 2003). They can work around the clock (Kossler & Prestridge, 2004; Lipnack & Stamps, 1999), connect to a wide pool of expertise (Lilian, 2014; Lipnack & Stamps, 1999; Townsend et al., 1998; Zaccaro & Bader, 2002) broadening an organisations' knowledge, base of clients and markets (Cascio, 2000; Kossler & Prestridge, 2004; Zaccaro & Bader, 2002). The global labour force is projected to grow to 3.5 billion by 2030 (Dobbs et al., 2012), increasing the number of GDTs (Zaccaro & Bader, 2002).

GDTs face coordination and social cohesion challenges (Cramton & Webber, 2005; Hinds & Bailey, 2003). Their geographical distance and lack of overlapping hours can reduce knowledge sharing & mutual awareness, lead to withholding and ignoring of information, coordination delays (Armstrong & Cole, 1995; Cramton, 2001; Cummings, 2011; Fang et al., 2021; J. S. Olson & Olson, 2006; Kiesler & Cummings, 2002), greater ingroup and outgroup dynamics, greater cultural diversity (Kossler & Prestridge, 2004; Lilian, 2014), increasing the likelihood of differing expectations and team conflict (Armstrong & Cole, 1995; Hinds & Bailey, 2003; Pelled et al., 1999).

Informal interactions are unscheduled, unplanned interactions (Hage et al., 1971). They can help to manage coordination and cohesion challenges within teams, by providing team members with insight into each other's skills, projects and expectations; providing opportunities to offer mutual support, create personal ties, and offer conflict identification and resolution (Elsbach & Bechky, 2007; Gabarro, 1987; Hinds & Mortensen, 2005; Kiesler & Cummings, 2002; Triandis, 1994). GDTs tend to not benefit from informal interactions due to their reliance on scheduled, formal virtual communication such as video communication (VC) (Hinds & Bailey, 2003; Hill & Bartol, 2016; Lilian, 2014; Neeley, 2021; Zaccaro & Bader, 2002; Weisband, 2002).

Studies that have reviewed the potential of VC to support informal interactions (Fish et al., 1990; Fish et al., 1993; Flepp et al., 2016; Goodman & Abel, 1987; Karis et al., 2016; Kraut et al., 1990; Myodo et al., 2018; Tollmar et al., 1999) have not clearly studied the role physical surroundings play on informal interactions across VC between dispersed workers. It is likely physical surroundings have a role to play, since spatial characteristics such as high visual connectivity and integration to surrounding spaces, and activity attractors like kitchens and printing facilities have been found to support informal interactions (Fayard and Weeks 2007; Sailer et al., 2016; Toker & Gray, 2008).

Therefore, two studies involving behaviour mapping and focus groups were conducted across the global offices of an architecture firm to investigate the following question:

How does the positioning of video communication units, and their immediate physical surroundings affect informal interactions between globally dispersed workers?

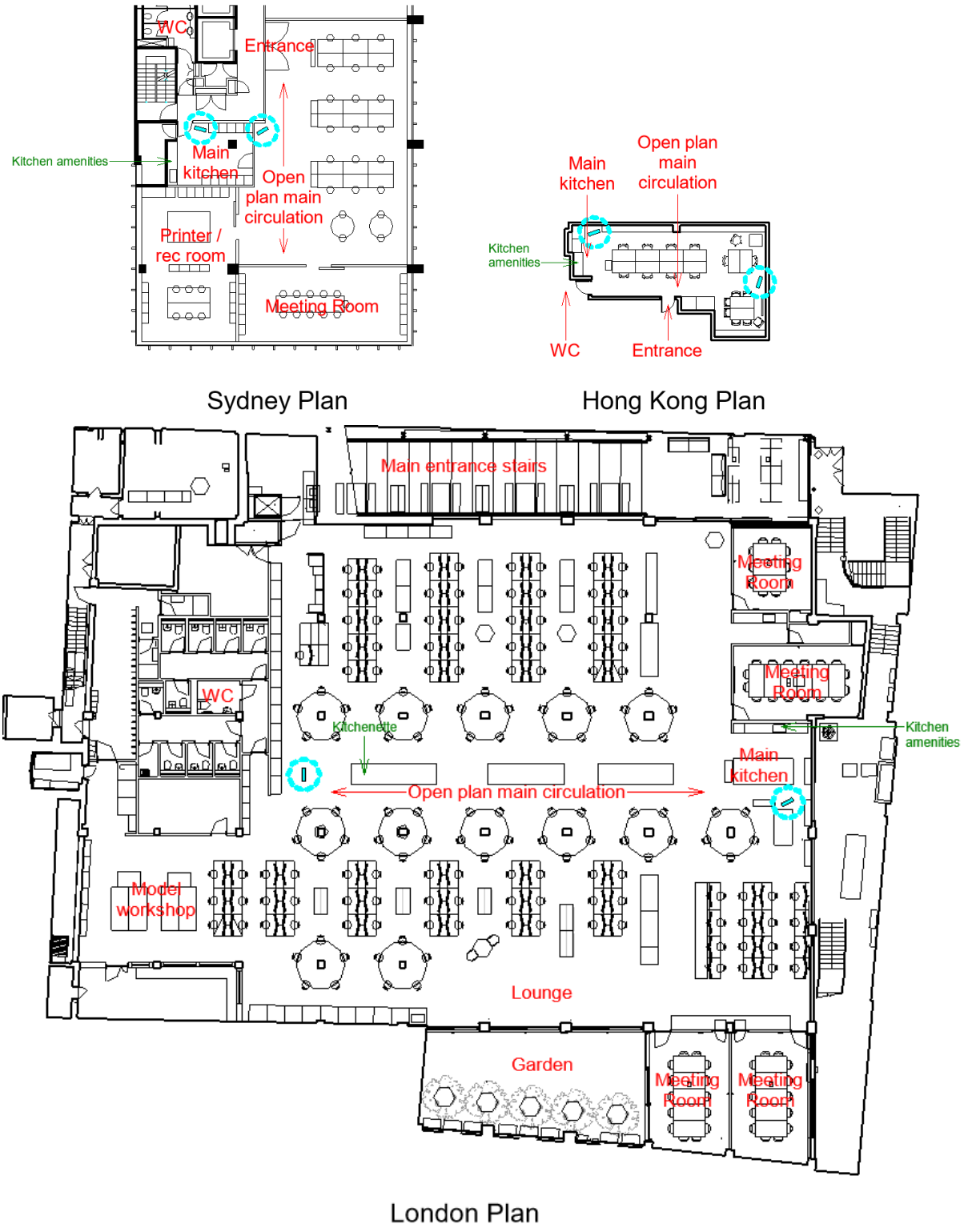
2 THE SETTING

The architecture firm has around 170 employees distributed across offices in London, Sydney and Hong Kong. Multiple teams with different specialities work across these offices. Each office had one VC unit. Refer to Figure 1 for a VC unit example.

Figure 1. Example Photo of a VC Unit.

Each VC unit was located in either two social areas – an open plan main circulation area, or a main kitchen area.

Figure 2. Office Plans.



Note. Location of VC units indicated in cyan.

They moved between the 2 types of social areas weekly, spending a total of 2 weeks in each area type. VC connections ran between Sydney and Hong Kong for 7 hours a day, Sydney and London for 2 hours a day, and Hong Kong and London for 2 hours a day, for a total of four weeks during working days. These connections ran between social areas of the same type. For example, London's main kitchen was connected to Hong Kong's main kitchen. For a timetable of VC locations and office connections times refer to Table 1 and 2.

Table 1. VC Locations in Each Office Per Week.

Week	London	Hong Kong	Sydney
1	Open plan main circulation	Open plan main circulation	Open plan main circulation
2	Main kitchen	Main kitchen	Main kitchen
3	Open plan main circulation	Open plan main circulation	Open plan main circulation
4	Main kitchen	Main kitchen	Main kitchen

Table 2. Office VC Connection Times.

Offices	24 hour time per office location																					
Sydney	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00	18:30	19:00	19:30	20:00	20:30
Hong Kong	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00	18:30
London	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	05:30	06:00	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30

Note. Yellow overlaps between rows indicate VC connection times between offices.

3 Study 1 – Behaviour Mapping Observations

3.1 Sample

A total of 103 out of a total of 159 staff (65%) provided informed consented to participate in the behaviour mapping. Refer to Table 3 for the spread of behaviour mapping participants across offices.

Table 3. Spread of Behaviour Mapping Participants Across Offices.

Informed consent	London		Sydney		Hong Kong		Full sample	
	n	%	n	%	n	%	n	%
Provided	82	62	15	75	6	100	103	64.8
Not provided	29	22	0	0	0	0	29	18.2
Unknown	22	17	5	25	0	0	27	17.0

3.2 Data Collection

This study employed manual behaviour observations adapted from Fish et al.'s (1990) VC study. The observation measures are outlined in Figure 4. Observations were collected from live video feeds, to allow the researcher to simultaneously observe multiple locations, whilst being hidden from participants to avoid researcher presence influencing participant behaviour (Friesen et al., 2020). The four-week study duration aligns with approaches of past studies Fish et al. (1990) and Fish et al. (1993). Observation measures were mapped every minute as symbols on separate plans of each office's social areas, via the computer aided design software Autodesk Revit. Each plan is a snapshot. Refer to Figure 3 for a key of the symbols used, and Table 4 for a schedule of

the mapping times. A total of 2,160 snapshots were collected, with 360 snapshots for each social area connection pair.

Figure 3. Observation Measures and Associated Symbols.

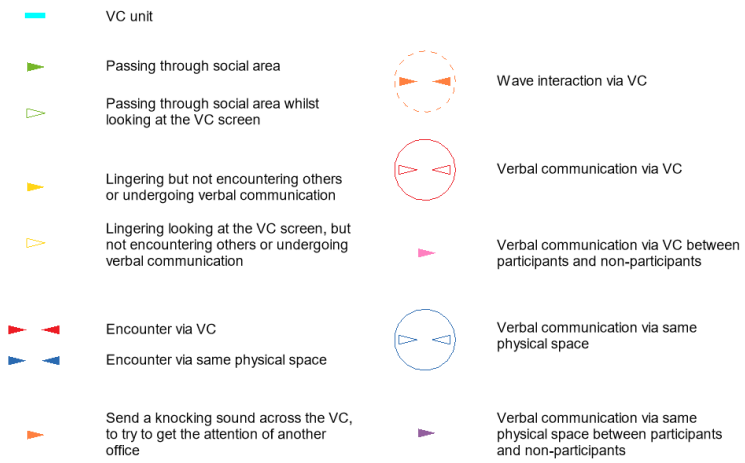


Table 4. Behaviour Mapping Times

Offices	24 hour time per office location																					
Sydney	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00	18:30	19:00	19:30	20:00	20:30
Hong Kong	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00	18:30
London	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	05:30	06:00	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30

Week 1 dates	24 hour time in London																					
05/06/2023	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	05:30	06:00	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30
07/06/2023	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	05:30	06:00	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30
09/06/2023	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	05:30	06:00	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30

Week 2 dates	24 hour time in London																					
13/06/2023	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	05:30	06:00	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30
14/06/2023	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	05:30	06:00	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30
16/06/2023	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	05:30	06:00	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30

Week 3 dates	24 hour time in London																					
19/06/2023	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	05:30	06:00	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30
20/06/2023	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	05:30	06:00	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30
21/06/2023	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	05:30	06:00	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30

Week 4 dates	24 hour time in London																					
26/06/2023	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	05:30	06:00	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30
28/06/2023	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	05:30	06:00	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30
30/06/2023	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	05:30	06:00	06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00	10:30	11:00	11:30

Note. Green indicates behaviour mapping times. Mapping times are generally around the start and end of the working day of the different office locations, when participants are usually found to be socially interacting in the social areas. These mapping times vary slightly per week in response to VC and internet technical difficulties, as well as national holidays and firm events.

3.3 Data Analysis

The behaviour mapping analysis method from Penn et al. (1999) was adapted for this study. All snapshots of each social area connection pair were overlayed on top of each other to locate clusters of observation measures / behaviours (refer to Figures 4-9). Revit's scheduling function was used to count the number of occurrences of each measure. These counts were transferred to excel tables and graphs representing each mapping day and week. These were then further

combined into a master table and graph representing the total four-week mapping period. The aggregation of counts was broken down into these steps to check for emerging patterns across different periods of time. In accordance with Sailer et al.'s (2016) approach to calculating workplace interactions, the behaviour counts in each social area was divided by the size of the area in metres squared, then multiplied by 100, to obtain behaviour counts per 100m2 for each social area. These normalised count values took the size difference of each social area into account, allowing the observation counts in each social area to be comparable to each other. The overlay snapshots, tables and graphs were analysed together to identify any emerging patterns.

3.4 Results

Figures 4 to 10, and table 5 show the location of measure types across all social areas during the four-week mapping period. Several features are highlighted across them. Refer to Figure 3 for all the behaviour measure symbols. The low VC interaction counts appear to be due to the low number of positions available for them to occur in. This is shown by the low count of this measure in Figure 9, alongside the concentration of this measure's symbol in front of VC units, as shown in example Figures 6 and 8. In contrast, same physical space interactions appeared to occur more frequently as they were supported across more positions in each social area. This is shown by the higher count of this measure in Figure 10, alongside the spread of this measure's symbol across social areas, as shown in example Figures 5 and 6.

Passing through movement is concentrated in the open plan main circulation areas. For examples of this, refer to Figures 4 and 5. This is shown by the abundance of this measure symbol on these snapshots. Lingering movement appeared the strongest in main kitchens. For examples of this, refer to Figures 7, 9 and 10. This is shown by the concentration of this measure symbol in these areas. This measure captured participants as they made drinks, prepped breakfast, shared food, and threw out waste.

Figure 4. Snapshot Overlay of VC in Open Plan Main Circulation Areas of Hong Kong and Sydney.

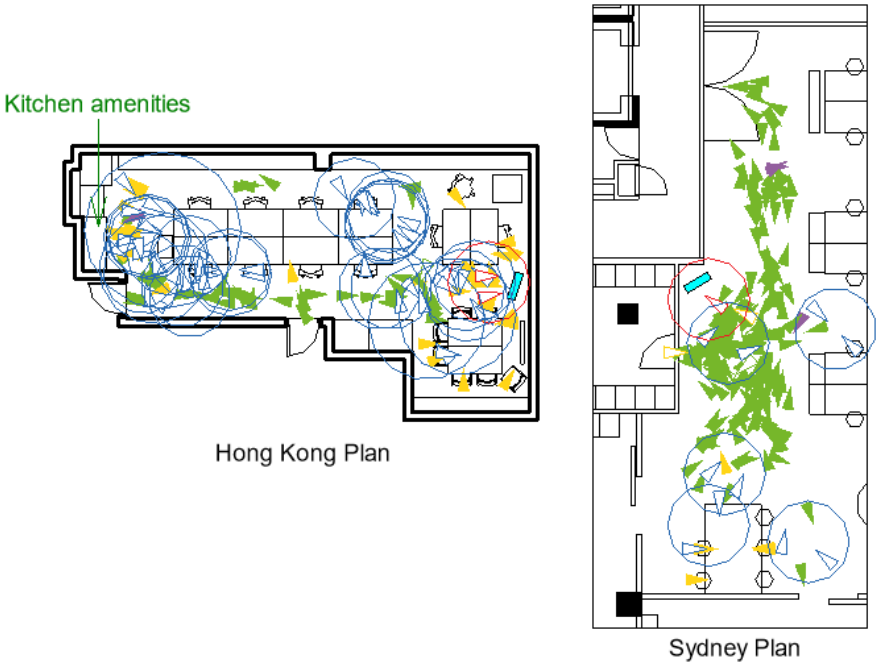


Figure 5. Snapshot Overlay of VC in Open Plan Main Circulation Areas of London and Sydney.

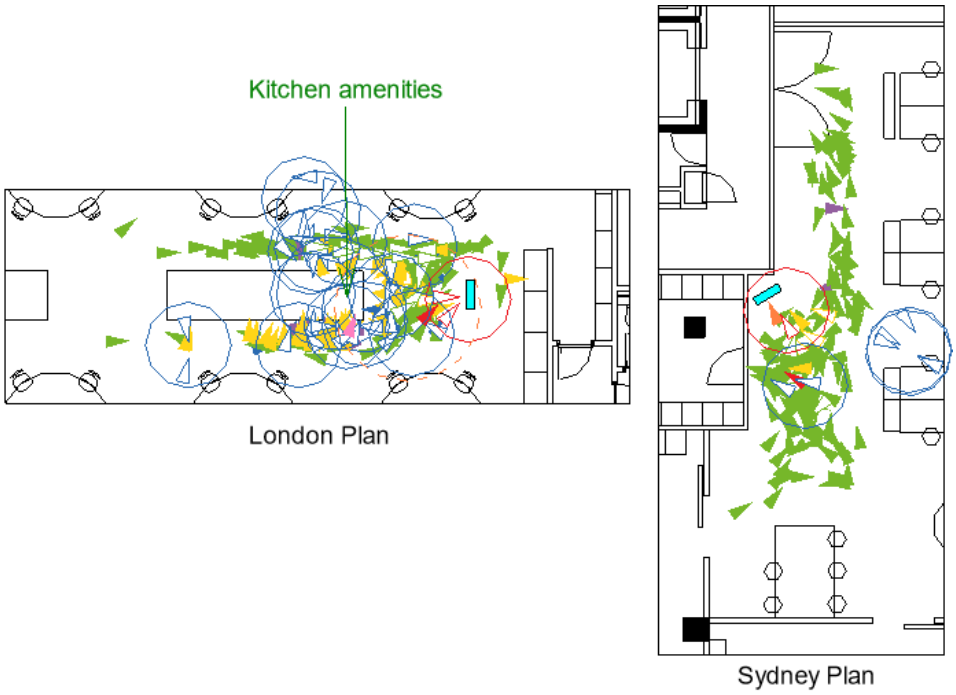


Figure 6. Snapshot Overlay of VC in Open Plan Main Circulation Areas of Hong Kong and London.

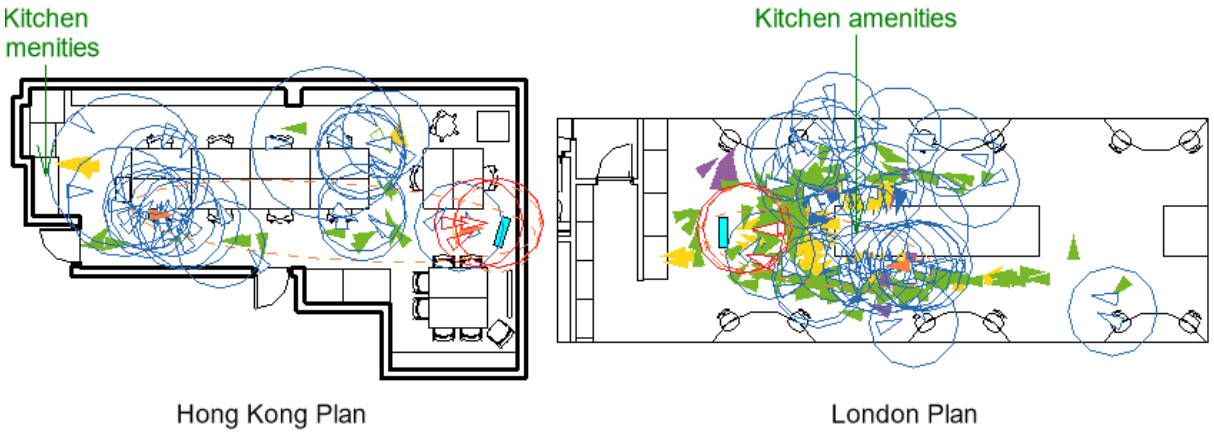


Figure 7. Snapshot Overlay of VC in Main Kitchens of Hong Kong and Sydney.

Figure 8. Snapshot Overlay of VC in Main Kitchens of London and Sydney.

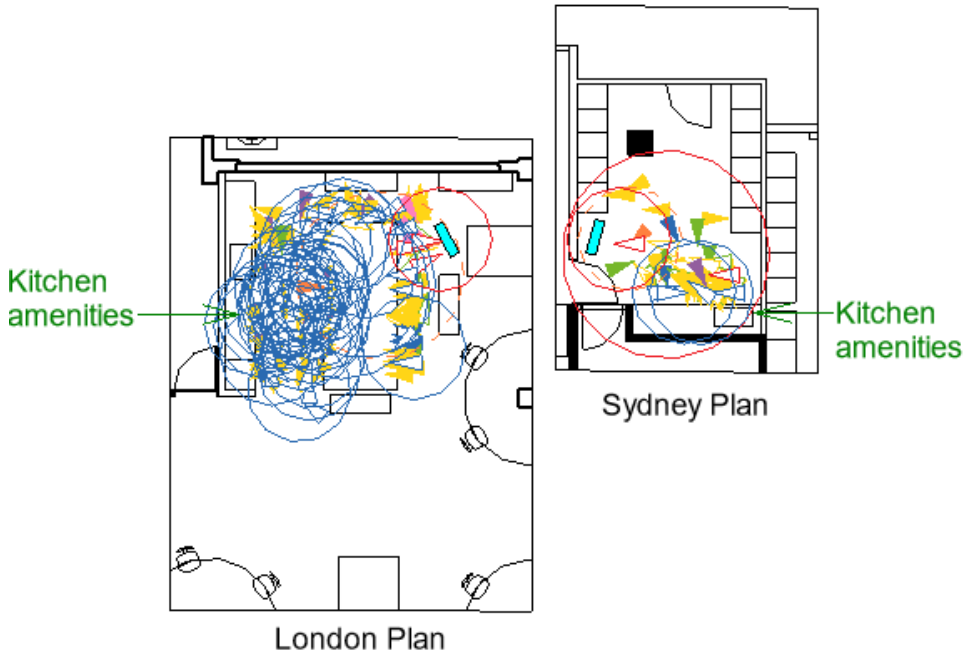
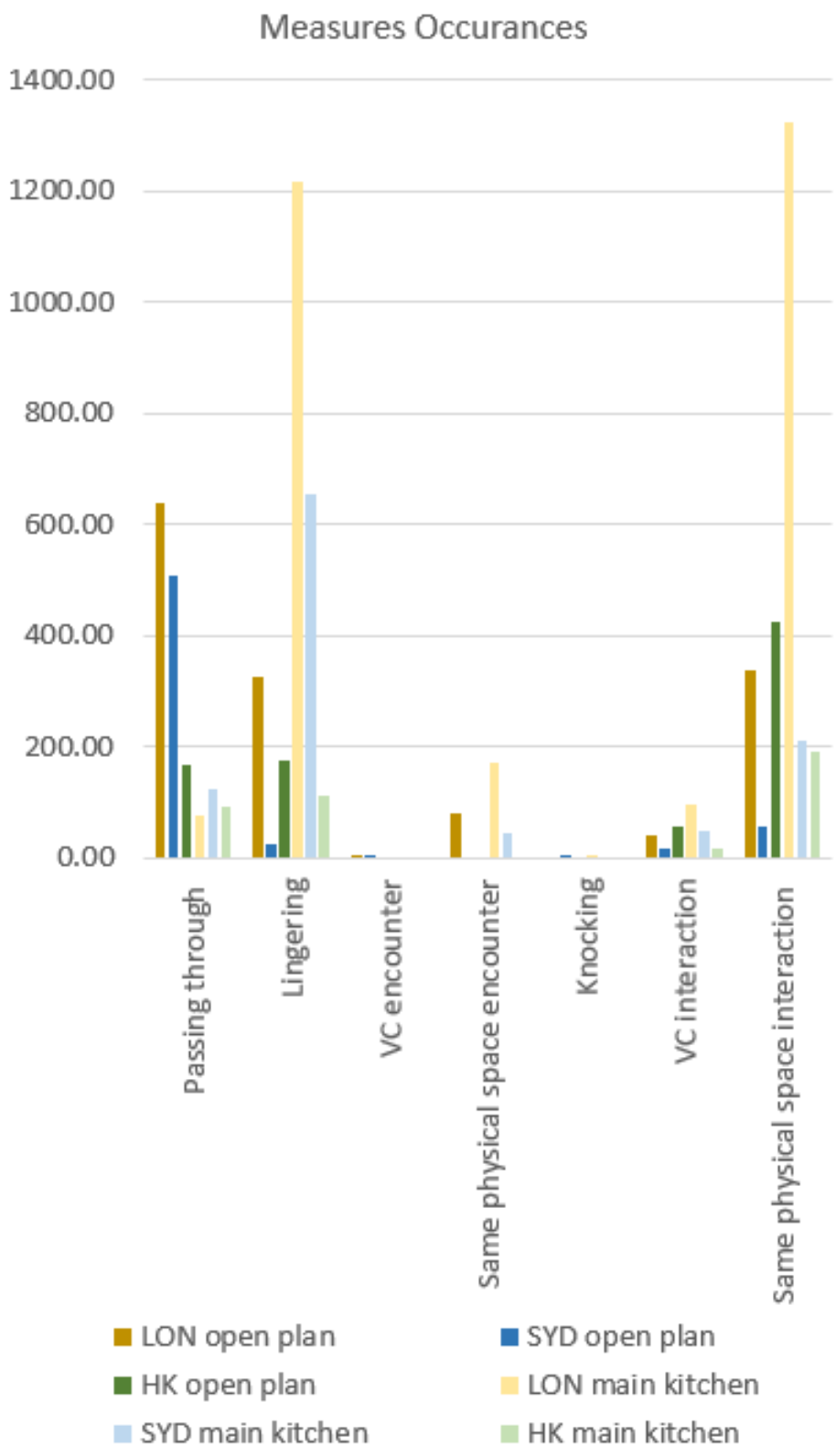


Figure 9. Snapshot Overlay of VC in Main Kitchens of Hong Kong and London.

Table 5. Master Table of Observation Measures

Measures	Normalised Counts					
	LON open plan	SYD open plan	HK open plan	LON open plan	SYD open plan	HK open plan
Passing through	645.45	530.30	168.09	76.19	122.22	91.49
Lingering	336.36	24.24	176.60	1214.29	655.56	112.77
VC encounter	1.52	1.52	0.00	0.00	0.00	0.00
Same physical space encounter	78.79	0.00	0.00	171.43	44.44	0.00
Knocking	3.03	1.52	0.00	4.76	0.00	0.00
VC interaction	40.91	16.67	55.32	95.24	50.00	17.02
Same physical space interaction	340.91	54.55	425.53	1323.81	211.11	191.49

Figure 10. Master Graph of Observation Measures Based on Normalised Counts



When both social area types of London and Sydney are compared, kitchens experienced higher interaction occurrences in general (i.e. VC and same physical space interactions) than open plan

main circulation areas (refer to Figure 10). In these kitchens, both lingering and same physical space interactions concentrated around kitchen amenities like sinks, water taps, and coffee machines. Refer to Figure 7 and 9 as examples, where this is shown by a concentration of these measures' symbols around these amenities. Higher same physical space interaction levels may have been associated to the higher lingering accounts because lingering may have made people simultaneously available for interaction.

Overall, the behaviour mapping results show that the frequency of VC interactions can be affected by how much space is available for the interactions to occur, and potentially by how close VC connections are to kitchen amenities.

4 Study 2 – Focus Groups

4.1 Sample

A total of 65 out of 159 staff (41%) provided informed consented to participate in the focus groups. Three focus groups with five to six participants each (one for each office location) were held. Participants were purposefully selected with an aim to have a balanced mix of female and male, and high and low VC unit engagement (refer to Table 6). Each session lasted for 75 minutes.

Table 6. Spread of Focus Group Participants Across Offices

Baseline characteristic	London		Sydney		Hong Kong		Full sample	
	n	%	n	%	n	%	n	%
Gender								
Female	4	67%	1	20%	1	20%	6	37.5%
Male	2	33%	4	80%	4	80%	10	62.5%
VC engagement								
High	3	50%	1	20%	3	60%	7	43.8%
Low	3	50%	4	80%	2	40%	9	56.3%

4.2 Data Collection

The focus groups were held online via Microsoft teams. Audio recordings were automatically transcribed via Microsoft Word. These transcriptions were manully reviewed to correct any automatic transcription errors. Participant names on transripts were replaced by pseudonyms, anonymising participants.

Focus group sessions were semi-structured, guided by a series of pre-prepared questions focusing on participants' experiences with the VC, their barriers and motivation to engage with the VC, and challenges or opportunities they found with the VC. For a table of the questions used, refer to Table 7.

Table 7. Focus Group Questions

Focus group questions	Prompts
What do you think informal interactions are?	
What were your experiences like with the VC screen?	Did you use it or not?
	Why? How?
	Do you know if other people used it or not?
	Why do you think they did? How did they use them?
	Did the screen encourage you to engage with people in the other offices?
	Why? How did you engage with the others?
	Was the experience with the screens good or bad?
	Why?
Were there any personal barriers or motivations to engage with the screen or people in the other offices?	Why? Any ways to overcome the barriers? Any ways to increase motivation?
Were there any challenges or opportunities you found with the technology?	Did it work or not? What happened? Could it be improved? How? What was good about the tech? Was it in the right place?
	Why do you think that? Was one position better than the other? Why?
Thinking more broadly, beyond this company, what do you think are the potential benefits of having the VC screens in offices across the world?	Good idea for the future? Why? Any recommendations for the future?
Any other thoughts you'd like to share in relation to the study?	

4.3 Data Analysis

Focus group transcriptions underwent thematic analysis (TA) (Braun & Clarke, 2013). Transcriptions were sorted into main themes and subthemes. Each occurance of a theme was counted to understand their prominance based on the frequency of mentions by participants. Rationale for themes were descibed and supported by quotes as evidence.

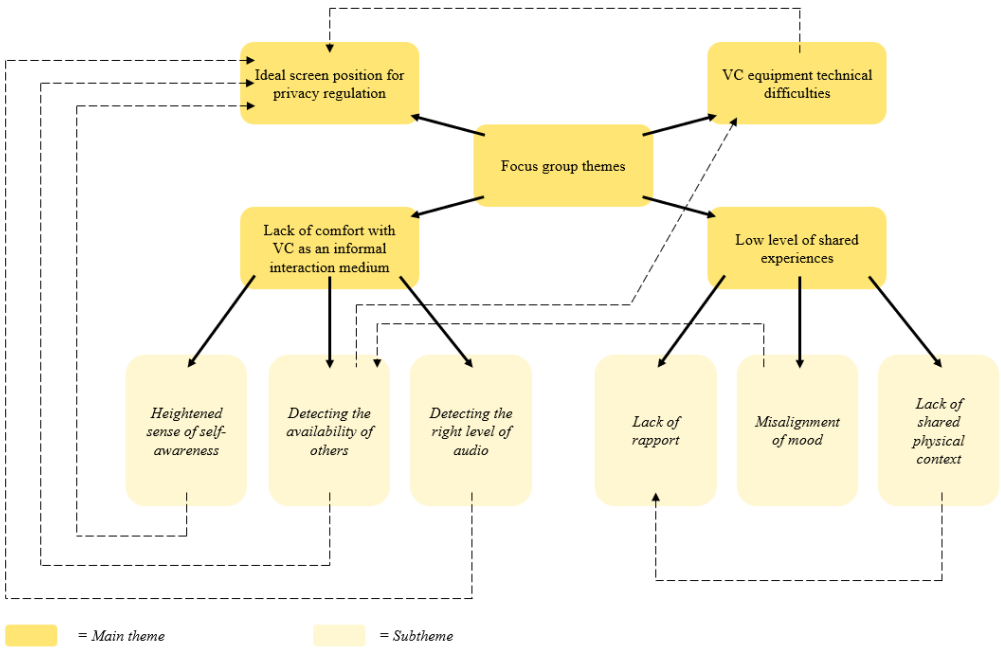
Table 8. Table Indicating the Occurrence of Themes and Subthemes Within the Focus Groups

Theme	Main Theme Occurances	Sub-theme Occurances
Ideal screen position for privacy regulation	28	
VC equipment technical difficulties	18	
Lack of comfort with VC as an informal interaction medium	18	
Heightened sense of self-awareness		3
Detecting the availability of others		12
Detecting the right level of audio		3
Low level of shared experiences	46	
Lack of rapport		35
Misalignment of mood		8
Lack of shared physical context		3

4.4 Results

The following main themes and subthemes were highlighted from the focus groups, as indicated on figure 11. In this paper we will focus on the themes linked to the physical surroundings' effect on informal interactions between globally dispersed workers.

Figure 11. Thematic Map



Ideal Screen Position for Privacy Regulation. To start and maintain informal interactions across the VC, participants felt they required a combination of an opportunity to encounter others across the VC, and privacy to continue an interaction once an encounter was made. Participants preferred the flow of people in the open plan areas of the London and Sydney office to support encounters but found being watched in these open areas when having a conversation across VC uncomfortable.

"I do think it was probably better in the studio [placement of the screens in open plan areas] [...] because people are just then having those, more of those informal chats when you're walking past [...] you're also being watched by your peers. So that's also a bit awks" (Marge – Sydney).

Participants highlighted that it is difficult to find locations for VC units that would support both frequent encounters and conversation privacy.

"It's nice that you get the flow of people though, for outside the toilets [...] if you somehow could have a flow of people going through the kitchen [...] there seems to be pluses and minuses of both locations, I don't think anything is ideal yet" (Leela – London).

In the case of London and Sydney, some participants preferred the privacy of the kitchens, but found these areas experienced less encounters and opportunities to see others across VC, to start interactions.

"The kitchen is more private, which is nice, but it's not as easy to start the interaction" (Homer – Sydney).

The higher sense of privacy provided by the main kitchen areas, may have made engaging in VC conversations more comfortable. Whilst participants highlighted preference towards having conversation privacy, it was also acknowledged that non-private conversations provided opportunities to bring people together to foster richer dialogue.

"I think there's also a balance between having the opportunity for multiple people to come in on conversations because some of the really interesting conversations are when somebody else pops by and joins in [...] you need that privacy sometimes, but also you need to be able to have that openness" (Fry – London).

A participant suggested and questioned whether the VC technology could change to provide conversation privacy in open plan areas. Suggestions included providing the ability to take VC calls away from the shared VC units to personal digital devices.

"if you could just like, yeah, put it on your iPad [...] if you start a conversation that's like ohh actually you're starting to ask me some personal questions that I don't feel comfortable answering in front of everyone, but take it to my phone" (Kif – London).

This contrasting need for both visual encounter and audio privacy reflects the importance of privacy control for the use of VC for informal interactions. Participants need to be able to expose themselves to encounters to start informal conversations, and reduce overhearing when conversations become more private.

Lack of Shared Physical Context. Participants highlighted that the physical activities such as making a drink occurring in a shared physical context can trigger informal interactions.

"informal interaction is like also ah like kind of, kind of forced interaction. [...] if you go to the kitchen and you have to make a tea and then somebody else would make a tea, and then you have to talk to each other, to say, oh, who goes first to get that hot water, you know, because there's only one tap" (Zapp – London).

However, when interactions occur across the VC units, the absence of a shared physical context, means physical triggers such as a shared tap are no longer available to trigger interactions.

The focus groups highlighted that physical surroundings can affect informal interactions across global dispersed workers in a number of ways. Shared physical amenities and open plan main circulation areas were better suited to starting conversations, whilst spaces or audio connections that were more private, were better at supporting more private conversations.

5 Discussion

The current study investigated the positioning of video communication units and their immediate physical surroundings effect on informal interactions between globally dispersed workers.

In terms of positioning, the number of VC units positioned within a social area and the orientation of VC units, appear to make a difference to the frequency of informal interactions between dispersed workers. According to the behaviour mapping, VC interactions occurred less than same physical space interactions. This may be due to the lower number of positions available for VC interactions to occur compared to same physical space interactions. For VC interactions to occur users only had the small width of space in front of each VC unit to see each other for interaction, whilst for same physical space interactions, users had an entire social space to see each other for interaction. This can impact interaction frequency as VC interactions are dependent on remote users' ability to see each other (Flepp et al., 2016; Goodman & Abel, 1987; Kraut et al., 1990; Myodo et al., 2018; Tollmar et al., 1999). These limitations on the frequency of VC interactions could potentially be mitigated by increasing the visual width available for VC interactions, such as by rotating a VC screen from portrait to landscape, daisy chaining multiple screens to each VC connection, adopting people tracking cameras, or transmitting VC connections via augmented reality (AR) glasses. Tracking cameras such as those adopted by Meta's VC device Portal (Hwang *et al.*, 2019), and in some web cameras (Logitech, no date; Poly, 2021), can track people as they enter by panning, zooming or widening its field of view. An AR approach such as Microsoft's Holoportation (Orts-Escolano et al., 2016) has the potential to provide a visual width similar to seeing people in the same physical space, only limited by the extent of the augmented reality overlay area. Future research could test the impact of these different approaches to visual width and orientation on the frequency of informal interactions across VC.

Additionally, the positioning of VC units can influence privacy regulation of conversations. It can in turn influence the frequency of informal interactions across VC. For participants to feel comfortable to engage in informal interactions across VC, they required VC units to be in public, well frequented areas to support encounters between remote participants; and the ability to switch conversations to a private audio channel, when conversation became private. This 'disclosure boundary tension' (Boyle et al., 2009; Palen & Dourish, 2003) was not supported in the study, and lead some participants to feel uncomfortable engaging in informal interactions over VC. Future research could test whether providing more public and private VC areas, and or transfers to private audio connections would improve people's use of VC for informal interactions. Transfers maybe achieved in a similar way to Microsoft Team's breakout rooms (Meazza, 2022).

The immediate physical surroundings may also impact the frequency of informal interactions between dispersed workers. The behaviour mapping found same physical space interactions congregated around specific kitchen amenities like sinks, water taps and coffee machines, aligning with previous literature on kitchens as attractors of social interaction (Fayard and Weeks 2007; Sailer et al., 2016). As the focus groups highlighted, the sharing of these physical amenities can prompt informal interactions. Users are prompted to simultaneously engage in interactions during turning taking use of these amenities. These amenities operate like photocopier rooms,

where they bring people together through the shared use of an amenity, which provides a basis for people to stay to talk to one another (Fayard and Weeks 2007). Under these conditions, informal interactions are carried out with ease, as they are a side effect of other activities (Kraut et al., 1990). Future research could investigate whether variations in the proximity of VC connections to such amenities could impact the frequency of VC informal interactions. Proximity variations could be achieved by placing VC screens closer to kitchen amenities, or by providing augmented reality VC overlays such as Microsoft's Holoportation (Orts-Escolano et al., 2016) on mirrored physical layouts of kitchen spaces between remote locations. Since the kitchens are physical mirrors of each other, the overlays could remove the distance between VC interactions and amenities like they are for same physical space interactions.

Ultimately, the positioning of video communication units and their immediate physical surroundings can affect the frequency of informal interactions between globally dispersed workers.

6 Limitations

The data used for this study only reflects one company. To understand these findings further, the methods employed would need to be conducted on more companies. During the behaviour mapping we do not know whether or not participants actually had informal interactions, as we were not able to hear what they talked about. Follow up qualitative work such as further focus groups or individual interviews would help to understand this. Additionally, the high number of interactions in main kitchens compared to open plan main circulation areas found in the behaviour mapping results, may not necessarily reflect a high number of new interactions, as the numbers may reflect the same interaction instances continuing. Further behaviour mapping could be adjusted to capture this distinction in interactions to clarify our understanding. Whilst the researcher was hidden from the participants during the behaviour mapping to help mitigate the researcher's presence influencing participant behaviour (Friesen et al., 2020), the presence of cameras used to transmit the video feeds for the behaviour mapping, could have still provided participants with some awareness of the researcher's presence. Focus groups help to study conscious rational thought and intentional behaviour, but since informal interactions are unplanned, the behaviour mapping helped to provide an alternative means to study informal interaction, strengthening the study's methodology.

7 Conclusions

VC can support informal interactions between dispersed workers. The frequency of interactions can be affected by the number of positions available for VC interactions to occur, and the amount of privacy regulation and shared amenities provided by the spatial characteristics surrounding VC connections. This study highlights the critical role physical space play in the informal interactions between globally dispersed workers. This role should be carefully considered in future developments of VC, so informal interactions can be better supported between GDTs. The research findings are relevant to organizations working in office buildings, science campuses and academic institutions, as they tend to strive for serendipitous interactions, to drive collaboration, camaraderie, and research investment.

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Revolutionising Sustainable Facility Management Outsourcing through the United Nations' SDGs: AI Applications and Case Studies

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ABSTRACT

The Contingency Outsourcing Relationship (CORE) model, a Facility Management (FM) Outsourcing Artificial Intelligence (AI) system, was published. This paper explores how the FM outsourcing system aligns with the United Nations' Sustainable Development Goals (SDGs) by analysing real business cases. Strategic Sustainable FM has the potential to contribute to the realisation of the 17 SDGs at all organisational levels. FM outsourcing is currently emphasising sustainability by incorporating the SDGs into business decisions. This study expands on previous work on the outsourcing relationships between a client and an FM service provider. It further examines the application of this model with the assistance of artificial neural networks (ANNs) to work towards a sustainable future. The paper first introduces the theory of the FM outsourcing relationship system, discussing how it can assist facilities managers in designing effective and productive FM strategies. It then outlines the research methodology, which involves conducting 8 case study analyses for testing and verification. The study concludes that FM outsourcing categorisation can help define the appropriate relationships between the provider and the client.

Furthermore, outcomes generated from the FM Outsourcing AI model serve as a valuable reference, explaining the existing outsourcing relationships between parties and assigning an outsourcing category to the FM relationship based on learned rules with the goal of improvement. One limitation of the study is the small number of case studies for testing and verification. The originality of this research lies in demonstrating how the SDGs can quantitatively measure the added value of FM to the core business and the industry, as well as the impact of outsourcing on stakeholders, including clients, service providers and researchers.

Keywords

Artificial neural networks, FM outsourcing relationships system, FM strategies, outsourcing categories, sustainable development goals

1.0 INTRODUCTION

Advanced technology and strategy can contribute to the sustainability of any profession and industry; however, it also requires a community to tackle problems. The research question of this paper is whether it is significant to develop sustainable facility management and implement sustainable development goals for FM. This research paper focuses on new emerging disciplines that will affect the operational phase of buildings and the people working therein.

FM is a strategically important discipline for all organisations in the management, operation, and maintenance of the workplace, its assets, and operational efficiencies (The British Standards Institution, 2018) and aims to achieve high-quality daily and working lives. Lok et al. (2023) addressed that standardised and strategic level support is important for the smooth adoption of sustainable FM practices and processes. Even though FM has grown from traditional day-to-day operational management to be a strategic management tool, janitorial services and facilities maintenance remain the most outsourced FM services (Ikediashi and Odesola, 2016). It is necessary for both FM clients and service providers to study and restructure future steps of their own FM departments or organisations. Lok et al. (2021) address and introduce the application of Artificial Neural Networks to the FM outsourcing relationship services model,. Artificial intelligence is useful to achieve better utilisation of FM resources and global health towards socio-economic development.

The research problem is about how to excel and advance the performance of FM outsourcing services through development goals. The significance of this paper is to understand the performance of FM services by using development goals. This will be achieved through the following research questions: What is the significance of development goals in the built environment? What are the challenges in developing FM services through development goals?

2.0 Sustainable Facilities Management collaborating with SDGs

Strategic Sustainable Facility Management (SFM) has the potential to contribute to the realisation of the 17 Sustainable Development Goals (SDGs) at all levels of the FM sector. Opoku and Lee (2022) emphasised that SFM concept integrates the principles of FM and sustainable development by utilising technology and innovative business practices to balance social, economic, and environmental impacts of business decisions. Lee and Kang (2013) asserted SFM

involves adopting environmentally friendly materials for good thermal comfort, as well as implementing sustainable renovation and retrofitting to promote sustainable cities and communities. Nielsen and Galamba (2010) focused on sustainability principles within core business, support functions, and their impact on communities of operation.

Additionally, Tucker (2013) provided a more detailed description of SFM, encompassing the management, implementation, and delivery of an organisation's core and non-core business services contributing to economic, social, and environmental sustainability. The FM sector should play a central role in integrating sustainability into day-to-day practices to enhance customer service. SFM involves making informed decisions that minimise negative environmental impacts. A study by the International Facility Management Expert Centre (IFMEC, 2018) in the Netherlands revealed that strategic SFM aligns with the 17 SDGs. The FM profession can incorporate the SDGs at all levels of the organisation, creating an enabling environment for sustainable practices.

Table 1 links sustainable FM to the SDGs in terms of the scope of work, highlighting the role of FM in areas such as economy, food, workplace, education, water management, innovation, maintenance, facility services, sustainable growth, building maintenance, city management, business management, procurement policy, animal products, peace, and justice for government and supporting organisations' departments. Moreover, Table 1 indicates the connection between the SDGs and ISO standards, interpreting the SDGs to ISO standards related to economy, food production, healthcare, education, social responsibility, equality, water ecosystem, energy efficiency, sustainability, resources, renewable energy sources, climate change, aquaculture, inclusive societies, institutions, and partnerships. Additionally, Table 2 outlines the benefits of sustainable facility management from social, environmental, economic perspectives, and drivers for SFM.

Table 1. The role of FM in achieving the SDGs (Source: United Nations, 2015[i] IFMEC, 2018, International Organization for Standardization, 2018)

The role of FM	SDGs		SDG Targets	Interpretation of SDGs to ISO standards
- Economic and social improvement	1	No poverty	1.2, 1.4	Economic activity from agriculture to banking
- Sourcing of food products & security, nutritional value and waste	2	Zero hunger	2.1, 2.4	Over 1 600 standards for the food production sector
- Responsibility for the working conditions of the employees	3	Good health and well-being	3.7,3.8	Over 1300 standards supporting safe, quality healthcare
- Education improvement	4	Quality education	4.3,4.4	ISO 21001, Educational organizations, Management systems
- Home-work balance	5	Gender equality	5.5,5.6	Social responsibility and equality in society
- Water efficiency	6	Clean water and sanitation	6.2,6.4	Over 80% of wastewater generated back into the ecosystem
- Innovations	7	Affordable and clean energy	7.2,7.3	Energy efficiency and renewable sources
- Working conditions	8	Decent work and economic growth	8.3	A common language internationally
- Smart buildings and workplaces	9	Industry, innovation, & infrastructure	9.5	Quality, safety and sustainability requirements
- Maintenance and facility services on a European and/or global scale	10	Reduced inequalities	10.2,10.6	People's health and safety and preserve the environment
- Sustainable growth by maintaining buildings, districts cities	11	Sustainable cities and communities	11.3,11.6	Responsible use of resources
- Food resources	12	Consumption and production	12.4,12.5	Environmental impact on use of renewable energy
- Sustainable business management	13	Climate action	13.3	Greenhouse gas emissions
- Procurement policy and waste control	14	Life below water	14.2,14.4	Development of fisheries and aquaculture
- Animal products and usage	15	Life on land	15.1,15.5	life on land through better use of resources
- Peace and justice for the government with strong institutions	16	Peace, justice, and strong institutions	16.2,16.10	Effective, accountable, and inclusive

- Supporting organisations' departments	17 Partnerships for the goals	17.7,17.9	Stakeholders from all corners of the Earth

Table 2. Benefits of Sustainability Facilities Management (Source: Abigo, et al, 2012 ; Elmualim, et al., 2012 ; Baaki Kurannen, et al., 2016 ; IFMEC, 2018 and International Organization for Standardization, 2018).

Perspectives	**Benefits of Sustainable Facilities Management**
Social	- Add value to their organisations and customers - Continuity responsibilities - Broad scope of enabling practices - A leadership network in executive management. - Profitability, productivity, energy management, waste management and employee wellbeing - Home-work balance
Environmental	- Protect people's health and safety and preserve the environment - Elimination of oil and air pollution, Reduction of deforestation and carbon dioxide emissions. - Higher efficiency of operations
Economic	- Benefit of reduced cost - Reduces the running/operational cost - Lifecycle cost reduction, financial gain, investment drive - Sustainability into FM practice - Lifecycle cost reduction
Drivers for SFM	- Job creation for communities - Enhance relationships with stakeholders

2.1 AI Applications and Case Studies in Sustainable Facilities Management Outsourcing Relationships

Artificial Neural Networks (ANNs) are mathematical simulations of neuron operations in the human brain (Aggarwal, 2018; Graupe, 2013; Hassoun, 1995/2003). The human brain's basic element for thinking and memorisation is the "neuron," with a total of around 86 billion neurons in the whole brain. The application of AI in the FM Outsourcing system helps FM decision-makers predict the service provider's performance more accurately. Once real data is consolidated and validated, this outsourcing relationship system is robustly applied to the FM outsourcing community, with different applications in the environment. Lok and Baldry (2015) introduced the Contingency Outsourcing Relationship (CORE) model, stemming from the Four Outsourcing Relationship Types (FORT) model. The CORE model was used in the globalised FM industry, while the FORT model originated in the global information technology industry. This study analyses simulated cases of four different categories (i.e., in-house, technical expertise, commitment, and common goals) of the CORE model from various clients' perspectives, building on previous work on outsourcing relationships between clients and globalised FM service providers.

The study further explores the application of this model with the aid of Artificial Neural Networks (ANNs) for a sustainable future. According to the Contingency Outsourcing Relationship (CORE) model, there are four original outsourcing categories: *OC*1, *OC*2, *OC*3, and *OC*4 (Lok et al., 2020). However, nothing operates perfectly in the real world. As learned from the system validation by raw case studies, it seems necessary to introduce three new groups, labelled as in-between categories, which are the outsourcing categories *OC*1/2, *OC*2/3, and *OC*3/4, to further explain the system's mechanism.

3.0 METHOD

The data collection stage took place from early August 2021 to the end of December 2021, spanning a 5-month period during the COVID-19 pandemic (Lok, et. al., 2022). Due to intermittent city closures and lockdowns in Hong Kong, China, collecting primary raw data was challenging. Our focus was specifically on the construction and built environment sectors, where FM professionals had a more technical understanding of the research scope. We used two approaches to identify suitable case studies. Firstly, we invited companies and institutes through individual research connections and sent invitational emails to local FM or real estate professional networks. The participants mainly consisted of FM facility owners and stakeholders in the built environment industry. Each company or organisation involved was required to invite two or three respondents to complete a standardised questionnaire for data collection. Our study primarily targeted the built environment to ensure the data is robust and reliable. The respondents needed to acknowledge the importance of good FM practice in their businesses. Practical case studies were drawn from various industries such as building maintenance, property management, property development, leisure and culture, education, and exhibitions for local and international companies.

We also conducted research analysis of the raw data using ANN in parallel with the data collection stage. It was important to categorise the outsourcing relationship corresponding to each case study. Following the analysis of the four cases, we observed that some outcomes did not precisely fit into the four outsourcing categories (*OC*1, *OC*2, *OC*3, and *OC*4) as they often fell close to the border between two neighbouring categories. Consequently, we decided to establish three additional categories (*OC*1/2, *OC*2/3, and *OC*3/4) to create a more comprehensive FM outsourcing relationship system. Finally, we had seven outsourcing categories for the system, and the details are recorded in the analysis section.

For a case study to be considered successful, the company or organisation had to fulfil ten criteria. These included: i) having a regional or international status, ii) being a facility owner or user, iii) providing two to three respondents to complete the standardised questionnaire individually, iv) prioritising senior or middle-level professionals, and v) ensuring that the proposed target participants did not have prior knowledge of the category their company belonged to. Additionally, the participants were briefed before completing their questionnaires, and they could crosscheck with an independent standard belonging to the company. It was important for different people from the same company to reach a fair, objective, and reliable outcome using a standardised method. Moreover, we believed that ANN could produce satisfactory and scientific results, and the AI approach could find outcomes that might not be achievable through human manipulation.

4.0 Analysis of the data

4.1 The ANN for Outsourcing Categorisation and Generation of Final *OC*

The structure of the entire Artificial Neural Network (ANN) was previously explained in detail by Lok et al., (2020), with a focus on utilising the ANN with more quantitative input. This paper, following comprehensive research, delves into the application of the ANN to CORE through a detailed mathematical approach using bespoke formulae and raw quantitative data from case studies. The quantitative measurement of the proposed FM outsourcing strategies has two axes: the X-axis and Y-axis. These axes represent the eight outsourcing strategies for the four outsourcing relationships (Lok et al., 2021). Specifically, the X-axis measures the impact of the outsourced FM portfolio on the client's competitive position and long-term plan, while the Y-axis gauges the ownership and control of various FM assets transferred to the service providers. This enables the prediction of the outsourcing relationships of FM stakeholders in specific FM outsourcing contracts, such as building maintenance, cleaning, security, and catering.

There were four inputs (*OC*1, *OC*2, *OC*3, and *OC*4) to the ANN and one output (*OC*). *OC*1-4 is computed from raw data surveyed from different FM firms, with the final value of *OC* used to determine the outsourcing category. This section demonstrates four outsourcing examples with a clear explanation of the framework. Lok et al. (2021) highlighted the existence of 4 categories, *OC*1, *OC*2, *OC*3, and *OC*4, but in reality, it is impractical to assign *OC*1 to a company with a score of 1.49 and *OC*2 to another company with a slightly higher score of 1.51. Consequently, it becomes necessary to create three new categories, namely *OC*1/2, *OC*2/3, and *OC*3/4.

4.2 Analysis of Outsourcing Categories

Lok et al. (2021) outline the relationship between the client and service provider across four Outsourcing Categories (*OC*1, *OC*2, *OC*3, and *OC*4), each with distinct impacts on different aspects of facility management and competitive advantage. Additionally, the authors propose three new Outsourcing Categories (1/2, 2/3, and 3/4) to further categorise and explain real-world cases that may not fit neatly into the original four categories. These new categories are meant to provide a more comprehensive framework for understanding outsourcing dynamics.

Outsourcing Category 1 (*OC*1) is a Support/Inhouse group (high impact on hard FM on the challenge of flexible facilities and competitive advantage); Outsourcing Category 2 (*OC*2) is the Alignment/Technical expertise group (high impact on soft FM on the challenge of flexible relationships in service provision and value points for leveraging FM portfolio and business process improvement); Outsourcing Category 3 (*OC*3) is Reliance/Commitment group (high impact on managerial control and decision making over operations, planning, development and implementation of facilities and personnel replacement in-house FM personnel, competitive advantage and competitiveness and Outsourcing Category 4 (*OC*4)

is the Alliance/Partner group (high impact on and long-term competitiveness, a close partnership, strategic inter-organisational relationship and new revenue) respectively. The details of these categories and their impact on aspects such as managerial control, decision making, competitiveness, and strategic relationships are presented in Table 3, documenting eight case studies over a period of 3.5 months (Source: Lok et. al., 2022).

Table 3. Profile of details of the eight case studies of the seven outsourcing categories (Source: Lok et. al., 2022).

Case Study	**Sector**	**Size**	**Number of employees**	**Level of respondent**	**Business nature**	**FM Outsourcing services**	**Final raw output calculation from ANN**	**Confirmed Outsourcing Category (*OC*) From the CORE model**
1	Private	Regional	Below 50	Assistant Manager	Building maintenance	Maintenance works; services	1.573 1.449	*OC* 1/2
2		International	500 – 1000	Senior officer	Property development	Office Maintenance; IT Hardware; Cleaning and Security	3.261 3.487	*OC* 3
3	Public	Regional	Below 50	Manager	Leisure and culture Government	Security; Cleaning and Antimicrobial	3.889 3.875 3.907	*OC* 4
4			500 – 1000	Property Officer	Construction and Maintenance	Security; Cleaning	2.529 2.478	*OC* 2/3
5			Below 50	Manager	Education and exhibition	Cleaning; building maintenance and catering	1.054 1.147	*OC* 1
6		National	500 – 1000	supervisors	Property management	Security, cleaning, customer and maintenance services	3.695 3.410	*OC* 3/4
7	Private	International	50 – 100	building surveyor	Building surveying consultancy	General Building maintenance works	3.370 3.434	
8		Regional	100 – 200	Associate Director	Property management)	Security, cleaning, renovation	1.058 1.107	*OC* 1

5.0 DISCUSSION

The Adoption of the SDGs in the FM sector

The Sustainable Development Goals (SDGs) can be used to measure the additional value that Facility Management (FM) brings to the core business and the global FM industry. This includes considering the impact of ISO standards and involving stakeholders such as clients, service providers, and researchers.

It is conceivable that FM outsourcing categories 1 to 4 correspond to SDGs 9, 11, and 17. In other words, outsourcing issues can have an impact on these three specific SDGs. SDG 9 focuses on industry, innovation, and infrastructure. In the context of FM, important technological advancements relate to smart buildings and workplaces. SDG 11 concerns sustainable cities and communities, and FM contributes to sustainable growth by maintaining buildings and districts within cities. Lastly, SDG 17 emphasises partnerships for the goals, and within FM, it can play a crucial role in aligning all supporting departments of organisations.

5.1 Clients

Long-established companies may believe they can continue operating without considering the Sustainable Development Goals (SDGs). However, some facility management practitioners are advocating for the relevance of these SDGs. The ISO Annex 41001 provides guidance on using the standard effectively, outlining specific functions for assignment and assessment. While each organisation and solution may differ, the universal framework is applicable to all (Reynolds, 2022). Some stakeholders have shown minimal interest in the importance of SDGs for their businesses, impacting the global productivity of facility management negatively. Certain business clients, particularly international companies or organisations may not prioritise these goals and may be hesitant to invest substantial financial and human resources in implementing the standards. If facility management's primary focus is on cost reduction rather than creating strategic value, this issue persists (Lok and Baldry, 2015). The added value of these goals may not be immediately apparent, leading to a lack of a positive business case for implementing another Management System. Many organisations have already implemented various mature ISO management system standards, such as 9001, 14001, and 55001.

5.2 Service providers

It is important to provide standard and strategic-level support for the successful implementation of sustainable facility management. While every organisation and solution are unique, there are universal frameworks that apply to all (Reynolds, 2022). However, there are psychological barriers that may prevent facility management practitioners from understanding or prioritising development goals. This can lead to a lack of understanding of the needs and expectations of users in relation to Sustainable Development Goals (SDGs), resulting in unsatisfactory user experiences. Some practitioners may not believe that adopting SDGs can improve or contribute to the success of their businesses. As a result, they may be resistant to change and hesitant to adopt new practices.

5.3 Researchers

Researchers may lack sufficient support and valid case studies for their research. They are looking to address several questions such as: "How can facility management (FM) be aligned with Sustainable Development Goals (SDGs) globally?" "How can FM professionals comprehend the significance of SDGs for their businesses?" "How can FM professionals integrate the understanding of SDGs into their services?" Researchers aim to provide a comprehensive understanding of both standards and goals and elucidate their importance for further investigation and evaluation. They seek to assist clients and service providers in grasping and embracing the significance of these standards and goals through their research. One of the challenges for researchers is to impartially advocate for both standards and goals based on their scientific value, despite the difficulty in obtaining sufficient data to analyse and explain the significance of these standards and goals.

6.0 Recommendations on the role of facility management AI outsourcing in achieving the SDGs

In recent times, facility management has been emphasising sustainability by incorporating the UN Sustainable Development Goals into their business decision-making process. This paper explores the

CORE model, an Artificial Intelligence (AI)-based FM outsourcing relationship system, by using real workplace scenarios to examine its impact on sustainability. The study suggests that big data can significantly enhance the effectiveness of AI FM Outsourcing systems. By analysing a growing number of cases, we can more effectively guide FM service providers on how to better serve their clients. This is because conducting tests and validating more case studies can lead to greater accuracy. Researchers and practitioners are encouraged to utilise updated data for further research. The former can conduct objective and scientific studies, while the latter can provide support through real-world case studies. It is important for researchers to recognise that individuals may encounter challenges when striving to meet the SDGs. Increased collaboration between parties can enable researchers to analyse and explain real-life examples more effectively. Clients who maintain clearer and closer FM outsourcing relationships with service providers are likely to receive more efficient FM outsourcing services.

7.0 Conclusion

This paper explores the integration of Sustainable Development Goals (SDGs) in the field of facility management (FM). While there has been a focus on Sustainable Facility Management (SFM), FM professionals will need to address new challenges during the implementation of these goals. The development of sustainable facility management and the integration of SDGs for facility management should be connected through a model that considers the importance of services from the three FM stakeholders. To obtain more generalisable results, it is recommended to conduct large-scale research on SFM and the new international FM SDGs. This paper contributes to the FM industry by providing recommendations for using SDGs to drive improvements. In summary, the paper aims to explore the relationship between SDGs and FM outsourcing issues. It is concluded that categorising FM outsourcing may help to define appropriate relationships between the involved parties. Conducting and verifying more case studies can improve the accuracy of the model and the precision of assessment, benefiting end users, clients, service providers, and governing bodies.

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Spatial Design in Virtual Reality Workspaces: A Paradigm for Future Remote Work Environments

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ABSTRACT

COVID-19 has fundamentally reshaped the landscape of workstyle, elevating the importance of remote work systems and creating a new work culture. Concurrently, Virtual Reality Workspaces (VRWS) have emerged as innovative solutions that transcend the limitations of traditional remote work systems by leveraging advanced virtual reality technology. VRWS platforms have strong potential in terms of offering immersive environments, allowing users the freedom to customize the design of their space and personalize the environment, and enhancing social presence through virtual co-presence with colleagues. This capability promotes creative thinking and strengthens fellowship among users.

Despite their potential, VRWS have not been widely adopted or utilized in practical settings, as evidenced by low public awareness and underutilization even within the companies developing these technologies. This is partly due to the technological limitations of head-mounted displays (HMD), which can affect user health and well-being. Still, it is expected to be resolved in the near future, given the pace and efforts of technological advancement in the virtual reality field. Furthermore, the spatial design of VRWS as a working environment has not been adequately considered, particularly in terms of how it accommodates user behaviors in virtual environments. This oversight can hinder the long-term use of VRWS.

This paper examines the critical need for a spatial design approach in developing VRWS, highlighting the importance of understanding and integrating user behavior in virtual environments to improve the spatial experience. Through a semi-structured literature review, the authors explore the current status of research on VRWS design and argue for a design framework that prioritizes spatial considerations. This paper aims to underscore the potential of VRWS as more than just tools—they are environments that can fundamentally enhance how remote work is performed, provided they are designed with a deep understanding of spatial dynamics and user interaction within virtual realms.

Keywords

Metaverse Workspace, Virtual Reality, Virtual Workspace, Virtual Working Environment, Workspace Design

1 INTRODUCTION

The surge in remote work systems due to COVID-19 has sustained high demand, shaping new work cultures even post-pandemic (Chen, 2023). In Korea, the proportion of WFH workers escalated from 5% pre-pandemic to around 20% by 2023 (KOSIS, 2023). As well, approximately 35% of eligible workers in the U.S. are engaging in remote work, a 7% increase from pre-pandemic levels (Parker, 2023). Originally a necessity, remote work has evolved into "Work from Anywhere" and "Workation," reflecting a shift towards enhancing worker autonomy and flexibility (Babapour Chafi et al., 2021; Fereydooni & Walker, 2020; Luebstorf et al., 2023; Statista Research Department, 2024; Voll et al., 2023).

The advent of Virtual Reality Workspaces (VRWS) leverages advanced VR technology to transcend the constraints of traditional remote work by enriching user immersion and presence (Carter, 2023; Chen, 2023). Platforms such as Horizon Workrooms[1], and vSpatial[2], exemplify VRWS by offering an independent, customizable virtual environment distinct from the physical world. These environments not only foster personalized spatial design according to user preferences but also enhance perceptions of co-presence and social presence, facilitating spontaneous communications and creative collaboration among colleagues. Thus, VRWS significantly augments the potential for innovation and community within the remote working domain.

Despite their potential, VRWS adoption remains limited. A Morning Consult survey (2022) indicated that 75% of the U.S. population is unfamiliar with Horizon Workrooms, and 55% have never heard of it, indicating low public awareness. Even Meta employees reportedly do not use the platform (Counts, 2023).

Interestingly, major big-tech companies such as Google (Elias, 2022), Apple (Leswing, 2022), Tesla, SpaceX (Bursztynsky, 2022), Meta (Field & Vanian, 2023), and Zoom (Phelan, 2023) have reversed remote work policies, urging employees to return to offices. They cite the decline in immediate follow-up opportunities and creative thinking from spontaneous in-person communication as reasons for this shift.

Reluctance towards VRWS is linked to technological constraints of Head-mounted Displays (HMD) (Ruvimova et al., 2020; Souchet et al., 2023) and a lack of VRWS design methodologies for virtual work environments. These technological issues also pose challenges to user health and well-being, complicating long-term use. However, optimism persists that these challenges will be addressed soon, given substantial investments in VR technology and rapid technological advancements (Chen, 2023).

The most critical issue, yet to be fully addressed, is that the design of VRWS has not adequately considered spatial design, particularly in terms of user behavior in virtual environments. Once technological hurdles are overcome, VRWS should transition from being merely tools to fully functional working environments. It is essential to recognize that user behavior in virtual settings differs markedly

[1] https://forwork.meta.com/kr/horizon-workrooms/

[2] https://www.vspatial.com

from that in physical ones, necessitating a spatial design approach tailored to these unique behaviors to ensure a satisfactory spatial experience in VRWS.

Despite its importance, a spatial design approach has rarely been applied in the development of VRWS, and there is a lack of sufficient guidelines and research on this aspect. Therefore, this paper aims to explore the significance of VRWS as a working environment and examine the current state of research on VRWS environment design through a semi-structured literature review. It will also initiate a discussion on the future direction of VRWS design from a spatial design perspective based on a framework tailored to the unique dynamics of virtual workspaces.

2 Spatial Design and Working Environment in VRWS

2.1 The Significance of Working Environments to Workers

Research indicates that multiple factors within the work environment significantly influence employee satisfaction and performance. Kim & De Dear (2013) noted that office features like enclosure, noise, and privacy are crucial for employee dissatisfaction, while Srivastava et al. (2024) identified that temperature, noise, and ergonomic settings are pivotal for perceived performance. Schwede et al. (2008) emphasized the importance of acoustics, visuals, and participant involvement in the design process, underscoring that thoughtful space design substantially affects worker satisfaction.

Interior design and furniture selection critically impact worker happiness (Stier, 2019), and spatial layout and desk arrangements are significant for job satisfaction (Kwon & Remøy, 2020). Samani & Alavi (2020) showed that open-plan spaces enhance social interactions, fostering a culture that boosts communication and creativity by minimizing barriers.

The working environment, including its design and the autonomy it offers to workers, significantly influences employee comfort, satisfaction, and productivity. According to Vischer's (2007) "Environmental Comfort Theory," workers' ability to control, modify, and personalize their space enhances comfort and promotes communication. The "workation" concept underscores the importance of choosing optimal work environments for effective and satisfying performance. Moreover, Kim & De Dear (2019) and Samani (2015) observed that open-plan offices often lead to distractions and reduced productivity due to a lack of control over their environment. The rising trend of "desk-terior" helps counteract this by allowing workers to personalize their desk space, improving psychological well-being and job satisfaction (Borzykowski, 2017; Lee, 2022).

In virtual reality workspaces, the influence of the environment on workers persists. Studies highlight how layout, lighting, natural elements, and color affect cognitive and psychological responses in virtual office simulations. High ceilings enhance aesthetic satisfaction (Cha et al., 2019), while the optimal Correlated Color Temperature (CCT) for comfort is found to be 4000K (Ma et al., 2022). Differences in façade geometry can affect enjoyment and interest, with irregular variations preferred over regular ones (Chamilothori, 2019). These findings underscore environmental design's critical role in virtual workspaces.

Window-to-Wall Ratios (WWR) are pivotal for workplace satisfaction, with 25% and 65% WWR representing minimum and maximum satisfaction thresholds, respectively (Ko et al., 2023). Ratios below 15% often lead to dissatisfaction (Hong et al., 2019). Ideal view sizes for psychological comfort are about 60%, while views less than 20% generally cause dissatisfaction (Yeom et al., 2020). Biophilic designs featuring elements like plants and natural light significantly alleviate stress and anxiety (Yin et al., 2020), and external views enhance job satisfaction and performance (Jeon et al., 2022). Studies also show that office layout affects privacy, communication, and concentration (Wong et al., 2023), and wall color impacts comfort and productivity (Latini et al., 2021).

In a virtual environment, especially in remote work contexts where workers are not physically together, Co-Presence and Social Presence are pivotal. Co-presence refers to the perception of being in the same space as a coworker, whereas Social Presence refers to having a social relationship with them (Nowak, 2001). Abramczuk et al. (2023) found that virtual reality enhances the sense of co-presence in team meetings that require creativity. Furthermore, the sense of co-presence is integral to fostering organizational culture and identity (Windlinger & Gerber, 2023) and supports virtual work functionality (Putri et al., 2023). Ongoing research explores how avatars and other virtual elements can further enhance the perceptions of co-presence and social presence in virtual reality workspaces (Bente et al., 2008; Yasuoka et al., 2022). Social presence also plays a crucial role in preventing social isolation (Toscano & Zappalà, 2020), which can adversely affect productivity and satisfaction by fostering a network of social interactions among coworkers. These insights collectively emphasize the importance of thoughtful environmental design and innovative technologies like VR to enhance well-being and performance in both physical and virtual workspaces.

The shift to co-existential virtual working environments enhances creativity and task efficiency by promoting spontaneous communication among colleagues. Traditional remote work systems, relying on asynchronous tools and occasional synchronous meetings, have led to adverse psychological effects such as social isolation and decreased job satisfaction (Yang et al., 2022; Galanti et al., 2022). In response to this limitation, Virtual Offices (VO), such as Gather[3] and Soma[4], launched advanced communication methodologies using virtual avatars in desktop-based, non-immersive virtual spaces. However, as an intermediate solution between conventional remote systems and VRWS, VOs are often only active if used for communication, limiting unplanned interactions and functioning more as communication tools than actual work environments (Nam, 2022). On the other hand, immersive virtual reality technologies using HMDs are poised to revolutionize remote work by providing a continuously immersive experience that mimics physical reality and enables natural workplace interactions (Carter, 2023; Malbos et al., 2012). This advancement addresses the limitations of earlier models, promoting a more dynamic and interactive virtual work environment.

2.2 Necessity of Spatial Design for Virtual Working Environment

For VRWS to serve effectively as a working environment, users must be able to engage comfortably for extended periods, such as over an hour. Technological limitations remain a significant hurdle; however, issues related to spatial design are emerging as crucial for long-term VRWS usage. Satisfactory spatial experience is vital for user adoption, even after overcoming technical barriers. Notably, unsatisfactory spatial experiences deter VRWS use (Guo et al., 2019), whereas satisfactory experiences encourage investment, even with existing limitations.

The environment in VRWS must be explored from a spatial design perspective due to its resemblance to physical spaces. Park et al. (2023) see VRWS as an alternative to physical workspaces, not merely as communication tools. MacLellan (2021) highlighted the need for spatial designs in VRWS to provide a more dynamic spatial experience. The spatial design of VRWS should focus on structure, function, and aesthetics. Structurally, the environment should offer varied spaces tailored to specific functions, with connections that facilitate convenience without compromising immersion. In an interview with professionals, a professor in Korea highlighted the necessity of spatial design for convenient spatial experience by linking VRWS with working tools and providing a spatial experience more similar to the real (Kim, 2021).

[3] https://www.gather.town/

[4] A virtual office platform launched by Zigbang, A Korean real estate corporation well-known for first trying a perfectly remote working system: https://company.zigbang.com/en/what-we-do/soma

Aesthetically, the appearance of the environment to which the user is exposed during the use of VRWS is comprised of brightness, color, texture and, etc. to compose the perceptional atmosphere of the space. Such aesthetic components of design can have cognitive, psychological, and physiological effects on the user, and they have been professionally dealt with by architecture and spatial design. Thus, spatial design perspectives must be incorporated into the design process of the VRWS working environment to improve users' spatial experience.

Meanwhile, synchronization or interconnection between the physicaland virtual environment should also be carefully considered as a part of spatial design in the aspect of interaction between users and space. When experiencing a virtual reality space, users cognitively get immersed in a different space in virtual reality, separate from the physical reality environment where their bodies exist. Accordingly, the disconnect between virtual and physical realms can pose safety risks.

Despite these considerations, the role of the environment in enhancing spatial experience in VRWS development still needs to be emphasized. The VRWS platform is still regarded as a supplementary tool that facilitates smooth communication among team members rather than an environment for executing tasks (Abramczuk et al., 2023). Research on the design of virtual workspaces has primarily focused on the interaction between virtual objects and users, with little exploration into designs that comprehensively encompass virtual and physical environments (Fujita et al., 2023). Consequently, current VRWS implementations partially improve specific aspects of work rather than replacing generic desktop tasks (Ruvimova et al., 2020).

2.3 The Current Status of Prior Research on the Design of VRWS

Amid these trends, this study explored research that approaches VRWS from spatial design perspectives. The scope of the literature review includes research conducted since 2020, from which the outbreak of COVID-19 precipitated rapid advancements in virtual reality technology. Targeted literature was searched from Google Scholar with keywords such as "Virtual Reality," "Virtual Workspace," "Workspace Design," "Remote Work," and "Virtual Working Environment," and a total of 69 papers related to virtual workspace design for ordinary knowledge work were selected for review. Among those, papers regarding virtual workspace design as simulation measures for physical office design were filtered out. Subsequently, studies focusing only on specific functions or reviewing the development and validation of practical applications and software were screened out. Lastly, papers covering the partial function of the workspace (e.g., functions only for collaboration or communication) were excluded, resulting in a final selection of eleven studies that suggest an overall design framework for a comprehensive virtual workspace. Through analytical reviewing, the present study found the limitations of these eleven studies predominantly propose broad and general solutions, not explicitly focused on spatial design perspectives, including enhancing the ethics of users and managers, revising organizational regulations and institutions, and improving workflow and systems (Table 1).

Table 1. The Analysis of Prior Research on Virtual Reality Workspace and Categorization of the Approach Perspectives

Authors (Year)	Design / Environmental Problems & Issues	Solutions	Approach Perspective
Fereydooni et al. (2020)	- Interruption by others - Situation Awareness Issues	- Developing Interface for Pleasant Interruption - Exploring Notification Technology	Technological

Kim & Shin (2021)	- Inconvenience of using HMD	- Overcoming physical limitations of HMD - developing proper software	Technological
Aufegger et al. (2022)	- The office design and productivity in the context or VR	- Establishing Ecology of Work Model - Identifying Design Requirements	Theoretical
Biener et al. (2022)	- Physical constraints/technological limitations for long-term use	- Experimenting workers using VR 8 hours a day for 1 week - identifying inconvenience factors and the causes	Technological
Tang et al. (2022)	- Emerging needs of Metaverse office - How to mix physical and virtual architectural elements	- Proposing Metaverse Architecture Framework - Focused on integrating the physical and the virtual	Spatial Design
Park et al. (2023)	- Risk of Surveillance - Newly Emerging Threats for Workers' Wellbeing - Inactive & sedentary posture due to lack of exercise - Needs for private physical workspace - Jobs irreplaceable to the Metaverse Workspace - Difficulties in controlling workload - Weakened Organizational Culture	- improving ethics - Revising institutions and regulations - Technological tricks making users move - Financial Support - Design of Artifacts, mechanisms and policies - Redesigning HR systems - balancing autonomy and discipline	Ethical / Attitudinal Technological Institutional
Heruatmadja & Ramadhan (2023)	- Identifying drivers and barriers of applying metaverse office in practice	- Financial Support for device - Preventing prolonged working hours - psychological factors for reluctance/intention	Institutional Ethical / Attitudinal
Souchet et al. (2023)	- Identifying causes for side effects of VR	- Providing code of conduct for designers, and employers	Institutional Technological
Zhang et al. (2023)	- Focusing on issues of displays in laptop, and VR devices	- Proposing Display evaluation framework	Technological
Fujita et al. (2023)	- Finding a possibility, but not yet done, of integrating physical/virtual working environment by computers	- Proposing Human-Workspace Interaction Framework	Spatial Design

		- Focusing on Interaction between users and design components	
Šímová et al. (2024)	- Questioning the insufficiency of basic research for practical applications	- Developing theoretical/conceptual framework for the definition of a metaverse in office	Ethical / Attitudinal Theoretical

Meanwhile, five papers, including three previously categorized under the spatial design approach, were found to align with the purpose of this research. However, they still need to propose practical design solutions for the defined problems and issues. Souchet et al. (2023) addressed the physical discomfort caused by the technological limitations of HMDs in VRWS. Aufegger et al. (2022) explored the relationship between workspace design and productivity within VR contexts, offering only high-level theoretical design requirements. A study explored the validity of virtual reality of design components from physical architecture (Maher et al., 2000), yet it did not consider user behaviors in VRWS.

Additionally, Fujita et al. (2023) defined interaction types among users, space, and objects in VRWS, proposing insights pertinent to both physical and virtual workspace design based on these interactions. However, the spatial design methodology was shown only in physical space, and they focused more on functionality and interactions in the case of the virtual working environment. Tang & Hou (2022) suggested a framework for Metaverse Architecture in their research, but it explained the Mixed Reality working environment, which integrates the physical and virtual space in user perception.

3 A Design Framework for VRWS as a Working Environment

The authors present a design framework for VRWS aimed at enhancing remote work by providing an appropriate environment for users to co-exist virtually with colleagues. This framework is inspired by 3 principles of architecture by Vitruvius and incorporates elements from the Human-Workspace Interaction (HWI) framework by Fujita et al. (2023). It is structured into three main categories: Structure Design, Ambience Design, and Interaction Design.

Structure Design: This category integrates the Physical, Postural, and Visual subcategories of the HWI framework to define the spatial structure of VRWS. It divides the virtual space into three **Space Types** including Task-performing, Communication, and Leisure spaces, each or combination supporting specific activities such as individual work, collaboration, and socializing. **Spatial layouts** are differentiated between cluster layouts, where all spaces are arranged together horizontally or stacked vertically and rendered simultaneously, and independent layouts, where only the occupied space is rendered, using fade-in-and-out techniques during transitions.

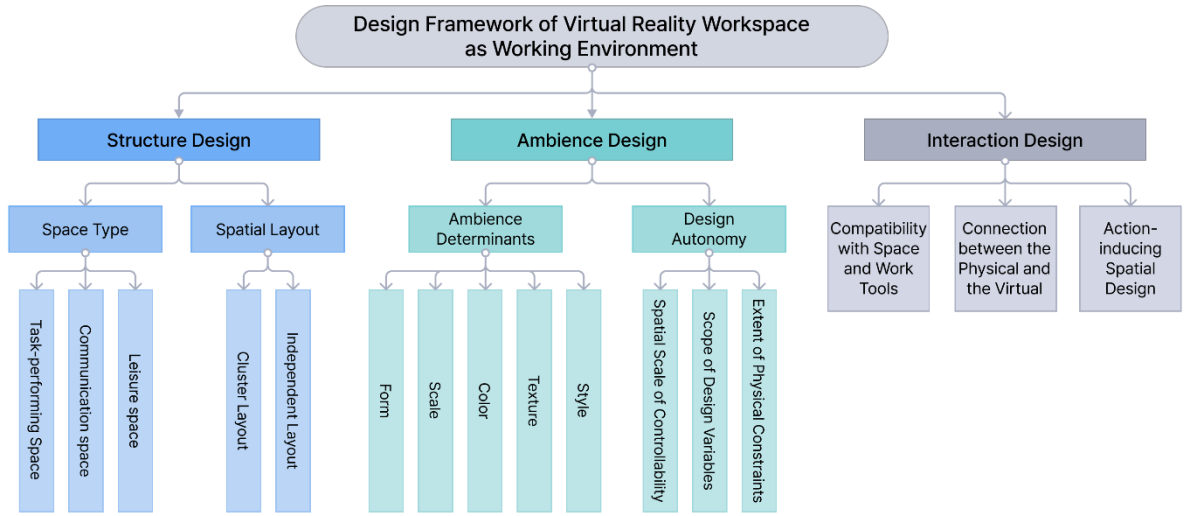
Ambience Design: This aspect, containing Visual, Atmosphere, and Design subcategories of HWI framework, focuses on the subjective and environmental factors that influence cognitive, psychological, and physiological responses, impacting workers' moods and job satisfaction. It includes **Ambience Determinants** such as form, scale, color, texture, and style, which define the environment's overall atmosphere. **Design Autonomy** is also crucial, offering users a degree of control over their workspace's design while considering the scale of controllability and physical constraints.

Interaction Design: Related to the Social and Interactivity subcategories of the HWI framework, this design facet addresses the spatial dynamics of user interactions with space and objects within the

VRWS. It emphasizes the **Compatibility with Space and Work Tools** for ease of use, **Connection between the Physical and the Virtual** for safety and comfort, and **Action-inducing Spatial Design** that promotes physical movement to counteract the health risks associated with long-term sedentary posture.

This framework aims to create a more integrated and immersive virtual working environment that addresses the practical and psychological needs of remote workers.

Figure 1. A Design Framework of VRWS as a Working Environment



4 Discussions

Based on the framework, this paper proposes discussion topics to enhance VRWS as work environments, focusing on structure, ambience, and interaction design.

Structure Design

Layouts: A balance between cluster and independent layouts is essential for cost-effectiveness and satisfactory spatial experience. Cluster layouts enhance co-presence but are costly due to infrastructure demands. Independent layouts are more affordable for large organizations but can disrupt immersion with loading times and screen transitions.

Spatial Separation: Spatial separation of individual workspaces mirrors traditional open-plan versus cellular layouts. While proximity to others enhances spontaneous communication, it may also increase distractions. Conversely, separation can protect users to keep focused but reduce casual interactions.

Auxiliary Spaces: Consider the role of auxiliary spaces, such as elevators, corridors, pantries, etc., in VRWS compared to loading times in virtual transitions. Designing these spaces could enhance immersion and social interaction, transforming mundane transitions into meaningful experiences.

Ambience Design

Customization Autonomy: Investigate the extent of personal customization allowed in VRWS to balance job satisfaction and co-presence. While customization offers autonomy, excessive personalization might diminish the shared space experience.

Interaction Design

Tool Integration: Effective integration of work tools within VRWS is crucial. Rather than simple technical solutions, spatial integration approaches should reflect user behavior and interaction changes, providing intuitive experiences.

Reality Synchronization: Develop strategies to synchronize virtual and physical environments, ensuring user safety and coherent experiences between both realities.

Health-Enhancing Behaviors: Address sedentary behavior by integrating design strategies that encourage physical movement, potentially improving health and well-being in VRWS.

These topics aim to refine VRWS as not only functional but also immersive and health-conscious work environments.

5 Conclusions

The working environment is crucial for task performance in both physical and virtual realities. However, traditional remote work systems have often disregarded its importance, treating it as merely a supplementary tool. VRWS, equipped with immersive virtual reality technology, offers significant benefits such as co-presence and social presence and facilitates spontaneous interactions that can enhance creativity and task efficiency. However, technological constraints and a lack of spatial design solutions have limited its broader application. This study addresses these barriers through a semi-structured literature review, proposing a design framework to enhance future remote work environments by leveraging VRWS advantages.

Despite its potential, the framework has several limitations: collecting user behavior data in VRWS is challenging due to technological hurdles, which hampers the design framework's empirical validation. Further research is planned to be conducted for empirically validating each suggested direction from the design framework (e.g., a relationship between aesthetic design autonomy of the users and work productivity, user's work productivity and workspace satisfaction according to the layout of the individual and public working area); the research may not fully represent the extensive literature on VRWS design, suggesting a need for a more comprehensive study to validate the results; moreover, there are still some limitations in long-term use in virtual reality workspace with HMD, such as cybersickness and simulator sickness, nausea, dizziness, though a bunch of fields is striving to solve these side effects, should be covered for the future works; and the framework's reliance on physical architecture design principles may not fully capture the unique dynamics of virtual spaces, potentially requiring future adaptation.

This study lays a foundational academic groundwork for practical VRWS design solutions. It may accelerate the commercialization of VRWS as a work environment, paralleling advances in virtual reality technology and design methodologies.

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Human occupation and behaviours VS environmental sustainability. An innovative calculation model to measure their effects in office buildings

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ABSTRACT

In the recent years, two major disruptions affected the construction sector. First, the climate change crisis addressed the need of reducing the environmental pressure of world economies. The rising importance of sustainability in both international policy debate and scientific field highlighted the importance for the sector to develop towards sustainability. Especially, the operation and maintenance has been identified as the most relevant phase on which the sector must focus in order to decrease its environmental impact. Second, the Covid-19 pandemic affected the global society by drastically changing human behaviours. More flexible ways of working have decreased the occupation level of office buildings. The increased level of uncertainty in offices' use showed the need to rethink the office space through the evaluation of users' occupation and behaviours.

Identified a gap in achieving an accurate impact assessment of in-use office buildings, this research implements a calculation model to measure the environmental impact while revealing the effects of human occupation and behaviours. The model, based on Ecological Footprint, identifies eight impact sources (built-up, energy consumption, water consumption, food & drink, material consumption, mobility, waste generation, and trade-off potential). The effectiveness of the model has been demonstrated by adopting the Participatory Action Research method, that allows to involve stakeholders (such as, facility managers and employees) since the beginning of the project. Calculations and results are reported by comparing nine case studies companies. This shows the potential of the model in addressing users and facility managers towards a more sustainable use of offices, which includes the comparison between office working and home working.

Going beyond energy efficiency, the research aims to answer the issue of office buildings use by adopting effective sustainability practices. Thus, the main advancement achieved is the development of a strategic framework that puts the roofs for steering a sustainable building management.

Keywords

Environmental sustainability, Workplace management, Facility management, Corporate real estate, User behaviour, Ecological Footprint.

INTRODUCTION

Office buildings are used differently after the Covid-19 pandemic has introduced more flexible ways of working (Hensher et al., 2022). Market trends and forecasts clearly highlight that, despite office market facing a downturn, environmental and sustainable features will be among the priority drivers of occupiers' workplace strategies over the next months and years (PWC and the Urban Land Institute, 2023). The pandemic represents an opportunity for offices to integrate more sustainable policies and practices by, on the one hand, reconsidering the amount of needed space and opportunity for downsizing and, on the other, during operation and maintenance (O&M). However, O&M is still an underestimated phase during which to foster energy reduction and sustainable practices. This study examines an innovative application of the Ecological Footprint (EF) as a sustainability indicator to be adopted in the workplace and facility management sector, exactly with the purpose to optimize office O&M. This can induce favourable changes in organizational policies and individual behaviour to support the UN's Sustainable Development Goals (SDGs). The role of the built environment in achieving SDGs is evident: 44% of the 169 SDG targets rely on construction and real estate activities (Goubran, 2019). In Europe, the sector accounts for about 50% of material consumption and a third of waste generated (ECORYS, 2014). Notably, 28% of GHG emissions result from the operational use of these existing buildings (WorldGBC, 2021).

Supporting the sustainable development and management of the built environment means to address cultural change both in building managers and in users. Even if the positive trends of sustainable transition are facilitated by certifications and ESG reporting encouraged by the EU, workplace and facility management still need an overarching scheme to integrate sustainable practices in office O&M. Understanding the use of Corporate Real Estate by observing user behaviour can offer new opportunities for integrating sustainable principles into office management (Hensher et al., 2022).

This study's objective is to propose an innovative calculation model for assessing offices environmental impact based on a relatively underexploited sustainability indicator, the Ecological Footprint (EF). We believe EF has the potential for measuring environmental sustainability in O&M and enhancing public engagement in managing building performance.

This paper unfolds as follows. First, it presents the current challenges in sustainability assessment, then introduces the EF methodology as a means to address current limitations. Later, it describes the experimental adaptation of the EF to nine case studies through a Participatory Action Research approach. Finally, it discusses the results and potential future developments of EF to improve office environmental sustainability in the O&M phase.

MATERIALS AND METHODs

Environmental impact assessment through international standards and indicators

Environmental impact refers to any alteration of the environment (physical, chemical or biological) caused by organizations' activities (ISO 14001:2015). ISO 14001:2015 highlights the need for organizations to identify, assess, and manage environmental impacts as part of their management to achieve environmental targets effectively. EN 15978:2011 provides a framework for measuring and reporting by considering the entire building life cycle. This framework sets indicators to be considered,

such as global warming potential, resource depletion, and acidification potential. In addition, BS EN 15643:2021 provides guidelines to achieve the objective of empowering users, clients, and managers to make informed decisions that enhance sustainability performance and of communicating sustainability achievements to third parties, such as users or investors.

Besides, environmental certification protocols, such as LEED and BREEAM, have been implemented with the aim to define criteria and methodology for the evaluation of buildings' sustainability and overcome the information asymmetry between the construction sector and the building owners and users (Matisoff et al., 2014). Even if the environmental certification protocols have played a significant role in advancing sustainability in the sector by raising awareness and driving improvements in design processes (Mangialardo et al., 2019), they fail in offering a unified methodology applicable globally (Doan et al., 2017; Mangialardo et al., 2019). Moreover, most certifications focus on limited aspects of sustainability, such as energy efficiency or materials selection, focusing on the design and construction phases, and use weighted matrices to evaluate buildings. A complementary approach can be found in the EF methodology, which offers several benefits for implementing an environmental impact assessment to optimize offices O&M. First, the definition of impact provided by the EF expresses the environmental impact of activities as the combination of population (number of people), affluence (activities per person), and technology (intensity of resources use) (Wackernagel and Rees, 1996). Second, EF focuses on continuous measurement, instead of one-shot evaluation (Mancini et al., 2015). Third, the EF facilitates comparisons across regions (Wackernagel and Rees, 1996). Finally, the unit of measurement presents a clear and unambiguous message, that well addresses the call for engaging various stakeholders in sustainable behaviours (Mancini et al., 2015).

Ecological Footprint Methodology

The Ecological Footprint (EF) was proposed to quantitatively assess sustainable development and demonstrate that worldwide economies are living beyond the biophysical possibilities (Wackernagel and Rees, 1996; Lu et al., 2011). The EF of a population, whether it's an individual, an ecosystem, or an entire nation, represents the productive lands and water ecosystems needed to sustainably produce consumed resources, absorb emissions, and manage waste (Sala et al., 2013). The direct comparison of demand (represented by the population) and the supply (represented by the ecosystem's ability to regenerate consumption and absorb emissions) supports the understanding of the environmental impact of the system, expressed into global hectare [gha] (Wackernagel and Rees, 1996). The ability of the ecosystem is named "biocapacity", while the population's demand is referred to as "footprint" (Wackernagel and Rees, 1996). Biocapacity is expressed in "equivalent productive lands", encompassing built-up land, forest land, cropland, pastureland, fishing land, and CO_2 sinks (Borucke et al., 2013). The Global Footprint Network (GFN)[5], responsible for the EF index, defines factors like the World Yield Factor (WYF), converting impact sources into tons of CO_2, and the Equivalence Factor (EQF), converting tons of CO_2 into gha. These factors are established globally by comparing Earth's biocapacity with the human footprint.

Initially, EF evaluated the footprints of nations or regions, then extended to smaller environments like buildings (Pomè et al., 2021). Critiques of the original concept were necessary to improve the methodology and adapting it to the complexities of the built environment. Over the years, numerous contributions have been made to measure environmental impact of buildings, building systems, and building materials towards EF (e.g. Wood and Lenzen, 2003; Bastianoni et al., 2006;; Martínez-Rocamora et al., 2017; Husain and Prakash, 2018). The existing studies still miss the opportunity to consider all the impact sources and to measure the effects of users when assessing environmental

[5] *The Global Footprint Network is an international research organization that provides data and insights into humanity's ecological footprint.*

sustainability performance. Only one study (Pomè et al., 2021) proposed a draft EF model to measure the environmental impact of an office during O&M, but it failed in the collection of data and in proposing practical suggestions to facility managers.

Participatory Action Research method

Table 1. Participatory Action Research Methodology adopted for developing WIEFA model – elaboration of the authors.

Step		Name	Activities	Stakeholders involved	Year
1	P	Needs gathering	Collection of needs	Investors and property companies	2020
2	R	WIEFA framework 1	Calculation model	Investors and property companies	2020 – 2021
3	A	Experimental Application 1	Test on three case study buildings (Building A – B – C)	Facility managers	2021
4	P	WIEFA framework improved 1-A	Definition of data entry for the impact sources of the calculation model	Facility managers	2021
5	R	WIEFA framework improved 1-B	Definition of calculations to convert data into a common unit of measurement	Investors and property companies	2021 – 2022
6	R	WIEFA framework 2	Definition of the flowchart of the WIEFA model	Investors and property companies	2022
7	A	Experimental application 2	Test on five case study buildings (Building A – B – C – D – E)	Company managers	2022
8	A	Experimental application 3	Test on four case study buildings and comparison of the all nine case study companies (Building D2 –F – G – H)	Company managers	2022 – 2023
9	P R	WIEFA framework improved 2	Definition of the reporting data sheets	Company managers Investors and property companies	2023

To advance Pomè et al. (2021) model, the present study adopts a Participatory Action Research (PAR) methodology by involving different stakeholders in the process of model development and enabling cultural change (Wallerstain and Duran, 2001; Schneider, 2012). PAR emphasizes the collaboration between researchers and stakeholders to identify and solve problems during the research development (Reason et al., 2001). This study lasted 3 years including a Participatory (P) phase to engage stakeholders, an Action (A) phase to test the model with data collected through interviews, and a Research (R) phase to structure the calculation model. Four companies were involved throughout the whole model development process. The first scheme of Workplace Integrated Ecological Footprint Assessment (WIEFA) was structured by collecting needs from property managers and investors. Afterwards, an iterative research process took place in 9 steps between 2020 and 2023 with workplace and facility managers and office end-users (i.e. company managers) (Table 1).

The calculation model of WIEFA

WIEFA boundaries are defined as the difference between losses and gains stemming from three offices components: site, building, and users (Figure 1). For each of three categories, the WIEFA model identifies different losses and gains, that encompass Built-up, Energy Consumption, Water Consumption, Material Consumption, Mobility, Food & Drink, and Waste Generation. Meanwhile, gains include Trade-off Potential and Occupation (Pomè et al., 2021). Following on Brownell (2019), a holistic

approach aggregating embodied footprint, operational footprint, occupant footprint, and influence footprint has been identified essential for a complete environmental impact assessment of offices, that considers user effects.

The model's boundaries of WIEFA define both the building and its site as physical limits. In detail, Built-up represents the area occupied by the building and paved; Energy Consumption considers consumption of electricity and fuels; Water Consumption measures the impact of consuming water; Material Consumption evaluates materials used for maintenance and cleaning activities; Waste Generation represents the impact of waste production. Users are a third order category that consume food and drinks (described by Food & Drink), access the building by different ways of transportation (represented by Mobility) and occupy the building. Advancing Pomè et al. (2021), occupation is not considered as input data but as a subsequent factor to interpret the results. To express the simultaneous occupation of users, WIEFA highlights simultaneous occupation as a variable to be factored into result reporting. Consequently, the impact of occupants on the overall footprint is not solely determined by their "consumption" of space but by their activities within the building (Figure 1). WIEFA results describe the potential benefit of "consuming" office space by more users via a new parameter expressed as gha/user. This parameter allows for a comparison between gha/employee year and gha/occupant year. The updated calculation model is presented in Table 2, along with the necessary data entry questions.

The calculations rely on factors that convert impact sources into global hectares (gha), allowing all addenda to be aggregated. Equivalent Factors (EQFs) serve as scaling factors that translate the actual usage areas of an activity into global hectares equivalence. The GFN offers the EQFs corresponding to the types of productive lands (Mancini et al., 2018; Pomè et al., 2021). In this research the EQF used are related to 2022:

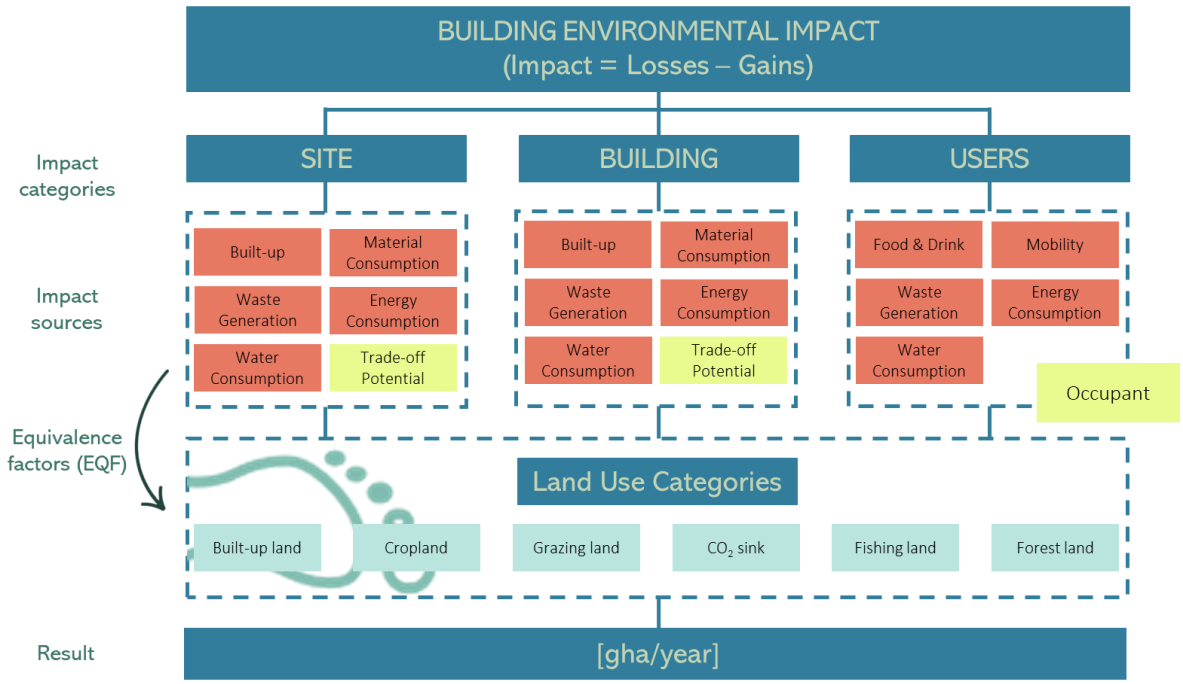

Figure 1. Workplace Integrated Ecological Footprint Assessment calculation model – elaboration of the authors

- Built-up land: 2,49
- Forest land: 1,28
- Fishing land: 0,74
- Pastureland: 0,46
- Cropland: 2,49
- CO_2 sink factor: 0,41

RESULTS

The case studies have been selected based on the following criteria:

1. The buildings must be a primary location of companies in Italy;
2. The organizations must belong to different industries and be all medium-large companies;
3. The buildings must vary in size and age;
4. A mix of workspace arrangements was sought: traditional workspace, activity-based workspace, coworking space.

The selected case studies (Table 2) represent a good mix of the factors described, which enabled an initial analysis of which factors most significantly influence the results, both in terms of building technological solutions and occupancy levels. The selected cases are located in Milano, Parma, and Brescia. The companies represent five different industries (pharmaceutical, facility management, technology, real estate, and multiservice companies) and count between 200 and 900 employees. The buildings vary in size and age from 6.000 to 44.000 square meters and from 1 year old to 73 years old, with various workspace arrangements.

Overall, the WIEFA application shows results in the same order of magnitude (from 237 gha/year to 1170 gha/year), which contributes to confirming the soundness of the methodology. In general, the age of the building results in a less efficient building system that causes a greater environmental impact. However, WIEFA is significantly affected by other aspects. For instance, by comparing Building D and Building H, it emerges that the environmental impact of Building D is greater due to the size of the building, entailing higher consumption not only of energy but also of water and materials, despite its more recent year of construction. Especially, its impact is remarkable when considering that the average occupancy does not exceed 50% which increases the account of WIEFA/occupant.

In sum, to understand the degree to which users' behaviours affect the environmental impact of offices, several factors emerge that highlight the potential of WIEFA in addressing sustainable principles to workplace and facility management, as follows.

Table 2.WIEFA results of the nine case study companies – elaboration of the authors.

YEAR	GENERAL DATA	CASE STUDY	BU	EC	WC	MC	F&D	M	WG	TOP
2022	Case study	**Building D-2**	6,43	566,85	6,78	27,12	168,11	135,10	140,24	-74,32
	Industry	Pharmaceutical								
	N employees	479								
	Average occupancy	230								
	Age	3								
	Location	Parma								
	Total SQM	30.503								
	Type of building	Office Building								
	Ownership / Tenant	1 Tenant								
	Workspace arrangements	Activity-based								
	Green Certifications	LEED Platinum								
Total WIEFA [gha/year]			**976,32**							
WIEFA/occupant [gha/occupant year]			**4,24**							
WIEFA/employee [gha/employee year]			**2,04**							
WIEFA/SQM [gha/m² year]			**0,03**							
Football fields			**1.367,39**							
2022	Case study	**Building H**	1,22	176,51	2,74	43,93	332,11	112,23	151,37	-0,4
	Industry	Multiservice								
	N employees	989								
	Average occupancy	363								
	Age	53								
	Location	Brescia								
	Total SQM	14.077								
	Type of building	Office Building								
	Ownership / Tenant	Owner								
	Workspace arrangements	Traditional								
	Green Certifications	/								
Total WIEFA [gha/year]			**819,70**							

YEAR	GENERAL DATA	CASE STUDY	BU	EC	WC	MC	F&D	M	WG	TOP
WIEFA/occupant [gha/occupant year]			**2,26**							
WIEFA/employee [gha/employee year]			**0,83**							
WIEFA/SQM [gha/m² year]			**0,06**							
Football fields			**1.148,04**							
2022	*Case study*	***Building G***	*1,15*	*282,47*	*3,42*	*40,61*	*57,70*	*68,64*	*120,20*	*-0,01*
	Industry	*Multiservice*								
	N employees	*937*								
	Average occupancy	*222*								
	Age	*73*								
	Location	*Milano*								
	Total SQM	*15.707*								
	Type of building	*Office Building*								
	Ownership / Tenant	*Owner*								
	Workspace arrangements	*Traditional*								
	Green Certifications	*/*								
Total WIEFA [gha/year]			**574,20**							
WIEFA/occupant [gha/occupant year]			**2,59**							
WIEFA/employee [gha/employee year]			**0,61**							
WIEFA/SQM [gha/m² year]			**0,04**							
Football fields			**804,20**							
2022	*Case study*	***Building F***	*1,04*	*83,06*	*1,81*	*9,82*	*126,40*	*50,08*	*24,88*	*-8,32*
	Industry	*Facility management*								
	N employees	*250*								
	Average occupancy	*162*								
	Age	*35*								
	Location	*Milano*								
	Total SQM	*6.161,7*								
	Type of building	*Office Building*								
	Ownership / Tenant	*1 Tenant*								
	Workspace arrangements	*Traditional*								
	Green Certifications	*/*								
Total WIEFA [gha/year]			**288,77**							
WIEFA/occupant [gha/occupant year]			**1,16**							
WIEFA/employee [gha/employee year]			**1,78**							
WIEFA/SQM [gha/m² year]			**0,05**							
Football fields			**404,44**							

YEAR	GENERAL DATA	CASE STUDY	BU	EC	WC	MC	F&D	M	WG	TOP
2021	Case study	**Building E**	2,22	34,46	0,48	10,96	248,03	116,15	24,88	-0,06
	Industry	Technology								
	N employees	338								
	Average occupancy	100								
	Age	3								
	Location	Milano								
	Total SQM	30.503								
	Type of building	Office Building								
	Ownership / Tenant	1 Tenant								
	Workspace arrangements	Activity-based								
	Green Certifications	LEED Platinum								
Total WIEFA [gha/year]			**437,12**							
WIEFA/occupant [gha/occupant year]			**4,37**							
WIEFA/employee [gha/employee year]			**1,29**							
WIEFA/SQM [gha/m² year]			**0,01**							
Football fields			**612,21**							
2021	Case study	**Building D**	6,43	672,21	6,78	41,39	200,67	146,67	167,91	-70,81
	Industry	Pharmaceutical								
	N employees	500								
	Average occupancy	250								
	Age	2								
	Location	Parma								
	Total SQM	44.000								
	Type of building	Office Building + R&D								
	Ownership / Tenant	Owner								
	Workspace arrangements	Activity-based								
	Green Certifications	LEED Platinum								
Total WIEFA [gha/year]			**1.171,25**							
WIEFA/occupant [gha/occupant year]			**4,69**							
WIEFA/employee [gha/employee year]			**2,34**							
WIEFA/SQM [gha/m² year]			**0,03**							
Football fields			**1.640,41**							
2020	Case study	**Building C**	1,17	27,33	0,37	15,74	51,80	116,16	23,95	0
	Industry	Owner (Real estate)								
	N employees	450								

YEAR	GENERAL DATA	CASE STUDY	BU	EC	WC	MC	F&D	M	WG	TOP
	Average occupancy	*450*								
	Age	*1*								
	Location	*Milano*								
	Total SQM	*34.000*								
	Type of building	*Coworking space*								
	Ownership / Tenant	*Owner*								
	Workspace arrangements	*Coworking space*								
	Green Certifications	*LEED Platinum*								
Total WIEFA [gha/year]			***236,52***							
WIEFA/occupant [gha/occupant year]			***0,53***							
WIEFA/employee [gha/employee year]			***0,53***							
WIEFA/SQM [gha/m² year]			***0,01***							
Football fields			***331,26***							
2020	*Case study*	***Building B***	*0,46*	*223,99*	*0,12*	*18,28*	*112,18*	*105,67*	*15,83*	*0*
	Industry	*Real Estate*								
	N employees	*850*								
	Average occupancy	*100*								
	Age	*16*								
	Location	*Milano*								
	Total SQM	*23920*								
	Type of building	*Office*								
	Ownership / Tenant	*1 Tenant*								
	Workspace arrangements	*Traditional*								
	Green Certifications	*/*								
Total WIEFA [gha/year]			***476,53***							
WIEFA/occupant [gha/occupant year]			***4,77***							
WIEFA/employee [gha/employee year]			***0,56***							
WIEFA/SQM [gha/m² year]			***0,02***							
Football fields			***667,41***							
2020	*Case study*	***Building A***	*1,17*	*644,02*	*2,46*	*13,63*	*194,79*	*115,15*	*14,93*	*0*
	Industry	*Technology*								
	N employees	*338*								
	Average occupancy	*100*								
	Age	*3*								
	Location	*Milano*								
	Total SQM	*30.503*								

YEAR	GENERAL DATA	CASE STUDY	BU	EC	WC	MC	F&D	M	WG	TOP
	Type of building	*Office Building*								
	Ownership / Tenant	*1 Tenant*								
	Workspace arrangements	*Traditional*								
	Green Certifications	*LEED Platinum*								
Total WIEFA [gha/year]			***986,15***							
WIEFA/occupant [gha/occupant year]			***4,40***							
WIEFA/employee [gha/employee year]			***1,42***							
WIEFA/SQM [gha/m² year]			***0,04***							
Football fields			***1.381,16***							

Impact sources

Looking at the impact sources, reported in Table 2, WIEFA is primarily influenced by energy and material consumption. Looking in detail at the WIEFA results of the nine case studies, some considerations can be highlighted.

First, the Built-Up (BU) area is determined by the ground covered by paved areas, parking lots, and the ground floors of buildings. Building D is the largest and occupies a larger area compared to the others. However, when comparing the percentage of the covered area (paved area over site area), Building D covers only 59% of the total site area. Situated outside the city center of Parma, Building D has the potential to include more green spaces. In contrast, Building C and G, located in the city centre of Milan, occupy 100% and 96% of their respective site areas.

Energy Consumption (EC) depends on the heating and cooling systems. Thus, buildings like Building A and F, which use fuel-based heating systems, have a higher EC per square meter. In contrast, district heating systems used by Building D, G, and H offer a good compromise for energy savings.

Water Consumption (WC) is greatly influenced by the presence of green areas. Thus, Building D consumes more water than the others.

Mobility (M) depends on the number of employees accessing the office daily and the location of the offices. A building in Milan, being more accessible via public transportation, impacts M less than a building in the countryside.

Fifth, Food and Drink Consumption (F&D) significantly depends on the presence or absence of a canteen.

Material Consumption (MC) depends on the renovations carried out during the analysed year. On average, cleaning activities do not significantly impact the results.

Waste Generation (WG) increases with the total square meters of the building and the occupation level. In large buildings (such as Building D) or in highly occupied buildings (such as Building H) the WG is higher than in buildings with green policies, such as Building E that promotes plastic-free office.

Finally, Trade-off Potential (TOP) depends on the renewable systems installed in the building. As it was expected that the older buildings would not have implemented renewable energies solutions, even in the most recent ones it was surprising to find few to no systems (for instance, Building C, renovated in 2020 and LEED certified, is only equipped with a set-up for photovoltaic panels, which are not in place yet).

Exogenous factors

The unpredictable use of office spaces following the Covid-19 pandemic affected the WIEFA results for both years of analysis. By 2022, organizations began to establish new policies for smart-working, providing clearer definitions for the occupancy levels of offices. This trend is also evident in the analysis of Building D that, in 2021, accounted for 1.171,25 gha/year, and decreased to 976,32 gha/year in 2022. Building D achieved savings of over 1.000 MWh in district heating and approximately 100.000 kWh in electricity. These savings were realized through the adoption of technological systems that control indoor and outdoor temperatures, monitor user occupancy and comfort, and manage entropy. However, this decrease can be attributed also to a reduction in the workplace population (from 500 to 479) and workplace occupancy (from 250 to 230).

Unit of measurement

WIEFA highlights the (in-)efficient use of office space by providing different units of measurement. For interpreting the environmental impact EF/m^2, EF/employee, and EF/occupant are compared. An older building's technological system (such as, Building A) negatively impacts WIEFA. Conversely, Building F, G, and H, which are older than Building A, appear to perform better. However, Building A performs slightly better than F on footprint per employee, showing that the environmental impact is shared by more people (i.e., the employees assigned to the building). This data contradicts the WIEFA/occupant ratio, as WIEFA for Building A was calculated in 2020, amid the Covid-19 pandemic. Building A also is evenly distributed over its square meter. On average, the total m^2 available for occupants is 2,4 times the m^2 allocated for employees, meaning that the space utilization could be spread across more people.

Other certifications

LEED certification doesn't necessarily mean a lower WIEFA compared to non-certified buildings. This is evident in Building D when compared to others. Despite using advanced technological systems for partitions and plants, Building D WIEFA per employee remains high (e.g., Building D-2 results 2,04 gha/employee for 2022 vs. 2,34 gha/employee for 2021), indicating ineffective use of office space.

Conclusion

This study contributes to enhancing attention to various aspects of sustainability while supporting the main objective of the European Union to harmonize environmental impact assessment for buildings. New smart-working policies being adopted by organizations may highlight the presence of extra office space that is not fully occupied. While to reduce operational and energy costs, offices might shrink in favour of flexible space utilization, optimizing energy and space efficiency also depends on the O&M phase. Therefore, a detailed analysis of individual office will be necessary to correlate employees' behaviours, working arrangements, and building occupancy.

This study adopted PAR to implement an innovative environmental impact assessment for workplace and facility management by exploring the EF methodology to address sustainability challenges in the O&M phase of offices. Specifically, incorporating user behaviour into environmental impact assessments and making impacts understandable to a wider audience, beyond just professionals and

policymakers, were lacking in previous EF applications and became specific objectives of this research.

Noticeable is that, while implementing the PAR, the research team felt the need and the potential to progressively expand the panel of stakeholders. Participants covering the role of facility managers started being complemented with workplace managers, HR managers and energy managers. This may indicate that environmental issues are a transdisciplinary issue with cannot prescind from a human component and therefore should be managed both by professionals that usually have to do with the facilities' O&M and those who manage people (i.e. employees). WIEFA helps understand that people behaviour plays an important role in environmental sustainability, therefore sustainability strategy in offices is inherently linked with human resources and workplace management strategies.

Moreover, the results demonstrate the EF methodology's versatility in integrating user actions within buildings and confirm that the EF indicator is comprehensible to various stakeholders, including end-users (represented by company managers), workplace, facility, and HR managers of companies. This increased understanding marks a crucial step towards the progressive integration of EF into office environmental impact measurement and management. At the same time, it enables the evolution of cultural mindsets on sustainable behaviours and practices both on the side of those who manage buildings and on the side of those who utilize them. This supports workplace managers in developing strategies to optimize workspace utilization and reducing the building's environmental impact by influencing user behaviour.

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Session 2

Session 2A: Workplace Wellbeing and Effectiveness

Evaluating mental health in the workplace; Crafting an 18-item mental health scale for knowledge workers

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ABSTRACT

Purpose. This study aims to develop a holistic, short mental health at work scale to quickly monitor employees' mental health.
Theory. According to the Salutogenic Theory, health and disease are not separate entities, but health moves along a health-disease continuum. A salutogenic orientation to health focusses on strategies to solve health issues and promote positive outcomes. Unlike existing research that mainly focusses on mental illness or the experience of poor mental health, the current study investigates how both positive and negative aspects of mental health can be measured by just one scale with a limited number of scale-items.
Methods. A cross-sectional survey has been distributed among both private and public organizations the Netherlands. This survey measures ten mental health indicators, namely stress, mood, well-being, concentration, productivity, fatigue, sleep quality, burnout, engagement, and depression, based on previously validated scales. These indicators include short-term and more chronic consequences, and positive and negative states and feelings. An exploratory factor analysis (EFA) is performed on this dataset (N=1219) to explore the latent structure of a set of items. This approach enables to reduce the number of scale-items without losing valuable information.

Findings. With only 18 items (instead of the original 54 items) first insights in employees' mental health at work can be gained. These items load on the underlying factors stressful mood, fatigue, exhaustion, concentration, sleep quality, and disengagement, which include almost the entire width of the original mental health indicators.
Originality. The novelty of this study is that it provides an easy-to-be-used scale for workplace managers to monitor mental health and determine whether additional inquiries on specific mental health indicators are necessary. The scale is independent of organizational factors, which makes it a highly usable scale in any context.

Keywords

Scale development, mental health, salutogenic theory, factor analysis

1 INTRODUCTION

In 1946, the World Health Organization (WHO) officially recognized mental health as one of the three fundamental parts of health, alongside physical and social health. Mental health is defined as *"a state of well-being in which every individual realizes his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community"* (WHO, 1948, p. 10). This definition shows that mental health is a complete state, that should not only address the absence of disease, but should also include how to elevate mental well-being and protect against mental illness (Keyes, 2014). This perspective aligns with the Salutogenic theory, which posits that health moves along a health-disease continuum, emphasizing strategies to enhance positive health outcomes and the availability of personal and social resources (Lindström & Eriksson, 2005).

To effectively evaluate employees' mental health, both indicators of mental illness/ poor mental health and mental well-being should be used (Bergström et al., 2015). Bergefurt et al. (2022) introduced ten indicators of mental health that are in line with the WHO definition, including stress, depression, burnout, fatigue, well-being, engagement, concentration, mood, sleep quality, and productivity. In their study, each indicator was measured by a previously validated scale. However, to the best of the authors' knowledge, no studies so far have developed a single scale that encompasses the entire width of the health-disease continuum.

For instance, the 12-item General Health Questionnaire (GHQ-12) measures general dysphoria (i.e., anxiety and depression) and social dysfunction (i.e., enjoyment and coping) (Graetz, 1991; Politi et al., 1994). This scale focusses mainly on people's psychological health, leaving their cognitive and physiological capabilities out of scope. Another scale is the Warwick-Edinburgh Mental Well-being Scale (WEMBS) that measures mental and psychological well-being using fourteen positively worded items (Stewart-Brown & Kulsum, 2008). A disadvantage of this scale is that an additional scale should be used to measure poor mental health, which means that the full health-disease continuum cannot be measured by one scale only.

The increased number of employees in Europe who were absent from work due to mental illness -from 3.6 million in 2006 to 5.2 million in 2020- (Antczak & Miszczyńska, 2021) highlights the critical importance of addressing mental health in the workplace. Consequently, Breedvelt et al. (2020) advocate for a standardized measure that aligns positive and negative mental health symptoms. Addressing this need, the present study aims to develop a short, holistic mental health at work scale that spans the entire width of the health-disease continuum. Given that employers are advised to regularly monitor their employees' mental well-being (Kropman et al., 2022), this study aims to provide a comprehensive tool to quickly assess employees' mental health.

2 Method

2.1. Research method

The development of a new scale in social science consists of three steps, namely *item development, scale development,* and *scale evaluation* (Boateng et al., 2018). This study will describe the first two steps to develop a new mental health at work scale.

2.2. Item development

Step 1.1. Domain identification

First, the uniqueness of the new scale is checked by comparing it to existing scales. In this case, the to be developed mental health at work scale is compared to the GHQ-12 and the WEMBS (see introduction). As both these scale focus mainly on the psychological aspects (e.g., stress and mood) of mental health and leave cognitive (e.g., concentration and productivity) and physiological aspects (e.g., fatigue and sleep quality) out of scope, the new scale is expected to be unique. In addition, each of the mental health indicators is explored by a separate validated scale or survey instead of using one instrument to measure several indicators.

Step 1.2. Item generation

In this step, the pool of items is determined by using either a deductive (e.g., using existing scales/literature) or inductive method (e.g., using focus groups/interviews). In this case, a deductive method has been used, which means that items from existing scales are used to measure the mental health indicators. Table 1 shows an overview of the scales that are used to measure each of the mental health indicators. To evaluate stress, two items of the Four-item Patient Health Questionnaire for Depression and Anxiety (PHQ-4) (Kroenke et al., 2009) were combined with two items from the Stress and Worry scale (Beute & de Kort, 2014). For all other mental health indicators, all items of the original scales were adopted.

Table 1. Mental health scales

Concept	Scale/ survey	Measurement	Reference	Cronbach's alpha
Well-being	Health at Work Survey of WHO	0. Low well-being 10. High well-being	(WHO, 2001)	-
Productivity	Health at Work Survey of WHO	0. Low productivity – 10. High productivity	(WHO, 2001)	-
	Health Performance Questionnaire (HPQ)	1. All of the time – 4. Little of the time	(Kessler et al., 2003)	
Stress	Stress and Worry	1. Not at all – 4. (Nearly) every day	(Beute & de Kort, 2014)	0.87
	Four-item Patient Health Questionnaire for Depression and Anxiety (PHQ-4)	1. Not at all – 4. (Nearly) every day	(Kroenke et al., 2009)	
Depressive symptoms	PHQ-4	1. Not at all – 4. (Nearly) every day	(Kroenke et al., 2009)	0.75

Disengagement (burnout)	Oldenburg Burnout Inventory (OLBI)	1. Strongly disagree – 4. Strongly agree	(Demerouti & Bakker, 2007)	0.87
Exhaustion (burnout)	OLBI	1. Strongly disagree – 4. Strongly agree	(Demerouti & Bakker, 2007)	0.72
Concentration	Checklist Individual Strength (CIS)	1. Yes, that is true – 7. No, that is not true	(Beurskens et al., 2000)	0.87
Fatigue	CIS	1. Yes, that is true – 7. No, that is not true	(Beurskens et al., 2000)	0.92
Sleep quality	Single-item Sleep Quality Scale (PSQ) Health at Work Survey of WHO	1. Very bad – 4. Very good 1. Never – 4. Almost every night	(Snyder et al., 2018) (WHO, 2001)	- 0.66
Hedonic tone (mood)	UWIST Mood Adjective Checklist	1. Definitely – 4. Definitely not	(Matthews et al., 1990)	0.81
Tense arousal (mood)	UWIST	1. Definitely – 4. Definitely not	(Matthews et al., 1990)	0.83

2.3. Scale development

This phase consists of the following steps: *gathering a representative sample, reducing the number of items,* and *extracting factors*.

Step 2.1. Sample characteristics

First, a cross-sectional online survey was developed and distributed among a sample that sufficiently represents the population. This sample consists of knowledge workers within three private organizations (N=393) and one public organization (N=826), leading to a total sample size of 1219. The survey was distributed between September 2020 and January 2021.

Step 2.2. Item reduction

This step examines whether the number of items could be reduced by checking the internal consistency of the original mental health scales. When scales have more than two items, Cronbach's Alpha is calculated, which should range between 0.70 and 0.90. Values below 0.70 indicate poor interrelatedness or heterogeneity between scale-items (Tavakol & Dennick, 2011). Table 1 indicates that the Cronbach's Alpha for sleep quality is somewhat low, but since the Health at Work Survey has previously been validated, it was decided to keep all original items.

Step 2.3. Exploratory factor analysis

With exploratory factor analysis (EFA) the latent structure of a set of items can be determined. In this study, Oblimin rotation was used to accurately represent the underlying factors. To test the adequacy of the sample size (N=1219) for the factor analysis, the Kaiser-Meyer-Olkin test is used and should be between 0.80 and 1.00, which is satisfied (see Table 2). Furthermore, the significance of the Bartlett's Test of Sphericity indicates whether items are sufficiently correlated to perform a factor analysis (Shrestha, 2021). For the current sample, the Bartlett's Test of Sphericity is significant. To find a satisfactory model, an iterative process is used. This means that only strong factor loading coefficients above 0.40 are included, and cross loading coefficients below 0.30. In addition, the eigenvalues of the new factors should be above 1, as this indicates that the common variance of the factor is larger than

the unique variance (Shrestha, 2021). The internal consistency of the new factors is checked by calculating Cronbach's Alpha values.

To optimize the model even further, a three-item solution is tested, in which the three highest factor loadings are selected for each new factor. As a factor with less than three items is generally considered as weak and unstable, the number of items per factor is not further reduced (Costello & Osborne, 2005).

Table 2. Goodness of fit statistics EFA

Nr. of model parameters	73
Model test user model:	
Chi-Square	1774.916
Df	362
P-value	.000
Model test baseline model:	
Chi-Square	17130.427
Df	406
P-value	.000
Comparative Fit Index (CFI)	.916
Tucker-Lewis Index (TLI)	.905
Akaike (AIC)	88350.212
Bayesian (BIC)	88722.634
Root Mean Square Error of Approximation (RMSEA)	.057
Standardized Root Mean Square Residual (SRMR)	.053
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	.938
Bartlett's Test of Sphericity	16968.154

3 Results

3.1. Sample description

Table 3 shows the characteristics of the sample. It shows that respondents on average rated their sleep quality, concentration, well-being, and productivity rather positively. The mean scores for stress, depressive symptoms, exhaustion, disengagement, hedonic tone, tense arousal, and fatigue were on the low side of the scales. This indicates that, on average, people did not feel stressed, depressed, exhausted, or disengaged. Furthermore, employees indicated, on average, to feel more happy and satisfied than sad or low-spirited, and more calm and relaxed than tense and nervous. The larger standard deviations for several mental health indicators show that not all respondents rated their perceived mental health positively.

Table 3. Sample characteristics

	Study 1 (n=1219)	
	Mean	SD
Sleep quality (1. Low sleep quality – 5. High sleep quality)	3.80	0.75
Stress (1. Low stress – 4. High stress)	1.81	0.68
Depressive symptoms (1. Few symptoms – 4. Many symptoms)	1.59	0.66
Exhaustion (1. Low exhaustion – 4. High exhaustion)	2.32	0.44
Disengagement (1. Low disengagement – 4. High disengagement)	2.24	0.49
Hedonic tone (1. Happy, satisfied – 4. Sad, low-spirited)	2.26	0.45
Tense arousal (1. Calm, relaxed – 4. Tense, nervous)	2.29	0.67
Fatigue (1. Low fatigue – 7. High fatigue)	3.49	1.41
Concentration (1. Low concentration – 7. High concentration)	4.48	1.45
Well-being (0. Low well-being – 10. High well-being)	6.66	1.69
Productivity (0. Low productivity – 10. High productivity)	7.21	1.46
Productivity with 2 items (1. Low productivity – 4. High productivity)	3.42	0.56

3.2. Factor extraction – Exploratory Factor Analysis

After the first run, the EFA resulted in nine factors, with several items having cross-loadings above 0.30 or item-loadings below 0.40. These items were removed, resulting in one item for productivity, well-being, sleep quality, and concentration being removed, as well as two items for depressive symptoms, three for exhaustion, five for fatigue, five for disengagement, and six for mood. After several iterations, six factors were obtained that had acceptable goodness of fit values (see Table 2). Table 4 shows the final six factors and the corresponding items, with Cronbach's Alpha values ranging between 0.73 and 0.86. This indicates that the internal consistency of the factors is satisfactory. The six factors are labelled as:

- Stressful mood: Two items of the PHQ-4 scale and two of the scale by Beute and de Kort for stress, and three items of the UWIST for mood, accounting for 34.2% of the variance;

Concentration: Four items of the CIS for concentration, and two items of the HPQ for productivity, accounting for 7.6% of the variance;

- Sleep quality: Three items of the Health at Work Survey of WHO, and one item of the Single-item Sleep Quality Scale, accounting for 6.4% of the variance;
- Fatigue: Five items of the CIS, accounting for 5.8% of the variance;

Disengagement: Three items of the OLBI, accounting for 5.0% of the variance;

- Exhaustion: Four items of the OLBI, accounting for 3.7% of the variance.

Table 4. Exploratory Factor Analysis

		Stressful mood	Concentration	Sleep quality	Fatigue	Disengagement	Exhaustion
Stress	Feeling nervous, anxious or on edge	.87	.02	.02	.01	.001	.04
Mood	Nervous	.83	.04	.004	.03	.003	.01
Stress	Not being able to stop or control worrying	.81	.03	.05	.01	.02	.02
Stress	Feeling stressed	.77	.04	.03	.05	.03	.13
Stress	Ruminating/ agonizing over things	.72	.04	.12	.01	.05	.03
Mood	Tense	.68	.03	.03	.09	.05	.19
Mood	Sad	.52	.09	.09	.03	.15	.01
Concentration	I can concentrate well	.08	.78	.07	.05	.007	.09
Concentration	I have trouble concentrating	.04	.76	.02	.09	.001	.11
Concentration	When I am doing something, I can concentrate quite well	.08	.73	.11	.04	.04	.05
Concentration	My thoughts easily wander	.12	.73	.01	.006	.03	.06
Productivity	How often did you find yourself not working as carefully as you should?	.08	.65	.04	.03	.01	.06
Productivity	How often did you do no work at times when you were supposed to be working?	.08	.56	.08	.03	.09	.30
Sleep quality	Staying asleep, when you woke up nearly every night and took an hour or more to get back to sleep?	.06	.01	.88	.06	.02	.03
Sleep quality	Waking too early, when you woke up nearly every morning at least two hours earlier than you wanted to?	.03	.09	.79	.06	-03	.005
Overall sleep quality	Overall sleep quality	.05	.06	.68	.17	.008	.04
Sleep quality	Getting to sleep, when nearly every night it took you two hours or longer before you could fall asleep?	.10	.11	.60	.07	.02	.09
Fatigue	Physically, I feel in a good shape	.03	.08	.01	.94	.03	.05
Fatigue	Physically, I feel I am in a bad condition	.03	.06	.01	.87	.02	.07
Fatigue	I feel fit	.04	.12	.03	.75	.04	.05
Fatigue	I feel rested	.02	.10	.18	.48	.03	.32
Fatigue	I get tired very quickly	.04	.23	.01	.45	.06	.27
Disengagement	I always find new and interesting aspects in my work	.02	.05	.01	.03	.85	.05
Disengagement	I find my work to be a positive challenge	.01	.05	-.03	.05	.84	.08
Disengagement	I feel more and more engaged in my work	.02	.13	.03	.02	.69	.14

Exhaustion	After work, I tend to need more time than in the past in order to relax and feel better	.02	.04	.06	.04	.07	.73
Exhaustion	After my work, I usually feel worn out and weary	.21	.01	.007	.09	.06	.67
Exhaustion	During my work, I often feel emotionally drained	.27	.14	.01	.02	.13	.58
Exhaustion	There are days when I feel tired before I arrive at work	.17	.17	.02	.17	.01	.47
Cronbach's Alpha		.74	.82	.75	.86	.73	.82
Eigenvalues		9.92	2.21	1.85	1.69	1.45	1.08
% of variance		34.20	7.61	6.39	5.82	4.99	3.71

3.3. Factor extraction – Exploration of three-item solution

To improve the usability of the mental health at work scale in practice, three items are retained per factor, based on the highest factor loadings. Table 5 shows that the model has a satisfactory fit to the data. Furthermore, Table 6 shows that all item-loadings are above 0.40 and all cross-loadings below 0.30. The internal consistency of the factors is also satisfactory, as all Cronbach's Alpha values are above 0.70.

Table 5. Goodness of fit statistics EFA – Three-item solution

Nr. of model parameters	51
Model test user model:	
Test statistic	558.2
Df	120
P-value	.000
Model test baseline model:	
Test statistic	9326.2
Df	153
P-value	.000
Comparative Fit Index (CFI)	.952
Tucker-Lewis Index (TLI)	.939
Akaike (AIC)	54475.0
Bayesian (BIC)	54735.2
Root Mean Square Error of Approximation (RMSEA)	.055
Standardized Root Mean Square Residual (SRMR)	.052

Table 6. Exploratory Factor Analysis – Thee-item solution

		Factor loadings					
		Stressful mood	Concentration	Sleep quality	Fatigue	Disengagement	Exhaustion
Stress	Feeling nervous, anxious or on edge	.87	.03	.03	.04	.002	.002
Mood	Nervous	.83	.005	.006	.03	.009	.03
Stress	Not being able to stop or control worrying	.81	.03	.03	.02	.02	.04

Concentration	My thoughts easily wander	.08	.85	.02	.01	.00	.04
Concentration	I have trouble concentrating	.02	.82	.04	.08	.03	.02
Productivity	How often did you find yourself not working as carefully as you should?	.001	.76	.03	.03	.01	.01
Sleep quality	Staying asleep, when you woke up nearly every night and it took an hour or more to get back to sleep?	.06	.008	.90	.05	.009	.005
Sleep quality	Waking too early, when you woke up nearly every night at least two hours earlier than you wanted to?	.04	.07	.85	.04	.006	.02
Overall sleep quality	Overall sleep quality	.04	.10	.66	.16	.01	.04
Fatigue	Physically, I feel in a good shape	.01	.04	.009	.93	.005	.02
Fatigue	Physically, I feel in a bad condition	.03	.04	.02	.86	.00	.004
Fatigue	I feel fit	.01	.15	.03	.73	.03	.10
Disengagement	I find my work to be a positive challenge	.07	.04	.02	.05	.85	.13
Disengagement	I always find new and interesting aspects in my work	.02	.06	.004	.03	.85	.03
Disengagement	I feel more and more engaged in my work	.11	.18	.005	.006	.67	.17
Exhaustion	After my work, I usually feel worn out and weary	.04	.11	.002	.04	.01	.87
Exhaustion	During my work, I often feel emotionally drained	.10	.04	.02	.07	.10	.79
Exhaustion	There are days when I feel tired before I arrive at work	.03	.10	.02	.09	.04	.74
Cronbach's Alpha		.83	.75	.75	.84	.73	.80

4 Discussion, limitations, and conclusions

This study aimed to develop a holistic mental health at work scale that encompasses both ends of the health-disease continuum. Six factors were identified, including stressful mood, concentration, sleep quality, fatigue, disengagement, and exhaustion. These factors range from short-term to chronic mental health consequences, facilitating workplace managers the ability to monitor both severe and mild health issues. The scale can be used for descriptive purposes to provide insights into workers' mental health at a specific moment, but also for longitudinal assessment to determine mental health changes over time. These insights are valuable for (workplace) managers to offer necessary support, such as workplace design adjustments or mental support and training.

A limited number of unique scale-items were used to enhance the practical usability of the scale. As the scale is compact and independent from organizational or contextual factors, it is a versatile tool for monitoring employees' mental health in various settings. Workplace managers can use the tool to quickly assess employees' mental health, and determine if further investigation into specific mental health indicators is warranted. The instrument is also valuable for academia as it is applicable to several research goals, such as cross-sectional investigations of the workplace-mental health relationship, or longitudinal studies of mental health changes due to specific workplace interventions.

This study has described the first two phases of scale development and left the *scale evaluation* step out of scope. The three-item solution identified through exploratory factor analysis should be confirmed by a confirmatory factor analysis on an independent dataset. The structure that was found

in the exploratory factor analysis will serve as input for the confirmatory factor analysis. The goodness of fit of the model should be checked in the same way as for the exploratory factor analysis. Furthermore, Koopmans et al. (2014) suggest to check the validity of a new scale by verifying whether it is related to comparable constructs.

A limitation of this study is the broad sample, including employees from both private and public organizations. Consequently, the derived scale is somewhat generic. Investigating specific characteristics of employees from either public or private organizations and incorporating these specificities into the scale development could be beneficial. Another limitation is that both well-being and productivity were measured by a single-item scale, of which the items were deleted due to high cross-loadings. Single-item scales are typically less reliable due to higher measurement error (Christophersen & Konradt, 2011). Future studies could consider using multi-item scales, such as the WHO 5-Well-being Index (WHO, 1998) for well-being, and the individual workplace performance scale of Koopmans et al. (2014) for productivity.

Future research could focus on verifying the newly developed mental health at work scale, by performing the last phase of scale development (i.e., scale evaluation) using confirmatory factor analysis. Furthermore, it might be worthwhile to investigate whether multi-item scales for productivity and well-being are more reliable than the currently used one-item scales. Despite these limitations, the mental health at work scale offers an easy-to-be-used scale for workplace managers to monitor employees' mental health, covering the full spectrum of the health-disease continuum.

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Setting boundaries: Maintaining a healthy work-life balance for teleworkers in South Africa

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ABSTRACT

This paper aims to explore the experiences of teleworkers in South Africa, delving into their challenges and opportunities. It also discusses the effects of teleworking on work-life balance and motivation, providing recommendations for improvement. Despite extensive research on work practices and work-life balance, there is still a need for a consensus on the benefits of teleworking, especially in South Africa, where teleworking is uncommon. To gain an understanding of the teleworking experience outside traditional office spaces, ten semi-structured interviews were conducted with teleworkers from various industries, selected through purposive sampling. Data was analyzed using thematic analysis. The results show that support and resources are vital for teleworkers to thrive and maintain a healthy work-life balance, ultimately leading to improved motivation. Organizations should prioritize employees' well-being, collaboration, teamwork, knowledge sharing, and mentorship. This study is valuable for both employees and employers as they contemplate teleworking and seek ways to enhance work arrangements and management in South Africa. With teleworking gaining traction in South Africa, further research is necessary to comprehend the challenges and advantages for teleworkers in different industries. It is important to note that this study is limited to a small sample size of teleworkers in Gauteng Province, South Africa.

Keywords

Teleworking, Work from home, Work-life balance, Digital technology, Motivation.

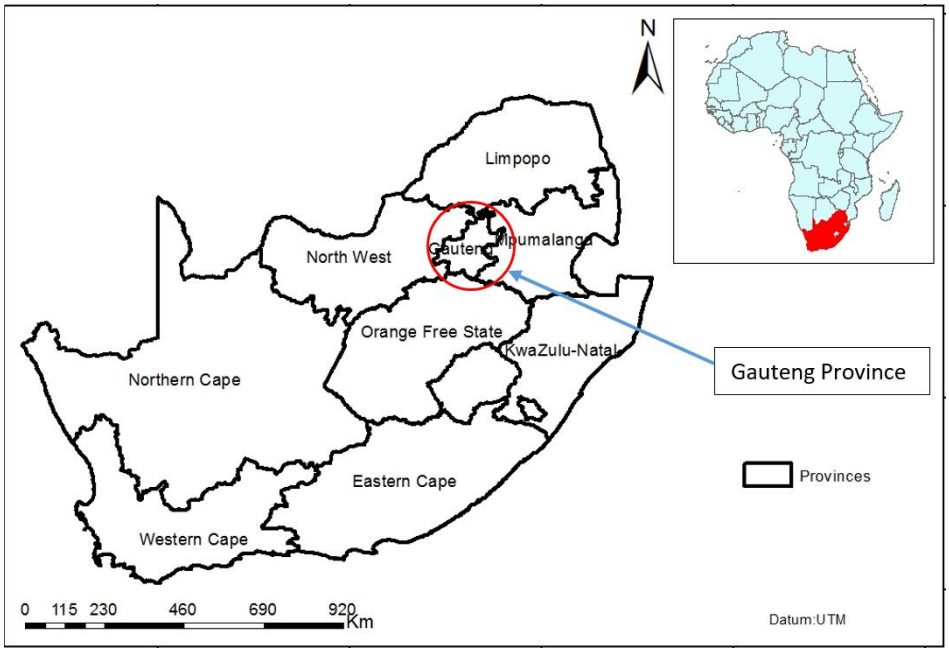
1 INTRODUCTION

Technological, social, and political changes significantly impact our lives, including work-life balance (WLB) (Vyas, 2022, p. 155). As a result, industries and individuals must take proactive measures to adapt in order to remain competitive amidst such transformations. For instance, the Fourth Industrial Revolution is leading to lasting changes in societies and economies, driven by accelerated digitalization and Artificial Intelligence, among other things. The advent of COVID-19 also served to accelerate the changes driven by the Fourth Industrial Revolution, which affected employees' work-life balance in many organizations. Organizations have had to adopt teleworking arrangements to sustain their operations (International Labour Organization [ILO], 2020; World Health Organization [WHO], 2020). Teleworking or as it is variously called, 'work from home', 'telecommuting', 'remote working', 'e-work', or 'virtual work', primarily requires information and communication technology (ICT) such as video conferencing and messaging tools, project management tools, video presentation tools, and data storage tools to allow the workforce to do its work outside the organization's physical location (Sahut and Lisillour, 2022; Sahut et al., 2022). Due to the COVID-19 pandemic, business trends have

changed, and many corporations have transformed, with most business activities now being performed through digital platforms (Battisti et al., 2022; Kniff et al., 2020).

The COVID-19 pandemic has profoundly impacted how organizations operate, leading to an acceleration of teleworking for many. However, some organizations worldwide still need to fully embrace teleworking, considering the advantages associated with on-site work arrangements, such as increased innovation and collaboration (Yang et al., 2021; Prager et al., 2022). In South Africa, as in many other countries, COVID-19 regulations forced many organizations to either halt or significantly reduce their operations, forcing them to explore alternative modes of operation to stay afloat. As a result, teleworking gained momentum as a mode of working despite it having been a privilege of the affluent in most places before the pandemic (DeSilver, 2020). Despite this momentum, several studies highlighted challenges with teleworking (Gibbs et al., 2021; Maier et al. 2022; Mustajab et al., 2020; Parker et al., 2020) and a need for more research in this area. Therefore, this paper explores the experiences of teleworkers in South Africa, exploring insights into their challenges and opportunities. It also discusses the effect of teleworking on work-life balance and motivation, offering recommendations for improvement. The focus is on teleworkers within Gauteng Province (Map 1).

Map 1: The location of Gauteng Province in South Africa.



2 Literature Review

Prior to the COVID-19 pandemic, most organizations provided designated workspaces for their employees; however, the separation between workplace and home was not complete (Silver, 2023). As already highlighted, some employees were allowed to work from home; however, it was usually seen as a special privilege reserved for certain employees (DeSilver, 2020). The concept of teleworking or e-work as a working model started in the 1970s (Katz, 1987); however, it was in the 1990s and 2000s, that teleworking started to mushroom (Huws, 1991; Mallus, 1998; Daniels, 2001; Siha and Monroe, 2006). Over the years until 2020, there was a growing demand for teleworking (Vitola and Baltina, 2013; Lachapelle et al., 2018). The advent of the COVID-19 pandemic significantly accelerated the adoption of teleworking and caused a re-evaluation of traditional workplace models (de Lucas Ancillo et al., 2020; Kniffin et al., 2021; Ratten, 2020; Savić, 2020). Due to the pandemic, many organizations allowed their employees to work remotely, with a preference for working from home or teleworking in most

scenarios. This manner of working is breeding a new culture of work and is influencing the way organizations operate, as they have embraced flexible work arrangements to cater to the changing needs of their employees.

Telework is a model of working that utilizes digital tools and takes advantage of technological advancements. To achieve their strategic objectives, progressive organizations embrace technology and the opportunities it provides for productivity, making digital tools essential for their workforce. With the increasing popularity of teleworking, the advancement in information and communication technology has made it more attractive. In essence, teleworking involves the use of information and communication technology (ICT) to work remotely, outside the physical location of the organization. (Lisanti, 2014; Offstein et al., 2010).

Besides technological advances, teleworking also came to be viewed as a work arrangement alternative giving employees some flexibility (Bernard et al., 2017). The flexibility of the employees implied that they could work in the spaces of their own comfort, be it at home or a coffee shop (Okoli, 2016). Therefore, teleworkers enjoy greater flexibility and can adjust their work schedules to better align with their personal and family needs (Vyas, 2022; 2021). The other benefits associated with teleworking include the following among others: improved performance (Bloom et al., 2015; Duther, 2012), increased job satisfaction by allowing flexible working hours (Lisanti 2014 ; Bloom et al., 2015), improved work life balance (Golden et al., 2006; Dockery & Bawa, 2014; Grobler and De Bruyn, 2011; Tomika et al., 2014), enhanced productivity (Bloom et al., 2015 ; Grant et al., 2013; 2019), financial savings in fuel and vehicle maintenance or travel costs (Hoch and Kozlowski, 2014), time-saving as no time is lost in traffic congestions (Shabanpour et al., 2018). While teleworking has its benefits, it is not embraced or viewed positively by all (Baruch & Nicholson, 1997; Peter et al., 2009; Aguiléra et al., 2016).

Teleworking also has its challenges that several studies have highlighted over the years. These includes productivity emerging from overworking, which impacts the health of the teleworkers (Vayre et al., 2022), feelings of loneliness and exclusion that negatively impacts on job satisfaction (Golden et al., 2008; Spikler and Breaugh, 2021); increased work disruption in the home environment (Gibbs et al., 2021; Mustajab et al., 2020; Parker et al., 2020); increased miscommunication; increased house operating costs, working long hours, disparity between teleworkers and regular office workers in the same organization (Maier et al., 2022). Balancing work and life is a challenge for teleworkers.

In South Africa, teleworking, while it was already gaining ground in some organizations, it was not the norm (Garg and Rijst, 2015). A survey conducted by StatsSA between April 29th and May 6th, 2020, showed that during the national lockdown, 77.9% (plus 1.5%) of those employed worked from their homes and no fixed location/mobile. This was a significant shift from the pre-lockdown period, where 95.6% used to work from non-residential buildings. However, with COVID-19 becoming a thing of the past, companies are starting to demand that workers return to office, this has also come with the drop in teleworking. Some suggest that in 2023, teleworking had dropped to about 40.8% while hybrid working has risen to 49.6% (see Business tech).

Whether teleworking is on the rise or decline in the South Africa context is neither here nor there, the fact remains that teleworking is here to stay, and therefore, at the heart of it is the issue of work life balance as failure to maintain the right balance would imply that either the employee suffers, or the company suffers. Therefore, in dealing with work life balance, focus is commonly on how employees balance between their family while getting the pleasure of life and career development (Mulling, 1999). Employees should be able to balance their responsibilities with minimal role conflict—be it responsibilities at work, home and in society (Clark, 2000; Brough et.al, 2014; Weckstein, 2008). Work life balance enables employees to unleash their full potential (Vyas, 2022). However, it is a challenge

to strike a balance between work and life but if achieved, it could help improve employees' well-being (Feeney & Stritch, 2019; Shagvaliyeva & Yazdanifard, 2014).

Some studies indicate that teleworking can increase work life balance (Crosbie & Moore, 2004; Pelta, 2020; Putri and Amran, 2021). With a good work life balance comes motivation to work, because employees have control over the way they work or schedule their work (Rupietta & Beckmann, 2016); however, failure to maintain the balance can lead to loss of work motivation.

3 methodology

For this study, semi-structured interviews were conducted amongst teleworkers across different industries. The data was collected between March and April 2024. Purposive sampling was used to select ten teleworkers who were interviewed for this study. All interviews conducted online on teams except one interview conducted on Whatsup. All interviews were recorded and cleaned up to ensure that the transcription represent the responses of the respondents. Thereafter, I went through the transcription to familiarize myself with the data before coding and identifying themes and patterns on the data.

3.1 Respondents profile

Information was gathered from respondents representing diverse industries (as indicated in Table 1) to gain insights into current trends. The respondents were experienced professionals, who possessed ample knowledge of telecommuting and provided valuable insights. There are two respondents in the financial sector: a Pension Fund Administrator and a Bookkeeper, as well as five Built Environment Professionals including a Construction Project Manager, Quantity Surveyor, Commercial Manager, and Property Analyst. In addition, there are Academics (Lecturers) and one Information Technology professional specializing in Digital Transformation and Knowledge Management.

Table 1. Respondents' profile

	Profession Background
Respondent 1	Pension Fund Administrator
Respondent 2	Bookkeeper
Respondent 3	Construction Project Manager
Respondent 4	Lecturer
Respondent 5	Lecturer
Respondent 6	Quantity Surveyor
Respondent 7	Digital Transformation and Knowledge Management.
Respondent 8	Commercial Manager
Respondent 9	Quantity Surveyor
Respondent 10	Property Analyst

4.1 Data presentation and analysis

Place of work

All ten participants are teleworkers work remotely but are occasionally required to be present in the office for certain meetings. One of them, Respondent 4, has opted to work from a co-working space in a coffee shop instead of their home. Those who work from home have designated office spaces or workstations in specific areas like the living room, dining room, or bedroom. One respondent

mentioned changing their workspace for inspiration and creativity, but ultimately, it boils down to personal preference (respondent 3). Some respondents have proper home offices, like respondents 4 and 5, while others work from any convenient spot in their homes. In any case, all the respondents have tailored their workstations to their liking to ensure they can be productive.

Support from Employer

Due to the pandemic, many individuals were required to transition to working from home, leading companies to provide various forms of support for their employees. This support ranged from administrative to technical, with respondent 1 mentioning that the employer even allowed employees to take home their office chairs and screens and provided them with 3G with enough data to last for months. Technical support was generally efficient unless an individual was not using a work laptop, in which case they were occasionally expected to bring their personal device to the office for configuration. While data was provided during the pandemic, respondent 3 noted that there was no teleworking policy in place and that technical support could have been more effective. Interestingly, after lockdowns were lifted, many companies recalled their employees, but respondents expressed reluctance to return to the office. However, all respondents agreed that there is support from both employers and colleagues while teleworking.

Teleworking and Working Hours

The interviews revealed that the participants had different schedules for work. Specifically, respondents 1, 2, 7, and 10 all begin their day around 8 am, but their end times differ. Respondent 1 sometimes struggles to stop working and end up working late, especially when dealing with projects that have tight deadlines. This can be quite challenging. Respondent 2 typically works throughout the day, and sometimes even on public holidays. Respondent 7 finishes work at 6 pm but may work longer if there is a deadline. Finally, respondent 10 takes breaks throughout the day but often works until midnight.

According to one respondent (respondent 3), working from home allows for more flexibility in their work schedule, as they can start working as soon as they wake up and continue throughout the day. Another respondent used to work around the clock but after experiencing burnout, they have set boundaries while still meeting deadlines (respondent 4). A third respondent (respondent 5) finds inspiration as their guide for work hours, while a fourth respondent works long hours from home, sometimes even overnight (respondent 6). They don't have to start their work at a specific time, unlike when working in an office. Lastly, one respondent tends to work beyond the typical 8-hour workday without keeping track of the hours (respondent 8).

Challenges in Teleworking

Teleworking is not free of challenges. The respondents highlighted several challenges they encounter while teleworking:

- *Distraction from children*: Respondent 2 and 3 shared their difficulty concentrating when their children are present, leading to distractions. This challenge would mainly affect those with young children. However, distractions may also come from other family members as well—a husband or wife, and guests.
- *Isolation:* Respondent 3, 6, 9, and 10 also remarked on the obstacles they face when separated from their team, as they often require face-to-face interaction to obtain information or assistance.

- *Information only available in the office:* While teleworking offers flexibility and access to information technologically, however, it is not all information that is readily available. Some information may only be available in the office, necessitating a physical presence (Respondent 3, 6, 8, 9, 10).

- *Not suited for all levels:* Respondent 3 believes that remote work is best suited for senior roles since juniors still require mentorship, knowledge transfer, and collaboration. Mentors must be nearby for effective knowledge transfer, and it is more manageable to approach someone's desk for help than scheduling an appointment. Junior positions can benefit from remote work if they prioritize learning. Working remotely can also affect relationships with colleagues, particularly when there are fewer opportunities to collaborate (Respondent 4). Respondent 1 expressed feeling guilty when unable to meet deadlines and consequently working more hours.

Benefits

Teleworking has its benefits. Several respondents shared their thoughts on the advantages of working from home.

- *Time saving:* According to them, not having to wake up early and commute to the office is a significant benefit. Respondents 1, 2, 3, 4, 5, and 10 mentioned that they no longer have to deal with the frustration of being stuck in traffic, a common issue in South Africa. Respondent 10 highlighted that traffic is the worst thing to experience in the morning and evening.

- *Flexibility:* Respondents 1 and 3 also mentioned that working from home allows them to structure their day more freely, while Respondent 10 pointed out that they save money on lunch because they used to buy lunch at the office. Respondent 5 also mentioned that working from home allows them to be there for their children when they return from school.

- *Power backup in time of electricity outages:* Power outages is one of the great challenges in South Africa. For employees working from home with back-up power such as solar panels or generators are able to continue with work when there is power outages (Respondents 1, 4, and 5), being able to access work systems on the phone (Respondents 3 and 7). However, many organizations are also having power backup systems to shield them from loss of production and productive during load shedding.

- *Collaboration:* Regarding collaboration with colleagues, respondents mentioned they are able to reach their colleagues using via telecommucation tools or video communation tools such as Zoom and Teams (Respondents 1, 7, and 10). Futhermore, there are platfforms such as SharePoint for collaboration (especially when working on something together). Respondent 6 mentioned that all their programs were live, making collaborating easier even when not in the office.

In summary, respondents found that working from home offers a conducive space to get work done, with fewer distractions enabling better concentration and increased motivation. Respondent 2 also mentioned that they want to show their employer they can do more work from home. For the interviewees, the measure of their productivity is the completed tasks (Respondent 1, 2, 4, 5, 7, 8, and 10).

Balancing work and life

Finding the right balance between work and life is key for teleworking. When COVID-19 came, it threw many into uncharted waters. Respondents 1 and 2 indicated they transitioned to working from home;

they initially focused exclusively on work. However, with time they discovered the importance of taking breaks during office hours to attend to household tasks or engage in other non-work-related activities, achieving a more harmonious work-life balance.

Respondents 3 and 5 expressed the freedom to structure their day to accommodate diverse activities beyond work. Respondent 4 uses a workspace located closer to their children's school, whereas respondents 5 and 8 can pick up and drop off their children, help with homework, and manage other household chores. However, respondent 8 understood the importance of setting boundaries to prevent overworking and compromising their well-being.

Respondent 7 values the flexibility of working from home but recognizes the need to maintain a reasonable balance between work and non-work-related activities. Respondent 8 highlighted the importance of having time to switch off from work and prioritize their family, having previously worked beyond regular hours. Overall, respondents have been successful in finding ways to balance work and personal life while working from home.

4.2 Discussion

Based on the feedback, many individuals appreciated the option to work from home citing its added flexibility. This sentiment aligns with previous research by Barnard et al. (2017) and Vyas (2022) on the benefits of teleworking. Participants shared that they worked longer hours and expressed gratitude towards their employer for allowing them to work remotely. They made a conscious effort to meet all their deadlines, resulting in increased motivation compared to when they were in the office. Some individuals even worked longer hours out of a sense of obligation for not being physically present at the office. Scholars have noted increased productivity while teleworking in various settings (Bloom et al., 2015; Duther, 2012). However, teleworkers' work-life balance tends to be compromised.

Many companies have adopted telework in response to the needs of their employees who work long hours. Teleworkers are generally content with working longer hours as long as it allows them to avoid returning to the office and offers the flexibility to fit in non-work-related activities during regular office hours. This arrangement creates a positive work atmosphere, as employers are not micromanaging their teleworkers.

Unfortunately, many employees transitioning to teleworking have faced difficulties adjusting to this new setup without proper training or workshops. Many have learned to manage their work and life balance through trial and error, often after experiencing burnout. While some have overcome these struggles, others are still dealing with burnout. Therefore, it is crucial to prioritize employee well-being among teleworkers, especially since many are putting in longer work hours.

Studies have shown that teleworkers often struggle to balance work and personal life (Grant et al., 2019; Nakrošiene & Butkevičienė, 2016; Palumbo et al., 2020). As such, it is essential to provide proper support and resources to teleworkers to help them maintain a healthy work-life balance.

The findings also shows that teleworking policies are either non-existent and for some companies, they policies need to be clarified. Many organizations struggle to enforce policies post-pandemic, while others are mandating a return to the office for all employees. However, certain employees have expressed reluctance towards this idea and argue that their work performance suffers when teleworking. Teleworkers must consider the long-term effects on their well-being, mainly as teleworking is a new concept requiring immediate attention in South African.

Based on the interviews with professionals from various backgrounds, teleworking is appreciated, but it can be challenging to maintain a healthy balance between work and family life. This is especially true when working from home, where it is easy for work to bleed into personal time. To establish clear boundaries, teleworkers need to have a designated workspace, whether it is in their home or at a separate location. Teleworkers must find ways to balance work and personal life to prevent a society where work takes over everything else, leading to negative long-term consequences.

The interviews shows that teleworking is a comfortable and viable option for many professionals across different fields. Nevertheless, certain professions such as those in the construction industry sometimes require an in-person office setting. Moreover, some jobs may necessitate infrequent visits to the office when circumstances demand it. These findings indicate that while some professionals can seamlessly work remotely, others may need to attend the office as needed.

Although teleworking has many advantages, new or junior employees often seek mentorship and engagement with more experienced colleagues. These interactions are most effective when employees are working in the office. According to respondents, there is a difference between calling on Microsoft Teams and walking to someone's desk because teleworkers do not feel the obligated or urgency to respond immediately. However, someone may schedule a meeting the following day or later, which may not be as convenient as immediate assistance. As a result, teleworking can be a disadvantage for knowledge sharing, collaboration, and mentorship, particularly when employees have varying levels of experience.

A recent study revealed that participants had no grievances regarding work-from-home expenses. They reported that costs were comparatively lower than when they used to work in the office, which is a different finding from previous research. The study emphasizes the importance of investing in digitalization to ensure that all documents and maps are digitized and accessible to telecoworkers. This will eliminate the need for physical offices or storage for paperwork since everything will be available digitally. To better understand why some organizations are hesitant to adopt work-from-home policies, further research is necessary. This will also aid in determining what organizations should do with their existing office spaces if employees telework.

5 Conclusion

In this exploratory study, the focus was on work-life balance for teleworkers in the Gauteng Province of South Africa. The results show benefits and challenges, indicating the need for further research to understand teleworking dynamics within specific industries with a bigger sample size. Teleworkers need adequate support and resources to succeed and maintain a healthy work-life balance, as these may help increase their motivation to get work done. The results also indicate a need for enhanced digitalization, particularly within the construction industry, allowing for all work-related data to be accessible online. Organizations should promote well-being, collaboration, teamwork, knowledge sharing, and mentorship. Teleworkers often encounter difficulties balancing their professional and personal lives, leading to physical, emotional, and mental strain, ultimately affecting motivation. Awareness and healthy work-life balance practices are crucial for successful teleworking and motivation.

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Stakeholders' perspectives on WELL Building Standard adoption within the APAC region: barriers and opportunities

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ABSTRACT

Over the last decade, there has been a surge of interest by industry around the importance of health and wellbeing initiatives aiming to improve workers' satisfaction, health and productivity. Organisations have demonstrated their commitment to these goals by incorporating these attributes into ESG (Environmental, Social and Governance) commitments and seeking certification and rating such as the International WELL Building Standard (WELL). Since 2014, WELL has certified nearly 80 million square meters in Asia-Pacific buildings. Despite this industry uptake, there is a shortage of peer-reviewed papers documenting the performance of certified spaces – at the time this abstract was written only eleven papers were found on Scopus. This constitutes a gap when closing the loop between the expected and actual performance of certified premises. This study aims to fill this gap by starting to map the main drivers behind the adoption of WELL programs within the Asia-Pacific region and the benefits received. To this end, semi-structured interviews were conducted with seven stakeholders from industry, including designers, workplace strategists, and/or consultants. Thematic analysis enabled critical benefits and challenges of WELL adoption to emerge. Preliminary findings underscore the expected impact WELL programs can have on enhancing employee health and well-being while also helping to foster an organisation's culture of health. For building owners, results from interviews show that there is agreement that certification adoption is likely to result in premium rents. Challenges were mostly associated with the costs of WELL implementation, particularly for tenant-occupiers, along with the expected need to adapt the standard to different contexts and to clearly articulate the motivation and expected benefits to be leveraged from WELL adoption. This study

provides insights into the WELL adoption in the Asia-Pacific region. Further research is needed to comprehensively understand the factors influencing its market adoption.

Keywords

CRE; decision-making; Asia-Pacific; health and wellbeing; WELL Building Standard.

1 INTRODUCTION

Over the years, sustainability rating tools in commercial property have gained attention in the design and construction field, given their pivotal role in addressing global energy consumption and CO2 emissions. The literature highlights the impact of adopting sustainable rating tools in many different fronts. Despite the fact that it often prioritizes environmental aspects over social sustainability (Awadh, 2017; Sayce et al., 2010; Zuo et al., 2014). Building rating tools were found to be instrumental in establishing a clear baseline parameter for achieving specific design strategies (Gollagher et al., 2017). Certification has also been identified to impact property prices and rent (Dalton & Fuerst, 2018; Fuerst & McAllister, 2011; Leskinen et al., 2020), with tenants willing to pay more for sustainable benefits associated with enhanced productivity and other corporate-level benefits (Leskinen et al., 2020), along with green building attributes such as air quality and access to natural light (Robinson et al., 2016). Additionally, building rating tools are pivotal for enhancing ESG performance, enabling organizations to showcase sustainability commitment in real estate assets by emphasizing considerations in building design and operations (Whistler et al., 2022), building construction, health and wellness and compliance with environmental standards (Urban Land Institute et al., 2023a).

Despite the presence of sustainable buildings in the market for years and their significant impact, a lack of understanding of real estate markets further impedes the implementation of sustainability rating tools. Ensuring an effective outcome out of sustainability rating tools adoptions requires a strong collaboration among all stakeholders involved (Gollaguer, 2017 and Ravik 2016), including end-users (Ravik 2016). The misalignment of incentives and knowledge (Hartenberger, 2008), valuer perception of sustainability rating tools (Warren-Myers, 2016), and the absence of a clear link between sustainability and value (Warren-Myers, 2012), along with a limited environmental awareness in the office building market, reinforce the challenges in achieving widespread adoption of sustainable practices.

More recently, some building rating tools have also shifted their approach to the social aspects of sustainability, with a focus on promoting health and well-being of building occupants and contributing to a more supportive work environment. These people-centric and health and wellbeing focused rating tools have had a faster annual growth in terms of implementation when compared to the first sustainability certifications developed in the late 90's and early 2000's in the corporate real estate realm (Danivska et al., 2019). Health and wellbeing strategies are expected to benefit business leaders and organizations, employees, investors, developers and other concerned actors (Joseph G. Allen & John D. Macomber., 2020). Furthermore, the Sustainable Development Goals emphasize the health and wellbeing as one of the primary goals for achieving global challenges (UN (United Nations), 2024), reinforcing a human-centric approach to the built environment. The importance of implementing

health and wellbeing in the workplace is consistently emphasised by the academic literature (Colenberg & Jylhä, 2021; Danielsson & Bodin, 2010; De Croon et al., 2005; Engelen et al., 2016; Flynn et al., 2018; Lindberg et al., 2018). The introduction of health and wellbeing design strategies can be beneficial in several ways. The indoor environment strongly influences employee health, affecting illness rates like allergies and asthma symptoms, ultimately impacting absenteeism and productivity (Ali et al., 2019; Danielsson & Bodin, 2010; De Croon et al., 2005), promotes postural changes (Zerguine et al., 2021), influence incidental physical activity opportunities and reduce time people spend seated (Engelen et al., 2017; Wahlström et al., 2019). A more human-centred approach to design of workspaces can positively impact satisfaction, perceived productivity and incidental physical activity opportunities (Candido, Chakraborty, et al., 2019; Candido, Thomas, et al., 2019).

These human-centric and more socially focussed sustainability approach has led the Corporate Real estate sector to develop, and increasingly adopt new building rating tools focused on health and wellbeing. A wide rang of health and wellbeing rating tools are available in the market nowadays, namely The Living Building Challenge (ILFI, 2024), Fitwel (Fitwel, 2024) and the WELL (IWBI - International WELL Building Institute, 2024). This constitutes an emerging trend and discussion around health and wellbeing in the built environment, suggesting that providing a healthy environment is thought to positively impact tenants, building owners, developers and more importantly, the end users (Joseph G. Allen & John D. Macomber., 2020).

The WELL Building Standard™ (WELL) is upheld in the industry as the world-leading tool for linking people's health and the built environment. Developed specifically to address the impact of the physical and social environment on human health, the tool draws support from academic literature distinguishing it for its robustness (McArthur & Powell, 2020),. Globally, WELL has certified more than 240 million square meters in buildings located in more than 98 countries (WELL Resources, 2021; IBWI-International Well Being Institute, 2019).

Despite the widespread adoption of WELL certification in Asia Pacific and worldwide, only a few peer-reviewed papers have been published to date focusing on research data from certified premises from a user and organisational perspectives. Five studies have used data collected from WELL-certified premises from a user perspective, usually evaluating user satisfaction, perceived productivity and health on certified versus non-certified spaces (Candido et al., 2021; Licina & Langer, 2021; Licina & Yildirim, 2021; Marzban et al., 2023; Xie et al., 2022).

These studies illustrate that while a non-certified office may offer a high-performance environment, WELL-certified premises surpassed non-certified on a range of environmental and non-environmental factors, including spatial and visual comfort, connection to the outdoor environment, building image and maintenance and overall performance, health and productivity, building and workplace cleanliness, colour, textures and furniture, physical configuration of the space and organisational aspects (Candido et al., 2021; Licina & Langer, 2021; Licina & Yildirim, 2021; Marzban et al., 2023; Xie et al., 2022).

When addressing the design process and its implications when adopting the certification, findings suggest that design baseline for achieving a high-performance workplace might differ when targeting features from the various WELL concepts. A study revealed that WELL certification requires a distinct

workflow in the building design process compared to other rating tools, which can potentially impact the design decisions between property owners and tenants, and the role of all professional involved in the design process (Villar & Shalaby, 2020).Regarding Sound Concept, the context in which the building is placed plays a significant role in impacting sound performance. Background noises were found to be difficult to address in cases where HVAC, environmental noise and building facades conditions are uncontrollable (Bourdeau, 2019). Gaps between local and international regulations and certifications, as well as challenges associated with integrating multiple certifications within a single project, were also found to be key implications of adopting WELL and other rating tools.(Villar & Shalaby, 2020).

The only study examining financial impacts of certification adoption show that WELL certified buildings were found to yield a 4.4 to 7.7 % rent premium per square foot when compared to their nearby non-certified buildings in the USA (Sadikin et al., 2021). These findings align with research on sustainable rating tools (Dalton & Fuerst, 2018; Fuerst & McAllister, 2011; Leskinen et al., 2020),.

Danivska et al. (2019) interviewed consultancy firms' representatives and showed that investments required combined with the complexity of the certification itself might be critical factors negatively impacting health and wellbeing certification adoption (Danivska et al., 2019). However, the compatibility with other sustainability tools have been found as a positive factor speeding up the adoption of health and wellbeing certification, including WELL, (Danivska et al., 2019). This indicates that Australian sustainability rating tools do provide insights into the coverage of the recently published IVS (International Valuation Standards) list of ESG categories, helping assist in providing direction to the market on how ESG is reported (Ghosn et al., in press).

These findings show an emerging but still limited understanding about the impact of WELL implementation in practice. To fill-up this gap, this research aims to map the main drivers behind the adoption of WELL certification within the Asia-Pacific. This paper introduces preliminary findings from semi-structured interviews conducted with seven stakeholders from industry, including designers, workplace strategists, and/or consultants. Findings from this research will help inform decisions on WELL certification adoption and report on expected impact on organization's returns and the health and wellbeing in the workplace.

3 METHODOLOGY

Semi-structured interviews were conducted to better capture the motivation and expected benefit leveraged from WELL adoption. This method was chosen for two main reasons: (1) it's efficiency in recruitment, and (2) the opened it provides for professional to discuss specific research topic in depth. Semi-structured interviews allow participants to answer the questions freely, ensuring a comprehensive coverage of the topic. Participants were recruited via several methods to ensure a balanced group. This includes strategies as establishing partnership with key institutions to help disseminate invitations, social media outreach, and targeted email invitations sent to consultancy firms and professionals. For this study, a total of seven people were interviewed between March and April 2023. This is part of a larger ongoing study, and this paper presents initial findings. The population for this study consists of professionals who are active within the APAC region, including, but not limited to, workplace strategists, designers, consultants, architects and/or WELL Accredited Professionals (AP) and/or WELL Advisory professionals. As depicted on Table 1, interviewees are: (i) professionals

that have experience and track-record on at least one certified project, and (ii) professionals with WELL AP and/or Advisory credentials. Interviews were recorded using Otter software, with the consent of the participants as per UoM's Ethics approval (Reference number: 2024-26791-50819-4). The transcriptions generated from OTTER in a word file were then uploaded into NVIVO 14 software for qualitative analysis. The interview questions focused on the professionals' beliefs regarding the main benefits and challenges of WELL adoption. This approach ensured that a wide range of insights and perspectives were captured, contributing to a thorough understanding of the topic.

Table 1. Participants profile.

Participants	WELL AP	WELL Advisor	Experience on WELL projects	Role
Participant 1		X	X	Consultant
Participant 2	X	X	X	Consultant
Participant 3			X	Consultant
Participant 4			X	Manager
Participant 5	X		X	Director
Participant 6			X	Director
Participant 7			X	Workplace strategist

4 FINDINGS

4.1 Word frequency analysis

Figure 1 depicts top 50 most frequently mentioned words during interviews, providing a high-level overview of topics. Findings show that wellness, buildings, certifications, people, employee, benefits, standards, designs, and spaces. These words collectively represent the diverse considerations involved in the WELL certification adoption and expectations about its likely impact on occupants' health and well-being. Key topics such as 'buildings', 'people' and 'benefits', reflects the WELL normative claims on being a people-centric building rating tool able at providing spaces that can enhance human health and wellbeing (IWBI, 2022, 2024). Topics as 'design', 'spaces', 'standards', 'benefits', 'organisations', 'sound', 'air' and 'sustainability', highlights crucial design considerations to be addressed and minimum performance goals essential for certain concepts and features when designing to meet the WELL standards (Bourdeau, 2019; Danivska et al., 2019; Villar & Shalaby, 2020). Although interviewees assumably would discuss WELL-relate topics, the word frequency analysis also reveals critical terms that reflect challenges, such as "cost", "change", "need", "investment" and "differently". Moreover, the analysis reveals a broader focus on building aspects rather than solely on the fit-out.

Figure 1. Word frequency analysis of transcripts.

4.2 Qualitative analysis of each topic

The Benefits of adopting WELL.

When it comes to expected benefits of the certification, seven main themes emerged from interviews, including:

(i) 'Employee Health'- where interviewees heavily mentioned that the WELL benefits is primarily focused on employee health and wellbeing.

(ii) "Design aspects", illustrating how the certification has become a standard when designing a space focused on health and wellbeing, benefiting end-users such as employees.

(iii) Building a culture of health", referring to how WELL can help build a culture of health, enhancing the sense of belonging to the organisation\.

(iv) "Benefits for Building Owners', covering aspects of WELL benefits exclusively for building owners and their returns.

(v) "Benefit for Tenants-Occupiers", referring to the benefits of WELL exclusively linked to tenant organizations and their reputation.

(vi) "Third-Party verification", covering aspects of the value of the asset and the organisation when having a third-party validation.

(vii) "ESG reporting", demonstrating the synergy between the certification and ESG reporting.

These findings align with research from certified projects highlighting the tangible benefits of WELL adoption on employee health (Candido et al., 2021; Ildiri et al., 2022; Licina & Yildirim, 2021; Marzban et al., 2023), and how WELL adoption can potentially impact the design baseline for achieving a high performance workplace (Bourdeau, 2019; Villar & Shalaby, 2020). Additionally, the benefits related to building owners, tenants and ESG reporting was also found in the literature regarding the adoption of

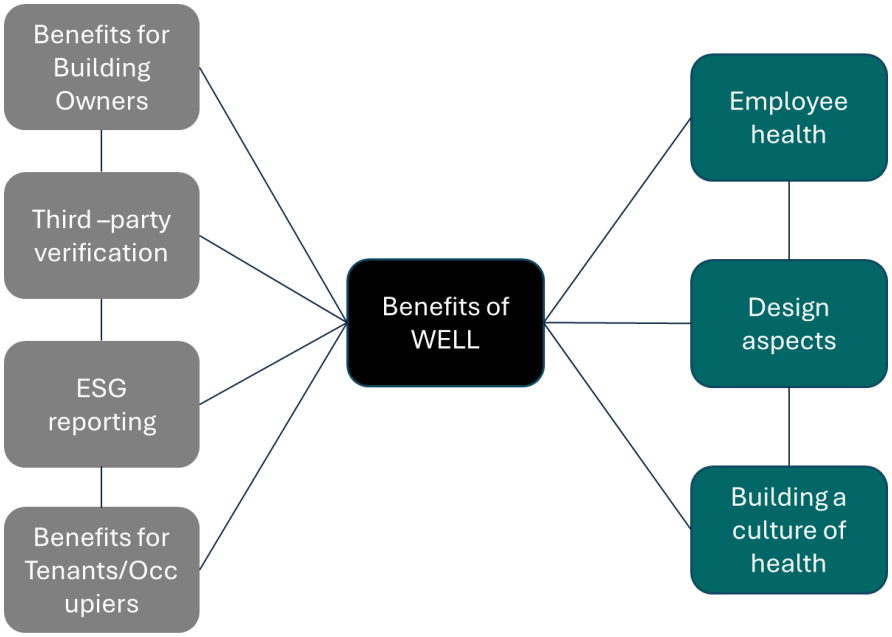
sustainable rating tools (Dalton & Fuerst, 2018; Leskinen et al., 2020; Urban Land Institute et al., 2023a; Whistler et al., 2022).

When thematically analysing the interview data on the benefits of WELL adoption, it was evident that certain themes are closely interrelated. Figure 2 illustrates the connections among themes on "Employee health", "Design aspects," and "Building a culture of health". It was frequently mentioned that WELL adoption helps create an environment focused on employee health, addressing issues beyond the scope of other rating tools that are usually focused on sustainability. It was also mentioned that the certification adoption helps create a *'blueprint of how a working environment" (Participant 2)* focused on health and wellbeing can be implemented. Sustainability rating tools were also found to work as a roadmap for designing and building sustainable buildings (Gollagher et al., 2017). Additionally, when focusing on employee health and wellbeing, organisations can foster a culture of health and wellbeing, that can positively impact the talent retention and employee health, and the sense of belonging to the space (Flynn et al., 2018). Participants mentioned that in improving health and wellbeing strategies, employees *"are going to be more productive" (Participants 1 and 6)* also improving *"physiological measurements, mood, sense of place" (Participant 1)*.

One participant also mentions the impact of COVID-19 is evident in talent retention strategies, with organizations aiming to bring employees back to the office despite downsizing. WELL certification adoption helps organizations demonstrate care for employees' well-being, ensuring a healthy workspace even with hybrid work arrangements. When discussing the design aspects of the space, one participant mentioned that, although it needs to be reviewed, some of the minimum performance addressed by WELL do *"call attention" (Participant 1)* to some design aspects that were not being discussed otherwise, including the importance and impact of sound and noise in the workplace. Additionally, participants also mentioned WELL as a corridor of best design practices, specifically when complying with thresholds that need to be met by the certification. A participant mentioned that "*...if I'm designing with well, then that number has to be religiously met. But if I'm not designing for well, then I'll do the best practice" (Participant 5),* when referring to certified to non-certified workspaces.

The themes related to the "Benefits for Building Owners", "Benefits for Tenants-Occupiers", "Third-party Verification", and "ESG reporting" were also found to be closely interrelated. It was mentioned that the benefits of WELL certification help organizations demonstrate their commitment to health and well-being. Third-party verification through certification strengthens this commitment, enhances the organization's reputation as an *"ethical employer" (Participant 2)*. Similarly to what has been published regarding sustainable rating tools (Leskinen et al., 2020; Robinson et al., 2016), WELL adoption can help building owners to attract highly quality tenants, serving as a third-party verification showing that the building has achieved high quality standard. It was also mentioned that building owners also benefits from a rent premium from WELL adoption, aligning with research on the financial impact on WELL (Sadikin et al., 2021) and sustainable rating tools in general (Dalton & Fuerst, 2018; Fuerst & McAllister, 2011; Leskinen et al., 2020). Finally, and also aligning with the literature on rating tools (Urban Land Institute et al., 2023b; Whistler et al., 2022), WELL was mentioned to support building owners on ESG reporting, as a synergy has been found between ESG requirement and building rating tools (Ghosn et al., in press).

Figure 2. Themes emerged from qualitative analysis on the Benefits of WELL and its connections.



The challenges of adopting WELL.

When it comes to challenges of adopting the certification, six themes emerged from interviews, namely:

(i) "Cost of certification", covering aspects of how the cost of certification can become a barrier when implementing WELL.

(ii) "Design and Performance aspects", covers aspects of the performance of workplace and/or building after certification.

(iii) "Enhancing the WELL standard", exemplifies the need for some of the concepts to be enhanced in terms of minimum requirements and optimizations.

(iv) "Extra work required", refers to the additional time and resources required for implementation.

(v) "Challenges for Tenants", includes challenges face by tenants to certify and/or re-certified the workspace.

(vi) "Communication", covers aspects of the motivation behind pursuing the certification and how it is communicated to the employees.

Similar to what was found in the literature, the cost of pursuing and implementing the certification is commonly mentioned as a critical barrier to building rating tools, including WELL (Danivska et al., 2019). Additionally, changes in the design aspects and extra work related to the WELL implementation is also found to be linked to recent literature (Bourdeau, 2019; Villar & Shalaby, 2020).

Critical topics emerging from challenges of adoption were frequently intertwined in mentions during the interview including "Costs of the certification", "Challenges for Tenants", "Extra-work required", "Design and performance aspects", and "Enhancing WELL standard" (Figure 3). The "Cost of the certification" was mentioned in terms of implementation of features and concepts needed for the

certification to be successful attained and maintained over time (Danivska et al., 2019). This was particularly highlighted in the case of tenants/occupiers, which usually had a short lease period, making it challenging to maintain the certification. Shorter leases raise uncertainty about long-term commitment to a space, making the certification more appealing for those "*owning or renting entire buildings" (Participant 2)*. This impacts the verification system designed by WELL, including annual reporting and re-certification every three years. Re-certification processes ensures that the projects maintain compliance and relevance over time. Therefore, short-term leases may find it challenging to commit to certification due to the uncertainty about long-term commitment and additional cost and work involved with the certification.

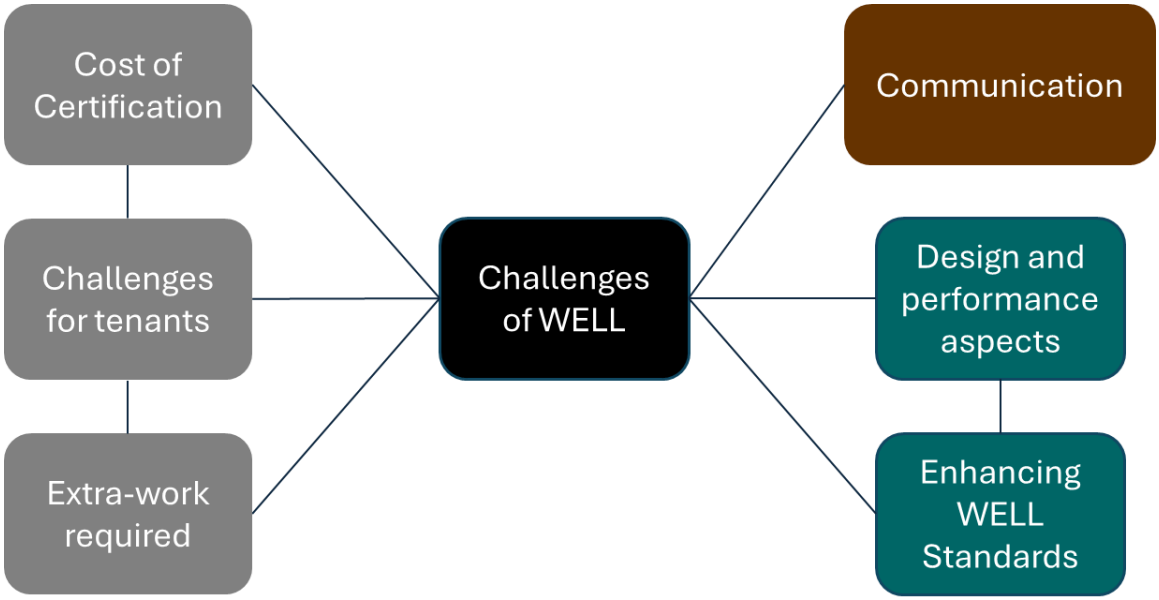
The cost of the certification was also associated with additional time and resources required for implementation of features and concepts. An example is the compliance with product and finishes thresholds, that when *"…designing with well, then that number has to be religiously met"(Participant 5)*. Additionally, it was mentioned that this cost, extra work and resources needed, such as hiring consultants, is likely to be *"make it inaccessible for small companies" (Participant 2)* to adopt the certification. In practice, this impression is supported by the number of certification led by building owners and/or large tenancies in Australia.

The "Design and Performance aspects" and the "Enhancing the WELL Standard" were mentioned focusing on the need for the certification to adapt to different contexts and consequently provide people with a more *"realistic picture" (Participant 1)* of a healthy building. The accuracy of certain performance tests, particularly those involving sound and other environmental factors as air quality, need to be improved to mitigate the potential for manipulation aimed at achieving test compliance. Such manipulation, usually taking place on the day of the test, may result in test outcomes that might not reflect the actual building performance and conditions experienced by occupants on a daily basis. Additionally, within the Sound Concept, some examples were given on the importance of considering the context in which the building in built, such as location, design strategies and HVAC systems, as it can impact the background ambience when setting sound levels. This is aligned with research emphasizing how background noises were found to be difficult to address in a WELL certified premises where HVAC, environmental noise and building facades conditions are uncontrollable (Bourdeau, 2019).

Lastly, the theme regarding "Communication" reveals that effective communication with employees is essential when disclosing and articulating the expected benefits and motivation behind adopting WELL within a project. It was mentioned that the *"challenge is ensuring that people are aware of it, and why we are a WELL building" (Participant 7)*. Effectively communicating the adoption of WELL certification, particularly to the employees, is crucial to ensure that all stakeholders are informed about its significance and implications. The lack of effective communication may impact the purpose of WELL adoption and how it can impact employee's daily activities *"the benefits are only as good as people knowing about them" (Participant 7)*. This lack of awareness can result in missed opportunities to leverage the benefits of WELL certification for improving health, well-being, and overall productivity within the workplace. Additionally, WELL offers a number of pre-requisite and optional features emphasizing stakeholder engagement from the project's starts, aligning with other building rating tools (Ravik et al., 2016). Ensuring effective communication to all stakeholders, from design to building

operations can significantly influence long-term project outcomes. Additionally, increased transparency regarding how certifications are achieved would undoubtedly improve understanding of building and/or fit-out performance. Unlike prerequisite features, understanding which optional features are most implemented can significantly enhance transparency and comprehension of performance.

Figure 3: Themes highly aligned on the Challenges of WELL adoption, and its connections.



5 CONCLUSION

This paper presented preliminary findings from research focusing on mapping the benefits and challenges of WELL Building Standard adoption within the Asia Pacific region. Findings from interviews with industry stakeholders shed light on the diverse range of aspects involved in the WELL certification adoption.

When talking about the benefits of adoption of the certification, seven different themes emerged, namely “Employee Health”, “Design aspects”, “Building a Culture of health”, “Benefits for Building Owners”, “Benefit for Tenants-Occupiers”, “Third-Party verification”, and ”ESG reporting”. These benefits highlight the potential of WELL on enhancing employee health and wellbeing, while fostering a culture of health within the organisation whilst demonstrating commitment and care for employee wellbeing. It also shows how these benefits can potentially and positively impact building owners by attracting high quality tenants and yielding premium rents.

Challenges of the certification adoption are mostly associated with costs, particularly for tenant-occupiers. The need for requirements to be adapted to different context was highlighted, as well as the

need to clearly articulate the reason and expected benefits from adopting the tool can be leveraged to further lift the uptake of the tool.

The interview responses could potentially be influenced by the background and role of the interviewees. The interviewees, who were consultants specializing in specific areas as sound, or air, and workplace strategies, might have had their professional background and expertise reflected in their understanding of WELL and its potential benefits or drawbacks for organisations and employees.

Limitations of this study can be linked to the small number of interviews conducted which may not fully represent the perspective within the targeted population, leading to potential bias in the results. Additionally, results presented in this paper reflect the perspectives of workplace strategists, designers, consultants, architects and/or WELL Accredited Professionals (AP) and/or WELL Advisory professionals, based on their perceptions of the benefits and experience designing and working with WELL programs. The perspectives of end-users, as building owners and tenants, were not measured within the scope of this study. Future research could include direct measures from end-user to provide more comprehensive understanding of the impact of WELL adoption.

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Workspace impacts and the moderating effect of job category on innovative team

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ABSTRACT

The literature highlights both positive and negative effects of the physical and architectural characteristics of spaces dedicated to project teams (Bernstein and Turban, 2018). Part of this influence is thought to stem from the impact on team member interaction, specifically team integration between members and subteams, which enhances creativity and effectiveness. Thus, the research objective is to further describe the mechanism of action of workspace design by exploring the moderation of job category (Artistic, Technical, and Administrative) on the effectiveness, creativity, and integration of team members in a combi offices design.

This study was conducted within a firm and its new product development (NPD) teams in different combi offices. It consists of 55 semi-structured interviews in the initial qualitative phase and a quantitative online survey with 645 valid responses. The results presented in this short paper mainly concern the quantitative part.

Results show that members of the Administrative job category are more demanding regarding most aspects of the space, while those in the Technical job category are the most positive, with Artistic team members often falling somewhere in between. The findings demonstrate a moderating effect, indicating that an open space contributes to team integration, which in turn significantly enhances team effectiveness and, to a lesser extent, team creativity.

Few researchers have examined how the diversity of multidisciplinary new product development teams affects the range of reactions to open space office designs and their associated layouts. Yet, this understanding could enhance the support offered to these teams.

Keywords

Workspace, Team integration, NPD team, Job category moderation, Team Creativity, Team Effectiveness, combi offices

1 INTRODUCTION

For several years now, workspace design has become more open and group-oriented, with an emphasis on inspiration (De Paoli, Sauer, and Ropo, 2019). Companies hope that creating open-space offices will attract and retain talent while boosting creativity, productivity, and reducing overhead. Accordingly, the new workspaces for new product development (NPD) teams are designed to support creativity and innovation (Coradi et al., 2015). The necessary "fit" between work setting layout and personal or professional needs has emerged over the years (Hoendervanger et al., 2019; Haynes, Suckley, and Nunnington, 2019) and suggests adopting more fine-grained methodological approaches (Maślikowsha and Gibbert, 2019). The research objective is thus to further explore the relationship between multidisciplinary NPD teams and how different categories of team members (Artistic, Technical, and Administrative) perceive the workspace (moderation effect). The research focuses on project teams and the combi offices that house them.

2 LITERATURE REVIEW

Researchers do not always describe the type of workspace observed in their studies; it is generally a form of open space. Seddigh et al. (2014) distinguish 5 workplace types: cell, shared room, open-plan, flex, and combi. De Been and Beijer (2014) consider three main types: individual and shared room offices, where we mainly find cell offices (from 1 to 3 occupants) with small shared room offices. The Flex Office and the Combi Office share the same design and layout, with only the use being different: in the Combi Office, workstations are mostly assigned to employees, while in the Flex Office, they are not reserved but are 'activity-based'. The other types of space that complete the office plan are the same. The aim remains to support both concentration and interaction (Van Meel, 2011), but moderating variables at the individual and organisational level can act to modify the outcome of the effects of space (see systematic reviews such as Engelen *et al.* (2019) and De Croon *et al.* (2005)).

2.1 Physical spaces and their effects

Employees are affected by noise, lighting, air quality and temperature (Sundstrom & Sundstrom, 1986). According to Bond-Barnard, Fletcher and Steyn (2018), proximity to team colleagues promotes collaboration, as does privacy and control over one's own environment, which must be of good quality for health and comfort (Colenberg, Jylhä and Arkesteijn, 2021). Other elements include aesthetics, attractiveness and the extent to which a space is emotionally, artistically or intellectually stimulating (Oksanen and Ståhle, 2013). The physical environment can also facilitate the creation of a collective identity, which in turn can promote cohesive and altruistic behaviour among project members

(Ashkanasy, Ayoko and Jehn, 2014) or encourage social networks that facilitate innovation (Wineman, Kabo and Davis, 2009).

2.2 Team integration leads to team effectiveness and team creativity

Integration was defined, many years ago, as the quality of collaboration between departments that must work together to meet the demands of the environment (Lawrence and Lorsch, 1969, p. 11). Coordination is defined as follows by Van de Ven *et al.* (1976, p. 322):

"..integrating or linking together different parts of an organisation to accomplish a collective set of tasks."

Pinto and Pinto (1990, p. 203) believe that cross-functional collaboration depends on the quality of interpersonal and instrumental relationships between members of functional units who work together to accomplish organisational tasks. Creative processes are not only internalised, but are mainly found at the intersection of an individual and his or her environment (Glaveanu et al., 2013). This may make them sensitive to physical layouts. Moreover, the transdisciplinary and collaborative work required to develop new products and services calls for spaces that are conducive to dynamic interactions on the one hand, and intensive, focused individual work on the other (Hua et al., 2011). Innovative workspace design influences organisational culture and creative processes (Kallio et al., 2015; Maślikowska and Gibbert, 2019; Dul and Ceylan, 2014), particularly through communication and collaboration (McCoy, 2000).

It is a blend of team characteristics, but also of team members' competencies and actions/reactions in an organisational context that leads to *team effectiveness* (a complex, multifaceted concept with important implications for overall organisational success (Andrews, 2012)).

Team creativity, in turn, has often been conceptualised and measured in terms of behaviours and the outcomes of these behaviours in terms of innovation and competitiveness (Montag, Maertz and Baer, 2012). Collaborative teams are known to readily accept suggestions from others and to take risks, qualities necessary for creative work (Barczak *et al.,* 2010).

2.3 Job categories as a moderating variable

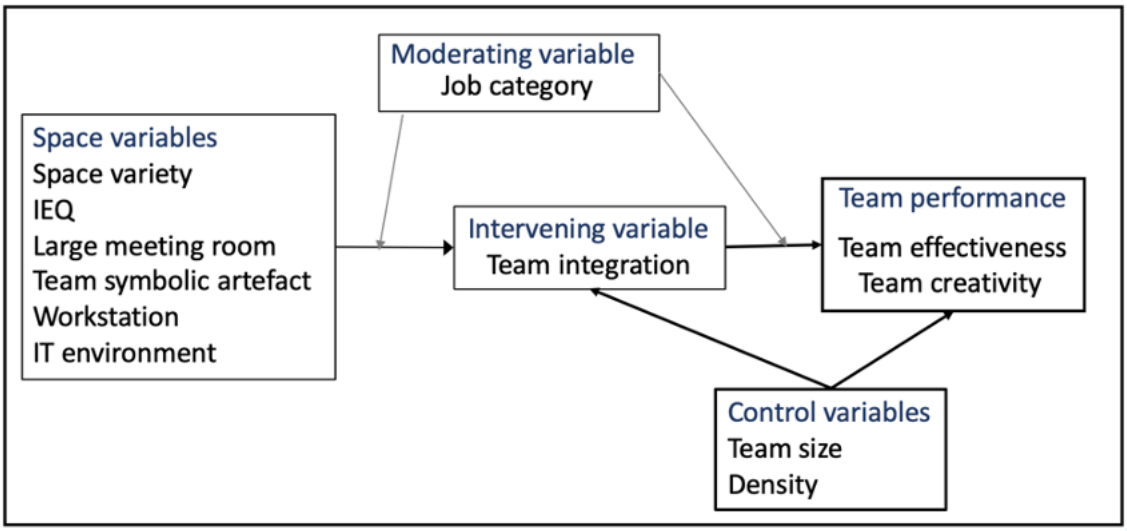
Research on workspace design mainly aims to clarify which characteristics best serve employees and organisations. Most studies give little attention to the typologies of individuals and organisations that may explain the effects of spaces and the reactions of individuals and groups (Smith, 2018). The paradigm seems to be that employees' perceptions are homogeneous, and so there is no need to add data on the nature of their roles. However, some researchers note that findings on workspace effects are often contradictory, which seems to indicate that explanatory and moderating variables have not yet been identified (Zerella *et al.*, 2017; Zhu and Zhu, 2013).

Other studies draw on the theory of person–environment (P–E) fit to find moderating variables between the environment and satisfaction with it or employee performance. Moreover, Vleugels *et al.* (2018) recommend being careful that the workplace design helps support a positive affect and thus allows employees an experience that reinforces a positive perception of person-environment fit.

In short, the literature highlights positive and not-so-positive effects between the physical and architectural characteristics of a space dedicated to project teams (Bernstein and Turban, 2018). The following model (Figure 1) will thus be explored, where Team Integration is an intermediate factor between the independent variables and Team Creativity and Team Effectiveness, and where three key Job Categories (Artistic, Technical, and Administrative) form the moderating variable. Our hypotheses are as follows (*control variables nor Job category moderation on relationships are tested*):

1. Space Variables[6] and Team Integration, Team Effectiveness, and Team Creativity are perceived differently by Job Category.
2. Space Variables impact Team Integration.
3. Job Category moderates the relationship between Space Variables and Team Integration.
4. Team Integration impacts Team Creativity.
5. Team Integration impacts Team Effectiveness.

Figure 1. Research framework with proposed main effects (black solid line) and moderating effects (grey line)



3 METHODOLOGY

The study was conducted within an electronic entertainment company with its product development teams working at the same location. The performance of the company hinges on the excellence of its teams, all of which work in combi offices (renovated more or less recently). Each team has members representing three Job Categories, which are defined as Artistic, Technical, and Administrative based

[6] IT Environment, Workstation, Large Meeting Room, Team Symbolic Artefact, Space Variety, Interior Environment Quality (IEQ).

on HR categorisation and IT profile (documentation was made avalaible to the research team) and which form the moderating variable.

First, a series of 55 interviews was conducted to develop an understanding of the organisation's history and practices. Each interview was conducted by two research team members and recorded if permission was granted. Codification was done independently by the two interviewers and double-checked by a third team member.

An invitation from the management to complete the online survey hosted by the university was sent to the product teams. Each team's questionnaire differed only in the space layout section, which was based on photos and drawings of the different team spaces to ensure clarity on what was being evaluated.

3.1 Measures

Measurements are all inspired by previous studies (see the footnote of Table 1). Each variable is formed with the means of two to seven questions on a five-point Likert scale. A confirmatory factor analysis (CFA) was conducted to further qualify the variables. The preliminary analysis shows scale reliability, with Cronbach's alpha ranging from 0.69 to 0.89, which is satisfactory. We also find satisfactory discriminant validity between each variable (see Table A2). Convergent validity was demonstrated with a $\chi 2/df$ less than 3 (Kline, 1998), CFI > 0.9, RMSEA < 0.08 (Hair, Black, Babin and Anderson, 2010). For each factor, the lambda contributions were highly significant and the average variance extracted (AVE) was greater than 0.5 (Fornell and Larcker, 1981). A high AVE indicates a correlation between factor items that, on average, explain over 50% of the variance of the latent construct, which is good.

3.2. Quantitative Results

Table 1 reports the correlations among all the variables. Among the independent variables, the four variables directly related to the immediate workspace (Interior Environment Quality, Workstation, Large Meeting Room, and Space Variety) are strongly correlated, which suggests the respondents see them as parts of a whole. Team Symbolic Artefact is the least correlated while all others are generally strongly intercorrelated.

Table 1. Correlation Matrix

N=645	Mean (Std error)	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11
F1. Team creativity	3.77(0.61)	0.87										
F2. Team effectiveness	3.85(0.69)	0.476****	0.84									
F3. Team integration	3.89(0.68)	0.454****	0.778****	0.87								
F4. Space variety	3.34(1.12)	0.188****	0.336****	0.375****	0.89							
F5. Team symbolic artefact	3.53(1.08)	0.220****	0.255****	0.180****	0.013n.s.	0.83						
F6. Interior environment quality	3.19(0.80)	0.160****	0.339****	0.379****	0.517****	0.038n.s.	0.74					
F7. Large meeting rooms	3.92(0.81)	0.215****	0.395****	0.464****	0.438****	0.009n.s.	0.381****	0.88				
F8. IT environment	3.66(0.84)	0.240****	0.457****	0.518****	0.330****	0.141****	0.318****	0.402****	0.89			
F9. Workstation	3.60(0.98)	0.091*	0.428****	0.395****	0.469****	0.048n.s.	0.514****	0.389****	0.362****	0.69		
F10. LN_Density	4.04(3.25)	0.004n.s.	-0.068n.s.	-0.073n.s.	-0.071n.s.	0.170***	0.012n.s.	-0.082n.s.	-0.076n.s.	-0.050n.s.	--	
F11. Team size	289.4(107.5)	-0.024n.s.	-0.027n.s.	-0.064n.s.	-0.132****	-0.021n.s.	-0.066n.s.	-0.149****	0.043n.s.	-0.166****	-0.025n.s.	--

* p < 0.10; ** p < 0.05; *** p < 0.01; **** p < 0.001;
Correlation strength interpretation based on Sawyer and Ball (1981): weak < 0.13; moderate < 0.26; strong > 0.26 and Hemphill (2003): weak < 0.20; moderate < 0.20 to 0.30; strong > 0.30
Blue number represents the Cronbach's alpha value (in the diagonal)

An extremely strong correlation can be observed between Team Integration and Team Effectiveness. Discriminant validity, however, is established (in Table A1, refer to the %AVE and the square root of AVE): the constructs are conceptually and statistically different.

We perform Kruskal-Wallis tests to determine the mean test of difference between variables for the three Job Categories. Thus, it is the degree to which Job Category has a direct impact on how the variables are perceived (Hypothesis 1). Members of the Technical job category provide the most positive evaluations (e.g., Space variety: Tech 3.64, Art 3.29, Adm2.77 sig 0.000****), except for Team Symbolic Artefact and Team Creativity. Technical employees are the ones who least need to move, which encourages managers to pay attention to their comfort in the open space office.

Not only is there no significant difference across Job Categories in how Team Creativity is assessed, but this variable is the only similar element across the categories. Paradoxically, Artistic employees have less need for Team Symbolic Artefacts in their space and rate Team Integration and Team Effectiveness less positively. Their assessments frequently fall between those of Administrative and Technical employees.

Table 2 shows the results of the structural equations modelling (SEM), which includes all the items of each variable as well as all their relationships, as shown in the model (Figure 1), thus testing hypotheses 2, 3, 4 and 5, summarised with the results in Table 3.

Table 2. EQS Model for the whole sample

All categories	LN Density Beta	LN Density T--V	LN T. size Beta	LN T. size T--V	Space variety Beta	Space variety T--V	T.symbolic Beta	T.symbolic T--V	IEQ Beta	IEQ T--V	Large meeting r. Beta	Large meeting r. T--V	IT environ. Beta	IT environ. T--V	Wrkst Beta	Wrkst T--V	T. integration Beta	T. integration T--V	R^2 (%)
T. integration	-0.083	-1.113	0.103*	1.296	0.063	0.642	0.202****	3.211	0.032	0.762	0.166**	2.061	0.167**	2.420	0.403****	3.59			49.9
T.creativity	0.037	0.612	0.006	0.092													0.454****	6.130	20.4
T. effct.	-0.010	-0.234	0.045	1.065													0.895****	9.610	79.9

KHI2	1456.216	P	0.00000	CFI	0.998	AGFI	0.738	
DF	933	KHI / DF	1.561	IFI	0.998	RMSEA	0.052	
		BENTLER-BONNETT	0.995	GFI	0.783			

Table 3. Hypotheses and results

1	Space Variables and Team Integration, Team Effectiveness, and Team Creativity are perceived differently by Job Category	Supported except for Team creativity
2	Space Variables impact Team Integration	Supported except for IQE
3	Job Category moderates the relationship between Space Variables and Team Integration	Not supported for IEQ, Large meeting room, Workstation, IT
4	Team Integration impacts Team Creativity	Supported
5	Team Integration impacts Team Effectiveness	Supported

4. DISCUSSION

Following the conclusions of Zerella *et al.* (2017) and Zhu and Zhu (2013), we formulated Hypothesis 1, which suggests that Job Category has a direct effect on Space Variables (Space Variety, IEQ, Large Meeting Room, Team Symbolic Artefact, IT Environment, and Workstation) and on Team Variables

(Team Integration, Team Creativity, and Team Effectiveness), as well as Hypothesis 3, which suggests that Job Category moderates the relationship between Space Variables and Team Variables.

McCoy (2000) notes that more Artistic people do not consider the aesthetics and beauty of locations to be important to their performance, and this is shown in the Kruskal-Wallis tests. Space Variety ranks second in terms of its effect on Team Integration in the Artistic job category but is negative for the Administrative job category and non-significant for the Technical job category.

Note that although correlations are strong with Team Integration and Team Effectiveness, none of the Job Categories shows the impact of IEQ. Quality of air and lighting are considered important by the facility manager and there is little difference in this regard between buildings and floors, which may explain the result. Also, beyond a certain level of comfort, there may be no improvement in satisfaction.

4.1 Theoretical implications

Moderating effects are difficult to distinguish using standard statistical tests, and the literature sometimes provides little guidance. However, as with some workspace research, studies in environmental psychology have pointed to moderation at the individual, team and organisational levels of analysis (Hoendervanger *et al*., 2019; Armitage and Nassor-Amar, 2021). Reflecting on these findings may open up the prospect of a new, more nuanced understanding of job requirements in terms of workspace design for teams.

4.2 Limitations and future research direction

Although this study shows that aspects of the physical environment contribute to the performance of innovative teams, our study is not without its weaknesses. Despite a variety of layouts across the teams, none were in a different type of layout (e.g. low partitions), which would have provided a more diverse comparison. In addition, the teams worked on site, mainly because of their equipment and the need for confidentiality.

The primary quantitative data collection instrument in this study is a self-administered questionnaire that collects data on dependent and independent variables, which tends to inflate relationships. Despite precautions and tests of discriminant validity, it cannot be claimed that the study is free from this problem.

5 Conclusion

The purpose of this study was to examine certain aspects of the physical work environment and their impact on new product development teams. Based on several months of observation and on interviews, we also wished to explore the moderating effect of Job Category. We did indeed discover a range of perceptions and relationships.

In addition to the questionnaire, the interviews and observations led to the conclusion that Artistic employees struggle more with an open space office design; they often need to isolate themselves more often and therefore appreciate nearby individual and small group rooms, quieter informal spaces and even meditation rooms or rooms where the work of local artists is exhibited. Conversely, technical

professionals are rarely seen in these spaces as they seem to spend their entire day in the open space area.

This study suggests a relationship of influence between the physical layout of an office and the degree of Team Integration, which in turn fosters Team Effectiveness and Team Creativity. To date, the literature on workplace design has proven this relationship for individual workers.

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Table A1. CFA

	Team creativity	Team effecti-veness	Space variety	Project commitment	Interior Environment Quality	Large meeting room	IT support	Work-station	Team communi-cation	Team collabo-ration	Team integration
My teammates often suggest new ways to achieve our goals.	0.863****										
My teammates often develop and promote new ideas.	0.907****										
My teammates often suggest new ways to improve the quality of our product.	0.691****										
My teammates often discover new practical ideas to improve our performance.	0.971****										
The ideas I develop are often implemented.	0.694****										
Overall, the ideas I develop are relevant to the success of my team.	0.784****										
It's easy to get help from my colleagues.		0.800****									
I feel close to people at work.		0.611****									
I feel good at ..		0.742****									
Overall, I think this work is good for my health.		0.623****									
I am satisfied with the collaboration in my team.		0.770****									
The coordination in my team is adequate.		0.714****									
Our team can be considered effective.		0.708****									
I am satisfied with the variety of collaborative spaces on my floor.			0.914****								
The range of collaborative space choices is positive for our team coordination.			0.899****								
It is important for me to see our project branding in my workspace.				0.996****							
Our project branding should be more present in my workspace.				0.704****							
The lighting at my workstation is adequate considering what I am doing.					0.853****						
The amount of natural light in the workspace I use the most suits me.					0.716****						
The ambient noise at my workstation is low enough or non-existent to avoid disturbing me.					0.856****						
I am satisfied with the temperature in my area during the summer.					0.667****						
I am satisfied with the temperature in my area during the winter.					0.768****						
The air quality is excellent.					0.996****						
I do not feel unpleasant drafts.					0.708****						
The furniture of the large meeting rooms is adequate for our needs.						0.811****					
The layout of the large meeting rooms is adequate to our needs.						0.778****					
The IT equipment of the large meeting rooms is adequate to our needs.						0.797****					
The acoustics of the large meeting rooms are adequate to our needs.						0.720****					
The large meeting rooms are comfortable.						0.767****					
The IT environment facilitates the exchange of information.							0.793****				
I easily find information about productions thanks to the IT environment.							0.659****				
I have access to the right technology to support collaboration between colleagues in our city.							0.912****				
I have access to the right technology to support collaboration among colleagues around the world.							0.807****				
I can access all the resources and documents needed to complete my tasks.							0.914****				
I can adapt the furniture of my workstation to my needs.								0.638****			
I am satisfied with– workstation.								0.808****			
My workstation is spacious enough for me to perform my individual tasks comfortably								0.668****			
The communications I received made me feel part of the team									0.660****		
I received information in timely fashion in order to complete my work									0.619****		
Communication between employees is easy									0.744		
Communication between employees, team members and head managers is easy									0.668****		
There is a good trust among my colleagues										0.864****	
It is easy to communicate face to face between colleagues										0.755****	
We share knowledge that advances the work										0.719	
We exchange information about "who does what?"										0.836****	
Team communication											0.961****
Team collaboration											0.890****
AVE (%)	0.681	0.508	0.822	0.743	0.643	0.601	0.676	0.502	0.455	0.560	0.858

* p < 0.10; ** p < 0.05; *** p < 0.01; **** p < 0.001

KHI² 1687.904; DF 852; P 0.000; KHI/DF 1.981; BENTLER-BONNETT 0.992; CFI 0.993; IFI 0.993; GFI 0.861; AGFI 0.831; RMSEA 0.046

IEQ variable inspired by Kim and de Dear, 2013; Team creativity from Amabile et al., 1996; Team effectiveness by McGrath, 1964; Team Integration by Sharma, Lampley and Good, 2015; Downs and Hazen, 1977; Satisfaction and comfort by Candido et al., 2021; Hoendervanger et al., 2019.

Table A.2 Discriminant test with square root of AVE in diagonal

F1		F2		F3		F4		F5		F6		F7		F8		F10
0.825																
0.403****	10.974	0.713														
0.162****	3.784	0.394****	9.261	0.906												
0.235****	5.906	0.286****	6.575	0.044(ns)	0.896	0.862										
0.125****	4.059	0.314****	9.820	0.449****	14.954	0.056*	1.615	0.802								
0.199****	4.702	0.432****	10.460	0.500****	12.394	0.070*	1.430	0.358****	11.041	0.775						
0.224****	5.724	0.444****	11.649	0.357****	8.357	0.155****	3.474	0.256****	7.936	0.420****	10.267	0.822				
0.088**	1.887	0.497****	11.680	0.641****	17.065	0.035 (ns)	0.668	0.503****	16.132	0.492****	10.919	0.441****	10.049	0.709		
0.433****	10.953	0.896****	48.896	0.477****	10.864	0.249****	5.091	0.383****	11.468	0.503****	11.712	0.529****	13.568	0.505****	10.669	0.927

Table A3. Correlation Matrix

N=645	Mean (Std error)	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11
F1. Team creativity	3.77(0.61)	0.87										
F2. Team effectiveness	3.85(0.69)	0.476****	0.84									
F3. Team integration	3.89(0.68)	0.454****	0.778****	0.87								
F4. Space variety	3.34(1.12)	0.188****	0.336****	0.375****	0.89							
F5. Team symbolic artefact	3.53(1.08)	0.220****	0.255****	0.180****	0.013n.s.	0.83						
F6. Interior environment quality	3.19(0.80)	0.160****	0.339****	0.379****	0.517****	0.038n.s.	0.74					
F7. Large meeting rooms	3.92(0.81)	0.215****	0.395****	0.464****	0.438****	0.009n.s.	0.381****	0.88				
F8. IT environment	3.66(0.84)	0.240****	0.457****	0.518****	0.330****	0.141****	0.318****	0.402****	0.89			
F9. Workstation	3.60(0.98)	0.091*	0.428****	0.395****	0.469****	0.048n.s.	0.514****	0.389****	0.362****	0.69		
F10. LN_Density	4.04(3.25)	0.004n.s.	-0.068n.s.	-0.073n.s.	-0.071n.s.	0.170***	0.012n.s.	-0.082n.s.	-0.076n.s.	-0.050n.s.	--	
F11. Team size	289.4(107.5)	-0.024n.s.	-0.027n.s.	-0.064n.s.	-0.132****	-0.021n.s.	-0.066n.s.	-0.149****	0.043n.s.	-0.166****	-0.025n.s.	--

* p < 0.10; ** p < 0.05; *** p < 0.01; **** p < 0.001;
Correlation strength interpretation based on Sawyer and Ball (1981): weak < 0.13; moderate < 0.26; strong > 0.26 and Hemphill (2003): weak < 0.20; moderate < 0.20 to 0.30; strong > 0.30
Blue number represents the Cronbach's alpha value (in the diagonal)

Session 2B: Educational Workspace

Shared Use of Academic Workspaces

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ABSTRACT

Purpose

This paper discusses the shared use of academic facilities and related notions. Its aim is to examine modes for effective and efficient use of facilities in the post-pandemic era. The paper first defines the aspects related to the shared use of spaces on campuses and academic workplaces. Based on the factors, it illustrates nine modes associated with the shared use of workspaces. The various ways to use shared facilities are clarified in the model description.

Theory

Theoretically, the paper reviews the access-based consumption of academic facilities.

Design/methodology/approach

This paper examines data collected from two universities in Finland during 2022. The main findings are formulated in an inductive process using qualitative content analysis and the theory of shared use of facilities. The material comprises 18 semi-structured interviews and 10 group interviews conducted through workshops. The interviewees represent all levels of the academic environment: administration, professors, teachers, and students.

Findings

The findings discuss the shared use of facilities through three thematic clusters of aspects. The first cluster illustrates the sharing on campuses based on the user groups, the time/length of use, and the access option. The second cluster defines four levels for shared facilities: individual, team, interface, and organisation based. The third cluster concentrates on workspaces from the individuals' viewpoint and formulates nine work modes based on time and space variables.

Originality/value

The shared use of facilities in university and academic work contexts still needs thorough investigation after the pandemic. The data collected in this study represents well the cynical approach to the problems yet to be solved. The results benefit the briefing and designing of campus environments from various viewpoints for shared use of facilities. The role of facilities management should be to follow the change processes within users' sharing practices.

Keywords

Sharing, shared use, campus, workspace, academic workplace

1 INTRODUCTION

The higher education institutions and their functions are evolving (Alexander et al., 2019). The context of academic environments has drastically changed during the last decades due to many societal, technological, and pedagogical developments (Fisher, 2019; Whitton, 2018; Marmot, 2014; den Heijer, 2011; Harrison & Hutton, 2014; Temple, 2014; Benneworth, 2014). The digital environment has immersed itself in all situations, and the contemporary campus is both post-digital and hybrid (Lamb et al., 2021; Jandrić et al., 2018; Goodyear, 2022; Fisher, 2019). In the hybrid campus, the campus users can engage in activities at a suitable time and place (e.g. Fisher, 2019).

Universities have responded to these changes by adapting their premises (Marmot, 2014; Benneworth, 2014; Harrison & Hutton, 2014) and retrofitting the existing facilities to meet the users' evolving needs (e.g. Nenonen et al., 2016). While some universities have invested in new buildings (Whitton, 2018), many institutions have reduced their footprint and focused on more efficient use of facilities due to, e.g., financial pressures (den Heijer, 2011; Marmot, 2014; Harrison & Hutton, 2014; Whitton, 2018). Instead, the focus is on the quality of spaces over their quantity (den Heijer, 2011).

The more intensive use of facilities is enabled by strategies of sharing (Dugdale, 2009; Harrison & Hutton, 2014; Nordquist & Laing, 2015; den Heijer, 2011; Marmot, 2014), such as centrally controlled booking systems (JISC, 2006) and ad-hoc use of the in-between spaces that are not necessarily 'owned' or controlled by any faculties (Dugdale, 2009; Nordquist & Laing, 2015; Harrison & Hutton, 2014). The campus facilities are shared with the whole community (Dugdale, 2009), and the faculty- or field-specific communities enhance community identity (den Heijer, 2011). In a post-pandemic era, universities are re-evaluating the role of campuses and what constitutes both effective and efficient premises as the hybrid campus realises. Lundgren et al. (2022) found that the virtual and hybrid solutions partially replace even the physical shared spaces. However, the various aspects of sharing require further discussion as the campus community consists of many levels and practices of use, and the traditions of sharing are rare in faculty-orientated premises.

Given the multitude of viewpoints to consider, the shared use of academic environments could benefit from systematically defining related concepts and notions to support the design and development of campuses. This paper is founded on the assumption that shared use is an effective and efficient method of using facilities post-pandemic. The second assumption is that the motivation for sharing

varies depending on whether the driver is organisational, team or individual. Thus, this paper aims to define the aspects and related variables of shared use that can benefit the evaluation, design and development of academic facilities.

The research questions are:

1. Which aspects influence the shared use of academic premises (from users' viewpoints)?
2. What are the levels of shared use in academic premises and workspaces?

2 Literature / shared use of academic workspaces

The shared use of facilities has gained new interest in general through the sharing economy (Brinkø et al., 2015; Reike et al., 2018). It is a business model where consumers pay for the function or utility instead of owning the products, which can lead to more efficient use (Ranjabi et al., 2018). In turn, the sharing economy facilitates access-based consumption (Curtis and Lehner, 2019) that in the built environment can be seen as short-term or flexible lease of spaces or spaces with a type of sharing aspect (Lundgren, 2023).

Brinkø et al. (2015) have defined shared use of facilities based on a. the *openness of the community*, b. *the types of shared facilities*, c. *the access to the spaces* and d. *the size of the user group*. These viewpoints are founded on the questions of

1. *what* is being shared, i.e., the physical space,
2. *when* the facilities are shared, i.e., if sharing is simultaneous or serial,
3. *why* facilities are shared,
4. *who* are sharing, i.e., who has initiated it and if the sharing partner is individuals or organizations, and
5. *how* the facilities are shared, i.e., the different, context-dependent configurations.

Brinko et al. (2015) find the last viewpoint the most difficult.
Francart et al. (2018) highlight the importance of a holistic perspective of sharing spaces that entails both the tangible properties of shared spaces and social interactions within the user group. For building users, the tangible benefits include, e.g., lower costs and high quality of spaces, while social interactions include, e.g., the importance of group cohesion, trust, and creation of identity (Francart et al., 2018). Additionally, Francart et al. (2018) identified a third aspect related to the internal organisation of the space-sharing community, which includes, e.g., decision-making practices. Lundgren (2023) discovered that incorporating shared spaces in adaptive reuse projects contributes positively to, e.g., social sustainability, predominantly through creating the so-called 'vibe' and 'tribe'.

In academic workspaces, often owned by the organisation or leased in the long term, the shared use can be seen as a contemporary solution to the request for both effective and efficient workspaces. According to van Ree (2002), these aspects create a productive workplace. Efficient accommodation requires establishing a favourable gross/net ratio, providing uniform workplaces and reducing the space per person and number of workspaces. Then again, effective accommodation requires providing a varying work environment and 'interactive-stimulating' area, applying collective, supportive elements and providing informal spaces. (van Ree, 2002, p.361.) In a post-pandemic era, the situation

in academia is even more varied with flexible work arrangements and workers who divide their time in a hybrid manner according to space and time between office and home (Nenonen & Sankari, 2022).

The contemporary campus context is shared with various stakeholders and comprises various spaces and functions (Harrison & Hutton, 2014; den Heijer, 2011; Nenonen et al., 2016; Fisher, 2019). Over the past two decades, new space types for academic context have been introduced. For example, universities have been utilizing third-party accelerators/incubators and new working spaces far from the university sites, exploiting distance learning for their students and remote working for researchers and staff. (Bouncken, 2018; Orel & Bennis, 2020) Thus, in addition to the questions by Brinkø et al. (2015), *where* the sharing occurs has been added to the discussion of academic facilities (Poutanen 2024).

In the form of maker spaces, Fablabs and coworking spaces promote the "third mission" of universities by integrating new services that provide new meanings to higher education institutions (Lange, 2021). They can be defined as "hybrid" facilities, as spaces between campus, work, and social spaces, which not only host the traditional activities of university campuses, that is, teaching and research. All these locations allow different groups to share a place with fluid boundaries and functions. (Star, 2010.) The places are configured as emerging design and building practices characterized by in-betweenness and indeterminacy (Migliore et al., 2021). Dugdale (2009) has urged universities to create a campus strategy employing the in-between spaces located outside formally scheduled facilities.

Office spaces can roughly be categorised between own (single-occupancy) office and various types of shared office spaces with either allocated desks (shared 2-3 persons, S(mall), M(edium), L(arge) sized open plans or combi-offices) or non-allocated desks, i.e. hotdesking (activity-based offices or flex-offices) (e.g., Colenberg et al., 2021; Danielsson et al., 2015). Similar types are found in academic workspaces (Pinder et al., 2009). Danielsson et al. (2015) highlight that combi-office with personal workstations and activity-based- or flex-office without personal workstations offer a combination of back-up rooms for meetings and private conversations that typical open-plan offices lack. The shared amenities in offices typically consist of these as well as canteen or cafeteria spaces or social spaces. The benefits of an action-based environment in the academic workplace context have not been demonstrated in the scientific debate in a large scale (Engelen et al. 2018). Kinnunen et al. (2017) state that an activity-based office is poorly suited for academic work, but Nooij et al. (2023) state that the studies investigating academic workplace concepts have led to inconsistent findings that lack an underlying framework. Additionally, data collection tools for understanding the nature of academic work are still rather scarce in literature (Palvalin et al. 2015).

In terms of the effectiveness of the workplace, academics can typically choose their time and location for work, but according to Tagliaro et al. (2021), scholars adopted a more flexible work style and worked from home during the COVID-19 pandemic. The home was reportedly increasing individual productivity by providing privacy for those otherwise working in shared or open-plan offices on campus. On the other hand, the home conditions between respondents varied significantly. (Tagliaro et al., 2021.)

According to Palvalin (2019), knowledge workers' well-being and work practices have the biggest impact on their productivity, while the role of the physical or virtual environments could not be confirmed. In turn, van der Voordt & Jensen (2021) concluded that the effect of the workplace on

productivity depends especially on the workstyles and activities and how well the environment supports those, while satisfaction with the workspace depends on the users' preferences concerning privacy and social contact (van der Voordt & Jensen, 2021). However, Colenberg et al. (2021) found that particularly open-plan offices, shared rooms and higher background noise negatively affect health, while other features of workspaces improve health.

3 Methodology

The data of this study was collected during the transition from the pandemic era to the post-pandemic era in the second-largest university in Finland. The individual and focus group interviews were conducted during 3-8/2022, i.e. the second semester when campuses were open without restrictions. Semi-structured interviews were conducted with 18 individuals on 3-4/2022 through Teams lasting between 45 and 90 minutes. The interviewees were chosen from two different faculties and represent the academic leadership (the deans, vice deans, head of units and degree programmes) and student unions' leadership (the chairs of unions). These faculties include various fields with different research traditions from experimental to desk-based, e.g., civil engineering, real estate economics, architecture, politics, business, and administration.

The interview questions were structured into four topics; 1. The organisational activities, 2. The effects of the pandemic on the organisation, return to campus and the future of academic work and learning, 3. The shared use of spaces and 4. The effects of the pandemic on the interviewee's own working styles. Additionally, ten workshops were organised face-to-face on work and learning environment topics (Table 1). The workshop participants represented all levels of academic staff and students from both faculties, and they volunteered based on open calls to participate. All workshop sessions lasted 1.5 hours. During the workshops, participants were divided into small groups and asked to discuss and ideate on given tasks that were formulated on the interview topics and early results drawn from interviews.

Both interviews and workshops were recorded and transcribed. All transcriptions were analysed using qualitative content analysis in Atlas.ti in several iteration rounds starting from interview data and increasing data on workshops' transcripts. The first round of analysis produced 109 codes in several areas of interest under six categories (1. Present situation, 2. Spaces in use, 3. Effects of the pandemic, 4. Needs & wishes, 5. Principles for shared use and 6. Future directions). In the following analysis rounds, the codes and categories were restructured into overarching themes and findings formulated in the iterative process. Some of these early results were tested in the workshops where participants commented and further developed the results, thus increasing the collected data. This paper presents part of the resulting themes, focusing on the aspects seen influencing the shared use of academic premises.

Table 1. Workshop details

Topic	Number	Date	Participants
Work Env. / The effects of pandemic	1	3/2022	7
Work Env. / The effects of pandemic	2	3/2022	3

Learning Env. / The effects of pandemic and solutions	3	3/2022	13
Learning Env. / The effects of pandemic and solutions	4	3/2022	5
Work Env. / Work modes & user personas	5	4/2022	8
Work Env. / Work modes & user personas	6	4/2022	2
Learning Env. / Teaching & studying weekly descriptions	7	5/2022	11
Learning Env. / Teaching & studying weekly descriptions	8	6/2022	5
Work & Learning Env. / Spaces	9	8/2022	5
Work & Learning Env. / Spaces	10	8/2022	7
Total			*66*

4 Results

The analysis of data produced three main thematic clusters influencing the shared use of academic workspaces:

1. Communities and times of sharing

2. Reasons to share

3. Ways to share

4.1 Communities and times of sharing

The first thematic cluster concerns the readiness and possibilities of sharing spaces. Table 2 illustrates three aspects that influence the readiness and possibilities. The first aspect concerns *the sharing partners*, the second aspect *the time and length of use,* and the third aspect includes *the access options*.

Table 2. Readiness and possibilities to share.

Aspect 1 Sharing partner level	Aspect 2 Time and length of use	Aspect 3 Access options
Individual	Simultaneous / serial	Private / allocated
Team / Research group	Continuous / periodical	Booking required
Unit / Department		Ad hoc / ID required
Faculty		Ad Hoc / anytime use
Whole campus / main organisation		

The partners sharing the places belong to the campus community, and one can identify five levels: 1. individual, 2. team or research group, 3. unit/department, 4. faculty, and 5. whole campus community/main organisation. The time and length of use include four dimensions: 1. simultaneous, 2. serial, 3. continuous, and 4. periodical. Finally, access options can be classified as 1. private, allocated, 2. booking required/bookable, 3. ad hoc use with limited access, and 4. ad hoc use without limitations.

4.2 The four types of shared environments on campus

The second thematic cluster concerned the reasons for sharing the campus environments. Four types of shared environments were identified:

1. Users' workplace profile-related environments
2. Team- or community-related environments
3. Boundary/interface-related environments
4. University organisation-related environments

The aspect of the sharing partner level is also connected to these types.

Users' workplace profile-related environments concern the needs and preferences of the individuals and how these individual needs are accommodated in the workplace. These environments consist of, e.g., individual workspaces, allocated desks, non-allocated desks (hot desks) and various types of backup spaces for discussion (on Zoom/Teams calls) rather than for concentration. Based on interviews, most interviewees either wanted to commit all tasks in one individual (allocated/personal) workspace they found a 'multi-use space', or they wanted to concentrate on their allocated desk and conduct collaboration and noisy activities elsewhere. The interviewees who preferred hot desking controlled their place of work and conducted concentrated activities at home or elsewhere. They also discussed the possibilities and limitations of sharing their dedicated workspace with others depending on serial and simultaneous use.

Team- and community-related environments are allocated to a team or a research group and intended to support team-based working. Noteworthily, within the team/group workspace, individuals may have differing workspace solutions: 1. allocated desk/space, 2. allocated desk shared with a specific team member (consecutive use), and 3. non-allocated hot desk for sporadic use. Furthermore, based on the interviews, we identified varying team circumstances that depend on individual- and team-based needs. The shared use of team-based environments is influenced firstly by how place-oriented or place-flexible an individual is (also to their group), and secondly, how (loosely or tightly) connected an individual is with the group and how campus-oriented or multi-locational the group is. These aspects are highly influenced by the shared rules of using the workspace(s). We identified individuals that are:

1. not a part of a group or the collaborators are outside the organisation,

2. loosely a part of a group or the group changes seasonally,

3. a part of a tight-knit group, and

4. they are a part of an intra-organisational multi-locational group whose members only sporadically visit the campus.

Boundary/interface-related environments consist of spaces that unite user groups and support their encounters, e.g., staff and students or researchers and teachers. Thus, these boundary environments are often shared within units or departments, such as canteens, group workspaces, and meeting rooms. Additionally, campus educational spaces are boundary environments shared simultaneously with teachers and students from the same field but serially with the whole campus community.

University organisation-related environments consist of spaces that support interaction within and between units and faculties, such as (shared) laboratories or faculty canteens. These environments also include spaces that are shared with the whole campus community, i.e. are intended for all, such as, academic libraries, restaurants, learning centres, and other open-access learning spaces. They include spaces that interviewees saw as crucial for the campus community and the atmosphere, and thus also spaces that are shared with only certain groups, such as student union spaces and group workspaces.

4.3 The nine modes of shared use of workspaces

The third thematic cluster describes how academic workspaces could be shared when focusing on the interconnection of individual and team viewpoints. We formulated nine possible (work)modes for shared use of workspaces based on two variables: identified time and space variables that could increase the efficient use of academic spaces in the post-pandemic era while maintaining their effectiveness. Where Nenonen and Sankari (2021) defined worker profiles based on time spent between office and home, we focus on time spent on campus premises. Time variable includes how often campus is used: 1. Every day, 2. Approximately three days a week, and 3. Once a week or less. The space variable consists of spaces, which are used: A. Allocated office, B. Allocated desk (in e.g., Team workspace), and C. Hot-desking (in e.g., Activity-based environment). These nine work modes illustrate the possible ways of using and allocating the campus workspaces, but not the specific types of supply of spaces or the amount of each type. Table 3 explains the combinations of variables structured into nine different work modes. In the table, each column represents one time variable, and each row represents one space variable.

Table 3 Nine work modes

	1. Every day -variable	2. Thrice a week -variable	3. Once a week or less -variable
A. Allocated office -variable	Every day, own office space. The person conducts most of their tasks in the office but can also meet people in other campus facilities.	Thrice a week, own office space shared with a colleague. The person conducts concentrated work at home and comes to campus to meet people. The person employs their office for meetings and, in turn, is employed by colleagues when vacant.	Once a week or less, own office space available to use by colleagues while vacant. The person uses their own office a maximum of once a week, and colleagues can use it while vacant. This allows the person to store their materials on campus and the space to be more efficiently used.
B. Allocated desk -variable	Every day, team space with an allocated desk. The person collaborates intensely with their team members, but they also conduct concentrated work in the team space.	Thrice a week, team space with allocated desk. The fifth mode is like the second; person's work consists of various tasks like the team and the workstation functions as a base camp, assuming the person conducts their concentrated work at home.	Once a week or less, team space with a hot desk. The person works mainly from home or other locations but visits the team space, where they have a hot desk, a maximum once a week.
C. Hot desking -variable	Every day, an allocated desk in a combi-office. The office is shared with colleagues from the same team/ unit. The person's work includes various tasks, both concentration and active collaboration. A supply of various spaces supports the working, but the environment includes a dedicated desk.	Thrice a week, hot desk in an activity-based office with colleagues from the same team/ unit. The sixth mode is similar to the third mode, likewise a community-oriented activity-based environment but without a dedicated desk	Once a week or less, a hot desk in an activity-based office that is shared with the unit. The person employs any location from a variety of activity-based supply of spaces when on campus once a week or less.

5 Conclusions

The shared use of campus premises and academic workspaces consists of various aspects that this paper has identified and structured thematically. The sharing of campus premises is gaining new momentum in the post-pandemic era, and it is seen as a manner to increase efficiency while retaining the effectiveness and variation in the academic workspaces to match the variation in needs and preferences. While the activity-based working concepts seem not to adequately support academic working processes (Nooij et al., 2023), the shared use concepts propose next generation solutions to the workplace discussion. This paper was based on interviews with users of academic premises from different fields and levels of the community. The interviews revealed various perspectives, both the possibilities to share and the limitations. For example, the nine work modes were formulated based on the observations of how the interviewees approached their workspaces and sharing. Some interviewees had very positive experiences of shared team spaces and sharing their own office. In contrast, others illustrated the limitations to sharing, such as trust issues or the effects of simultaneous online calls.

In the end, the results responded to two main questions:

1. Which aspects influence the shared use of academic premises (from users' viewpoints)?
2. What are the levels of shared use in academic premises and workspaces?

The results of this paper highlight that the campus premises can be shared at many different levels, not only with the whole community, e.g., restaurants, but also in academic workspaces. The results show that the possibilities depend on the individual and community attributes and readiness to share. The thematic clusters intend to benefit the discussion by showing the variation in (approaches to) shared use.

The research topic suggests that universities should consider the facilities as shared resources. Based on the results, one can see that the question is also about the change of culture and change of attitude – it is an individual and community transformation. While this research investigated two faculties from different fields, more research is needed to identify the insights about the differences in different disciplines and faculties as, based on the interviews, the subcultures on campus vary. The current practices influenced the interviewees' readiness to share, but most acknowledged the post-pandemic inefficiency and ineffectiveness of the workplace and its practices.

The university's role as a role model for sustainability and responsible use of facilities provides possibilities for changes and transformation. For that, one needs more evidence, metrics, and practices – what makes sharing a sustainable experience. The motives and drivers for sharing on campus can be strengthened, but they need to be investigated more.

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Transforming workspaces: A topological perspective on multi-location work

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ABSTRACT

While work becomes increasingly flexible, distributed, multi-located, and asynchronous, the understanding of its spatial dimensions is still limited. This study explores the evolving nature of organizational spaces in the context of multi-location work (i.e., when the workplace consists of a multiplicity of locations). Using a topological spatial perspective, we investigate how organizational spaces adapt to meet the demands of multi-location work. Using a mixed-method approach, we investigate the work experiences of academics from three higher education organizations during and after the Covid-19 pandemic. Preliminary results uncover two key topological changes and various linked topological shapes. This research provides a novel lens for understanding the dynamic and relational nature of spatial arrangements in contemporary work practices, offering valuable insights for organizations adapting to changing work landscapes.

Keywords

Organizational spaces; Multi-location work; Workspaces; Topological perspective.

1.INTRODUCTION

The recent surge of remote work (Petani and Mengis, 2023) and the increasing mobility of workers (Costas, 2013) have ignited scholarly exploration into the configurations of organizational spaces. While work becomes increasingly dislocated, multi-located, and asynchronous, the understanding of the spatial dimensions of work is still limited in this context (Petani and Mengis, 2023). Specifically, how do organizational spaces adapt, transform, or deform to accommodate the multifaceted demands and interactions associated with multi-location work? Organization studies have witnessed

a resurgence of efforts to reintegrate spatial dimensions (Beyes & Steyaert, 2012; Dale & Burrell, 2007; Kornberger & Clegg, 2004; Taylor & Spicer, 2007). These spatial approaches within organization studies span various paradigms, including traditional (Elsbach & Pratt, 2007; Weinfurtner & Seidl, 2019) and critical (Taylor & Spicer, 2007). While these approaches provide a relational understanding of organizational spaces, emphasizing their generative role in shaping social interactions, they have been criticized for compartmentalizing space into dichotomies (Beyes & Steyaert, 2012) where the conceived space (the space that according to Lefebvre, 19991 is planned by architects and designers) contrasts with the lived space (the space felt and altered through individuals' experiences). More recently, processual (Stephenson et al., 2020), constitutive (Cnossen & Bencherki, 2019; Wright et al., 2023), and topological (Beyes & Holt, 2020) spatial approaches have gained prominence in the study of organizational spaces. Collectively, these studies acknowledge that organizational spaces are not static entities, but rather dynamic phenomena shaped by ongoing processes. Particularly, there have been efforts to conceptualize organizational space as an open-ended "spacing" (Beyes & Steyaert, 2012), offering a performative and continuous view of space marked by incompleteness and disorganization. It is within this context that topology becomes a valuable tool for exploring multi-located work, compelling us to explore organizational space as unfolding across various topological configurations (Lash, 2012). In this framework, distinctions between "lived" and "conceived" spaces blur, and conventional notions of space, boundaries, and calculations are deconstructed (Beyes & Steyaert, 2012). According to Ratner (2020, p. 1526), when space is viewed topologically, organizational actors operate with the sense of being on the brink of an imminent "breakdown". In this paper, to further our comprehension of organizational space, we investigate how members of three higher education organizations located in Milan (Italy) manage different spatial configurations when working in a multiplicity of work (and non-work) locations. By definition, multi-location work involves dispersed workspaces and activities across multiple locations in the daily lives of workers (Hislop & Axetell, 2009). In our empirical analysis, we thus collected and analyzed data on how academics managed their multi-location work in the wake of the pandemic. Through our analysis, we demonstrate how the organizational space shrinks and expands dynamically in response to the multifaceted demands and interactions associated with multi-location work after the pandemic and how it unfolds across various topological shapes. This paper represents a step toward unraveling the complexities of organizational space in the context of evolving work practices.

2.BACKGROUND: ORGANIZATIONAL SPACES, TOPOLOGICAL DEFORMATIONS, AND MULTI-LOCATION WORK

Previous research has investigated the spatial practices of workers in different work environments. Most research on organizational space has focused on the spatial practices of workers inside organizational workspaces (e.g., Wasserman and Frenkel, 2015; Sivunen and Putnam, 2020) including universities (Beyes & Michels, 2011; Van Marrewijk and Van den Ende, 2018; Jones, 2014) and new working spaces (e.g., Cnossen and Bencherki, 2018). Some authors have studied spatial practices during homeworking (e.g., Brocklehurst, 2001; Halford, 2005; Wapshott and Mallett, 2012); other authors have studied spatial practices in public spaces (De Molli et al., 2020; Munro and Jordan, 2013), virtual spaces (Maznevski and Chudoba, 2000), in *absent* (i.e., unfinished) spaces (Giovannoni and Quattrone, 2017) and while being mobile (Brown and O'Hara, 2003; Costas 2013; Felstead et al., 2005;

Halford, 2005; Hislop, and Axtell, 2009; Lucas, 2014; Messenger and Gshwind, 2016; Munro and Jordan, 2013). The focal point of these studies is that space is not a container of everyday practices, instead, space and practices reflexively account for each other to the point that people and the material continuously renew organizational spaces (Stephenson et al., 2020). This study extends the focus to examine how workers experience organizational space through a topological perspective. At the heart of topology is the concept of space (and time) as emergent *becomings*, rather than predetermined and rigid categories. This conceptual shift envisages space as in constant flux and deformation (Lury et al., 2012; Ratner, 2020). One illustrative example is the Möbius strip, a topological construct that challenges conventional notions of space, highlighting its dynamic and ever-changing nature. We see organizational spaces as akin to the Möbius strip, continuously evolving and adapting in response to the actions, processes, and interactions that define them (Beyes and Steyaert, 2012). Topology provides a novel lens through which to conceptualize and analyze the multi-location of work. As other examples of topological changes (e.g., Ratner, 2020 analyzing interruptions during meetings in a Danish school), multi-location of work blurs the previously established boundaries of work (e.g., those between private life and work life; those between virtual and physical), and spatial configurations challenge established notions of spatial scaling and hierarchy (Taylor & Spicer, 2007). Therefore, topology helps us tune into those moments of change.

1. METHODOLOGY

Both the data collection and the data analysis for this paper are distinctly mixed-method. Two studies analyzed academics working at the three public universities in the city of Milan (Italy). The choice of academics is not casual. Academic work is unique in its nature as it offers a great level of work autonomy, a low degree of formalization, and an unconventional organizational structure (Wilhoit et al., 2016). These factors enable academics to work from various locations such as their university workspaces, their homes, or temporary workspaces beyond these locations. In a first quantitative study, we developed a survey asking participants about their work location choices, including frequency of access to their office, home, and other spaces beyond the office and home (e.g., libraries, cafés, co-working spaces, public spaces, companies' sites, etc.). The survey asked for this information referring to the periods before and after the Covid-19 pandemic to provide a complete overview of where academics work(ed) and whether the pandemic disrupted their habits[1]. The survey also collected information about the physical arrangements of the multiple spaces where academics worked. The survey was administered in the summer of 2020 to the whole number of tenured academics working at the three public universities of Milan (n=4,614), 1,064 answered the survey (response rate=23,1%). The sample is representative of the population. Among the respondents, 51% were female and 49% were male. The average age of the sample is

50.45 (SD = 9.25). The sample belongs to multiple disciplines: physical science (23%), life science (29%), architecture and civil engineering (11%), industrial engineering (14%), social science (10%), and humanities (13%). Referring back to our research aim, in analyzing our quantitative data we focused specifically on the workspaces that academics use and the frequency of their usage before and after the pandemic. We aimed to uncover any changes in their practices of multi- location work and determine if there were any shifts in their topological patterns. We constructed a transition matrix based on subjective experiences that academics revealed through survey responses.

In a second qualitative study, we zoomed into the experiences of 22 survey respondents. All the interviews were conducted in the academics' offices. The interviews served to collect narratives of academics moving across different physical locations (i.e., their offices, their homes, and other spaces where they work) and how their experiences eventually changed with the pandemic. Interview questions were designed after the quantitative analysis in which we disclosed the presence of two main groups of academics marked by topological changes.[2]

In total, the 22 interviews translated into more than 320 pages of transcripts. After each interview, we created a memo summarizing additional observations coming from the site visit to each university campus and office. Furthermore, we collected pictures of workspaces and campuses' spaces, in general, to add the highest details to understanding spatial settings as done in similar studies (e.g., Van Marrewijk, 2009; Peltonen, 2011). Referring back to our research question, in analyzing our qualitative data we focused specifically on the spatial deformations and topological shapes that emerged in academics' narratives and their conceptualization of organizational space. We organized the field notes by coding them into a spreadsheet database. To do this, we used coding strategies that are known from grounded theory (Corbin & Strauss, 2008). Our approach involved three types of coding: descriptive/topic coding, which involved categorizations of 'what was happening' in an open-ended way; in-vivo coding, which highlighted the terms used by the participants; and process coding, which detailed the activities we detected while observing the spaces. The qualitative analysis was complemented by a second round of quantitative analysis. Data patterns were identified across both datasets using a convergent mixed-method design (Creswell & Pablo-Clark, 2011).

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[1] This period proved ideal for addressing our research topic. Strict mobility restrictions were eased, limiting only access to crowded places (e.g., cinemas, theatres, cafés, and public spaces). Although some people continued to work- from-home, many returned to their offices. This contingency made the period more relevant, marking the exact time when working from home and working from the office became equally attractive to academics.

[2] During interviews, it quickly became apparent that 'place of work' as a singular, distinct location was an outdated concept for all of our participants. Their everyday working lives revolved around multiple work sites which were different compared to before the pandemic. Our interviews asked participants for details about what constituted a working day, what sites were involved and to describe them.

[3] For instance, one of the interviewees says: "After going through years where home was the hotel of the night, now, I discovered home as a variation of my previous routine and I did the opposite, that is, I don't want to go to the office. I only go there if I have to pick up papers and then I leave. Probably soon, I will change again." (interview #9)

1. PRELIMINARY FINDINGS AND CONCLUSIONS

In what follows, we describe the preliminary findings that emerged from the mixed-method analysis of our two datasets. The first empirical contribution of this paper reveals two main topological changes in how academics produced their workspace within and beyond the boundaries of their university offices. After the Covid-19 pandemic, academics either decided to *extend* or *compress* their organizational space. Academics *extend* their space by locating temporarily their work in additional work locations. Conversely, they *compress* their work by reducing the number of work locations they work from (usually reducing it to the unique home workspace and making the other spaces temporarily disappear). In our sample, it was found that 55% of academics (586) compressed their organizational space, while 45% of academics (478) extended their organizational space.

The second empirical contribution expands the findings of the first study and uncovers how and why the two described practices of *compression* and *extension* can be spatially interpreted through different topological shapes, one deforming into the other. Although the analysis is still ongoing, we report below initial interesting results.

Space compression is linked, both quantitatively and qualitatively, to the presence of *enclaves*, that allow the organizational space to shrink temporarily, excluding other work locations. Frequently, the university space does not exist anymore (or it is only a memory), and the home workspace dominates supreme[3]. Indeed, through multinomial logit estimations (N=1,064 academics), we discovered that *space compression* is positively related to the availability of a home office (p- value=0.095). However, the organizational space shrinks into other locations (i.e., the university). In our quantitative analysis, we found that space compression is positively related to the possibility of access to meeting rooms on campus (p-value=0.026). Meeting rooms often serve as designated

spaces for gatherings and interactions, resembling again *enclaves* in which the organizational space shrinks[4].

Space extension implies the organizational space to expand across multiple locations to include streets, countryside, and various leisure and non-leisure spaces. Formerly insignificant when work was secluded in a single work location, these spaces became large and a matter of concern after the pandemic for a consistent group of academics[5]. Space extension is linked to the topological shape of the *parallax*. Describing the parallax, architect Steven Holl (2004) states that different viewpoints reveal distinct shapes within a building's design, and these shapes can change as the viewer's perspective changes, highlighting the dynamic nature of topology. For instance, in our empirical material, we found that classrooms are no longer just places for teaching, but also serve as meeting places due to the dispersed nature of work[6].

In conclusion, the paper investigated how organizational spaces adapt, transform, or deform across diverse topological shapes and spatial formations (Lash, 2012; Beyes & Steyaert, 2012; Ratner, 2020). By examining the experiences of multi-location workers in various workspaces, including offices, homes, remote locations, and third workspaces, the study preliminary found that the organizational space can take shape across different topological figures, such as enclaves, or parallaxes, and these shapes may continuously deform or transform as work practices evolve. This dynamic flexibility is

essential for adapting to the changing needs and demands of multi-location work which is found to push academics toward compression or extension of the organizational space.

[4] *For instance, one of the interviewees says: "[...] in my room in the department, the ones assigned to me, I don't have a desk anymore. In the sense that the tables are kind of occupied almost permanently by other people. I mean it's not that I don't have a desk because I can't have, it is just because I don't need it. I mean: when I'm in the department I always relate to somebody, so I sit in the meeting rooms for instance if I have to be with you or let's say with one of my doctoral students, I sit with them, so I don't really need it [an assigned desk]" (Interview #1)*

[5] *For instance, two of the interviewees say: "Now I work in any place. It can be the train back home because I live in Brianza...I always have books and my computer... I take my computer everywhere, even when we go walking in the countryside" (Interview #5)*

"Working tools are now divided between home and office. Here I have more resources for teaching. At home, I keep research-related resources. For example, some books I borrow from the library, I keep them at home for a few months..." (Interview #6) For instance, one of the interviewees says: "Existing and established spaces have become much more hybrid, so the classroom also became a place in which I can have meetings with my staff, make an online call..." (interview #1).

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Never two without three – sustainable university campus management

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ABSTRACT

Purpose: Universities are seen as forerunners in climate actions and sustainable development. A sustainable university campus contributes to economic, social and environmental goals. The purpose of this paper is to identify sustainable university campus management measurements and key figures in Finnish universities. The research question is: How university campus management balances between economic, environmental and social sustainability in Finland?

Theory: The Tripple bottom line framework (TBL) theorizes that as an alternative of one bottom line, there ought to be three: people, profit and the planet. This framework measures an organization's level of obligation to corporate social accountability and its impact on the environment in due course.

Methodology: The research is qualitative while the intention is to understand the sustainable campus management in selected country, Finland. The method used is a group interview method. Nine Finnish universities joined to the study.

Findings: According to the data, universities generally have measures for sustainability. However, the object of measures varies. All universities emphasize economical sustainability measures such as space costs of the overall costs. Environmental measures such as emissions per number of students and staff are mentioned in some universities. Only a few universities include social sustainability measures in their key performance indicators.

Novelty: The paper provides insights into sustainable real estate and campus management. It explains how the sustainability aspects are measured in practice in university campus management. The study presents results which are interest also for the whole university communities, university administrators, urban planners and policy makers in promoting campus sustainability. The framework of the integrated approach for sustainable university campus provides research results which can be both compared and applied in the context of sustainable campus management.

Keywords

Sustainability, University, Campus Management, Measurement, Key Performance Indicator, KPI

1 INTRODUCTION

Universities are typically seen as forerunners in climate actions and sustainable development. It can be considered that a sustainable university campus contributes to economic, social and environmental goals. The aim of this paper is to identify sustainable campus strategies including sustainable campus measurements and key figures in Finnish universities. The research question is: How university campus management balances between economic, environmental and social sustainability in Finland?

Updating campus strategies towards sustainability is relevant due to environmental responsibility targets, global climate goals, student and staff expectations, cost savings, research and innovation opportunities and community engagement. There is a growing demand among students and staff to prioritize sustainability actions, and there is a tendency to seek institutions reflecting sustainable values. Implementing sustainable practices such as energy efficient buildings often lead to long term cost savings for the universities (Ribeiro et al., 2021). With focus in sustainable campus practices, universities can utilize the campus as a living lab for innovation or using the campus data in their research. By prioritizing sustainability, universities have the opportunity to engage with the local communities, stakeholders, businesses and government entities to promote and collaborate on sustainable initiatives (Purcell et al., 2019).

The research method is qualitative with group interviews focused on campus management professionals. The results were documented with a template that was sent out beforehand and presented in a seminar with a wider audience. Nine different universities participated in this study. In the analysis, the templates with the results were compiled into a table matrix, which is explained later in this paper.

In general, universities are expected to transform into more sustainable institutions and act as change-agents promoting sustainability development (Lattu et all., 2020). Furthermore, university strategies typically shape and guide campus strategies, making it essential to establish a connection between the two. Campus strategies generally involve long-term planning and decision-making aimed at managing and developing the physical campus. To provide insights into the campus sustainability measures in the Finnish university campuses, the paper consists general information of the Finnish universities and their property ownership strategies, as these influence the practices and ways of operating sustainable campuses.

2 SUSTAINABLE CAMPUS MANAGEment

In the new millennium, universities have made noticeable contributions to sustainability in a generation where society is assessed on its ability to evolve in response to global climate changes (Baker-Shelley et al., 2017). It is essential to indicate how socially responsible and sustainable campus management can be measured. The triple bottom line (TBL) is a concept that inspires organizations' pledge on social and environmental concerns as well as financial performance. The TBL theorizes that instead of a single bottom line, there should be three: people, profit, and the planet. This framework measures an organization's level of commitment to corporate social responsibility and its impact on the environment over time (Kappo-Abidemi and Kanayo, 2020).

The sustainability implementation in university campus development involves issues like the creation of green spaces, the requalification of leisure areas, and the development of strategies to reduce the consumption of paper, plastic, energy, and water, as well as the creation of programs to encourage

recycling (Martins et al. 2021). University campuses consume a significant amount of energy. Given the high volume of people who commute to and from campuses, the resources consumed, such as water and energy, and the amount of waste that must be managed, they can be compared to small towns. To address this issue, university managers and decision-makers have implemented various technical measures to improve water and energy efficiency and waste management. These measures aim to increase campus sustainability and enhance the well-being of the academic community (Araújo et al. 2023).

The creation of a Smart Campus, using the Internet of Things (IoT) concept as a practical tool to achieve the SDGs, has been the subject of investigation in research from the 2010s (e.g. Yoshida et al., 2017; Mendoza et al., 2019 and Alshuwaikhat and Abubakar, 2008). Recently, the potential of artificial intelligence (AI) has also been investigated. Factors such as urbanization, improper building construction, transportation, environmental changes, and population growth have led to excessive consumption of energy and the use of unsustainable energy sources. AI can offer a range of intelligent solutions, from predictive and prescriptive energy consumption insights to intelligent energy generation and distribution (Saheb et al., 2022).

The study by Nunes et al. (2018) on the environmental activities of 50 universities found several topics connected to circular economy. The economic significance of universities provides an appreciable demand for circular products and services. Universities should develop “hidden curriculum” plans to promote improved environmental behaviors of staff and students. Universities can also catalyze a circular economy by working with business to improve eco-effectiveness as well as eco-efficiency. For example, projects should extend the focus from decreasing carbon footprint to achieving carbon positivity, from improving water efficiency to treating wastewater, and from recycling to reverse logistics for repurposing.

Environmental sustainability and economic sustainability can sometimes be overemphasized within society's education system, while social responsibility has been overlooked in terms of quantified and measurable aspects. Severino-González et al. (2024) conducted a study on university social responsibility and environmental education, indicating that social responsibility from the sustainable development goals (SDGs) should consider the link between university social responsibility (USR) and environmental education. They state that empathy and solidarity in relation to respect and dignity, freedom and citizenship, and environment, could lead to the definition of new principles and values linked to sustainability and social responsibility.

3 Universities in finland and property ownership

There are 13 different universities in Finland which operate within administrative branch of the Ministry of Education and Culture (MEC). These universities focus in scientific research and education based on it. They are tasked with engaging in scientific research and artistic activity, as well as promoting lifelong learning, interacting with society, and promoting the social impact of research results and artistic activities. Finnish universities have administrative and economic autonomy and are considered independent legal entities.[7]

MEC coordinates the activities of higher education institutions and holds agreement negotiations with them. At the start of each four-year agreement period, the objectives, key measures, tasks, profile,

[7] https://okm.fi/en/heis-and-science-agencies

core areas and newly emerging scientific fields are agreed upon, including the specifics of how the outcomes of the objectives will be reported on.[8] In the agreement period 2020-2024, each university was tasked with meeting carbon neutrality targets. There are ongoing discussions and collaboration among sustainability researchers and practitioners from different universities to unify the scope and boundaries of carbon neutrality, including the definitions and methods of measuring, for example, CO2 emissions.

The ownership of university properties reflects the university campus sustainability strategies, affecting where and how the university can exert influence. During 2007 and 2010, the establishment of university property companies was initiated to ensure the financial and credit standing of the universities. Three geographically defined university property companies were founded: one company to own the Helsinki area university properties, except the recently founded Aalto University's occupied properties; and the third company to own the properties of universities occupied elsewhere in Finland. Two-thirds of the shares of these companies were owned by the university or universities, and one third by the government.[9]

Since 2010, some universities have reshaped their property ownership and leasing strategies, leading to a mix of occupier-owners, tenant-occupiers or a combination of both. The variations in these strategies depend on factors like financial situation, core campus locations, or flexibility needs. There have also been instances where universities have completed property transactions, such as the University of Vaasa purchasing a property where they had previously been tenants[10].

Due to the variation in property-owning strategies, the areas of responsibility for campus real estate and facilities organizations differ among the universities. Universities with a larger focus on being an occupier than an owner prioritize services. For instance, at the University of Oulu, the campus management encompasses property and facility services, as well as providing short-term space rentals for various events[11]. On the other hand, owner organizations may focus their activities on campus property development or energy efficiency improvements to enhance long-term revenues.

The national discussion and collaboration among universities in Finland are particularly strong, especially in the context of sustainability. The active sustainability collaboration and the intellectual potential within these networks make this study relevant. Understanding the structural similarities in the universities lays foundation for investigating sustainability in terms of strategy and key performance indicators.

5 RESEARCH DESIGN AND METHODS

The research is qualitative, with the intention is to understand sustainable campus management and campus strategies in the selected country, Finland. The study and the focus group interview were conducted in 2023. The background aim of the study was to gain an overall understanding of the different campus strategies in Finnish universities and the main themes of these strategies. This was essential to delve into more detailed sustainability factors of the campus strategies.

[8] https://okm.fi/en/steering-financing-and-agreements
[9] https://www.finlex.fi/fi/esitykset/he/2009/20090007
[10] https://www.uwasa.fi/en/newshub/news/university-vaasa-buys-energylab-property-palosaari
[11] https://www.oulu.fi/fi/yliopisto/yliopiston-yhteystiedot

The research process consisted of four phases. The first phase involved developing the template within the research group. The template was based on the literature and validated through discussions with a group of experts. The group interview template consisted of the following themes and questions:

- Campus strategy (yes/no)
- Number of campuses (number)
- Main themes of the campus strategy (text)
- How the campus strategy is updated and what is the horizon of it (text)
- What is unlikely to change (verbal)
- Key figures in a nutshell (2022):
    - Square meters in university use (number)
    - Number of staff, Full Time Equivalent (number)
    - Number of students, Full Time Equivalent (number)
    - Utilization rate of the spaces, estimated or measured (%, text)
    - Other Key Performance Indicators (KPIs) (text)
    - Contact person (name)

The second phase involved identifying the sample and sending out the template to them. The sample of group interviews consisted of campus directors or facilities managers from nine Finnish universities. The group interview template was sent to the participants beforehand, and they filled it in to prepare for the interview.

The third phase involved the actual group interview. Each participant presented their template, and the discussions based on the template topics were facilitated to identify the differences and similarities between the different universities. The responses to the specific template questions related to the “main themes of the campus strategies”, “utilization rates of the spaces” and “other KPIs” were the most important ones in this study, aiming to answer the research question: How university campus management balances between economic, environmental, and social sustainability in Finland. The metrics were thoroughly discussed during the group interview.

The fourth phase of the process involved the analysis of data. The templates and the memos from the discussion were analyzed individually by a group of researchers. The results were then compared and summarized, with data organized into tables and different content measures and matrices. Comparable observations about the data were collected to summarize the templates. The content of the discussions was clustered according to three sustainability topics: ecological, economic, and environmental sustainability.

6 results

Most of the respondents were in the process of updating their campus strategies, which could be attributed to the impact of the Covid-19 period, resulting in hybrid ways of working and the emergence

of changed space utilization needs. Additionally, there have been university merger processes in Finland in recent years, prompting a thorough examination of which campuses to focus on, how to address potential administrative overlaps and redundancies, and the enhancement of campus physical and digital services.

According to the results, the campus sustainability targets were not emphasized or even mentioned in the universities strategies. In general, some universities were very clear on their campus sustainability targets and measurements, but for most of them, the targets were very vague. It was noted that possible reasons for this included the campus sustainability targets not being identified at a university strategy level, and there may have been more actual actions to address the strategic initiatives.

The responses varied from concrete CO2-neutral campuses to future workplaces, which could be attributed to different property ownership strategies among the universities. Occupier-owners may have more resources to drive goals such as energy efficiency and have a comprehensive perspective on campus development and potential financial opportunities. On the other hand, tenant-occupiers prioritize creating exceptional research and learning environments. Balancing the needs of both owners and occupants is crucial for economic sustainability, as it involves reconciling rental income generation and property value maintenance with the provision of quality services and facilities. Finding areas for compromise is essential to reconcile these perspectives.

It is important to note that almost all of the universities were updating their campus strategies at the time this study was conducted. Therefore, their responses may not be conclusive as the campus strategy process was ongoing. The variety of campus sustainability targets and measurements are explained in Table 1. The targets and measurements with clear definitions are marked with “x” in the table, while those what were somewhat unclear are marked with “?”.

Table 1. The variety of campus sustainability targets and measurement

	Social	Economic	Environmental
University 1	x	x	x
University 2	?	x	x
University 3	?	?	?
University 4	?	?	?
University 5	?	?	?
University 6	x	x	x
University 7	x	x	x
University 8	x	x	?
University 9	x	x	?

It is noteworthy that three universities had mentioned all three elements of triple bottom line in their strategies, while three were lacking the elements. An interesting detail is that two universities had only social and economic perspectives, while one university was more focused on economic and environmental values. Surprisingly, the weight among the three elements was as follows: economic

aspects were mentioned the most, while the environmental perspective was mentioned less. The social perspective was in between. The variation between these focus areas may be explained by the different ownership strategies.

Focus group interviews shed light on the relevance of economic targets. It can be observed that the financial situation in Finnish universities plays a key role in determining economic campus sustainability targets, as careful consideration is given to how existing resources are utilized and where opportunities for savings can be identified. This reflects the universities' strategic approach to achieving economic sustainability.

When transitioning from campus sustainability targets to the actual measurements and KPIs, variation was identified between different universities. Social measurements were found to be more descriptive, while economic and environmental measurements were more explicit by their nature. Some universities were very clear about their targets and measurements, while others did not mention sustainability targets or their measurements at all. All the measures mentioned are explained in Table 2.

Table 2. The content of sustainability measurements

	Social	Economic	Environmental
University 1	community engagement, collaboration, wellbeing	space efficiency, improved utilization rates, new partners and income	carbon neutrality, energy efficiency, campus natural capita
University 2	survey results, workshops	share of facility costs of the overall costs, sqm/FTE	CO2/m2
University 3	?	?	?
University 4	?	?	?
University 5	?	?	?
University 6	wellbeing, satisfaction	decrease in facility costs, improved utilization rates, space use efficiency	carbon neutrality
University 7	comfortability	space use efficiency, low facility costs	energy actions
University 8	stakeholder participation	increase in space use efficiency, flexible space use, facility costs/sqm	responsibility
University 9	Participatory planning	Space use efficiency sqm / FTE (staff+student)	?

The most common measurement for economic sustainability was efficient space use, mentioned as a campus strategy target in six universities. It was discussed that efficient space utilization can be a

double-edged sword. While striving for high efficiency, there is a potential for decreased customer satisfaction and a subsequent decline in organizational commitment. Furthermore, efficient space utilization may lead to an increased interest in remote work, presenting challenges in collaboration and face-to-face interactions.

The measurement of facility costs as being a component of economic sustainability was mentioned by four universities. Typically, there were relative facility cost measures such as percentage of the total costs or facility costs per square meter. There were two mentions about utilization rates and one mention in new income in economic measurements category. During the discussion, the topic of space utilization rate and space fill rate was raised. The space utilization rate typically indicates whether the space is occupied or not, while the fill rate implies whether all the available seats or spaces are occupied. With the impact of Covid-19 and the resulting emphasis on safety and security considerations in workplaces, it may not be pertinent to target filling all the available seats if doing so compromises the sense of safety.

In environmental measurements, the most common mentions were carbon neutrality and energy-related measures. Energy actions and CO2 emissions per square meter were also mentioned as environmental measurements. Campus natural capital was mentioned only by one university. This may be because there are not yet commonly accepted or developed measures for natural capital. In the social measurements category, stakeholder participation and community engagement were mentioned. In target setting, describing goals for social sustainability were typical. Comfortability, well-being, satisfaction, and related surveys were also mentioned.

To emphasize the responses to the question “What is unlikely to change”, the locations of the current campuses were specifically mentioned in the responses of two universities. Interestingly, no university was aiming to operate fully without physical campuses. Themes such as campus as an enabler for success, efficient and effective space use, multilocational learning, research and work, and sharing practices with different stakeholder groups, were also mentioned. In discussions, these themes are very relevant in every campus or facility organization due to hybrid work practices and the uncertainty of the future.

7 Conclusion

Based on the results, it can be inferred that university strategies, particularly those related to the campus, may not always have clear sustainability targets. Several reasons may account for this lack of clarity. Firstly, sustainability initiatives may not always be given the same level of priority as other goals or objectives, potentially due to limited resources or competing demands. Furthermore, sustainability targets with environmental, economic and social aspects are complex and multifaceted, involving many different stakeholder groups. The complexity could be compounded by limitations in financial resources, knowledge, and infrastructure that the implementation of sustainability targets would require.

Some universities may not fully recognize the importance of sustainability when incorporating it into campus strategies. There might be a lack in understanding regarding the value and relevance of sustainability targets. Resistance to change can be another factor when it comes to changing institutional structures and cultures. In some cases, universities may have sustainability initiatives, but they fail to effectively communicate them to stakeholders. This points to a need to improve the

communication of universities' strategies, from top management to operational management, and to foster greater engagement and commitment when setting realistic but still challenging sustainability targets.

On the basis of this research, there are identified uncertainties and speculative aspects when making conclusions. The following challenges in campus strategies and their sustainability targets can be identified.

1. **Definition challenge**: Defining sustainability in universities' campus strategies is somewhat obscure. While the economic and environmental factors were quite well mentioned, there was a lack of clarity in identifying social sustainability targets. There may be consideration for well-being on campus as part of sustainability, but it is not clearly articulated. On strategic campus level, commuting or sustainable transportation was not mentioned at all - should it be included? Additionally, some of the targets were mentioned at a very generic level, for example "responsibility" as an environmental target but without clear practical implications.
2. **Data and comparability challenge**: The quality of the data is uncertain as it was collected from different universities, which may have different data sources, definitions, and the organizational structures. As a result, there might be discrepancies and human errors in the data, making it inconsistent or incorporable between universities.

The weak level of generalization in the results is attributed to the fact that the campus strategies were undergoing an updating process in many of the universities. Future studies about sustainable campus management should aim to achieve a deeper understanding of the measurements and sustainability ambitions. It might be beneficial to focus on implementing different kinds of pilots on university campuses as part of further research in this area. There are interesting examples of sustainability initiatives in different university campus in Finland, such as need-based energy production, campus biodiversity initiatives, and use of local culture and art as part of the interior design in public areas. These examples highlight the innovative approaches being taken to promote sustainability within university campuses.

The involvement of students and staff in sustainability activities is noteworthy, and discussions about different innovation models and sustainability are expanding the number of stakeholders to surrounding areas, the community, and the city. Exploring governance models and practices in sustainability reporting could be a potential next step to further elucidate the comparisons, which this preliminary study did not fully address. In conclusion, the setting of sustainability targets involves balancing between these three different targets: social, economic and environmental.

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Campus Crossroads: Insights into High School and University Resource Sharing

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ABSTRACT

This study explores the relocation of two high schools to university campuses in the Helsinki Metropolitan Area (HMA). This relocation reflects the global shift towards more collaborative and integrated educational models. The aim is to assess the advantages and disadvantages of such shared use of space and other resources from the perspective of the high school. The

significance of this study lies in its potential to contribute to global sustainability goals through effective resource management within the built educational environment. Utilizing a qualitative methodology, the research examines two cases where high schools coexist with university campuses, gathering data through stakeholder interviews, public documents, and a collaborative workshop. SWOT analyses were used to identify the principal advantages and disadvantages. The advantages were enhanced resource access, pedagogical integration, and strengthened social connections. The principal disadvantages included managing shared spaces, coordinating conflicting schedules, and navigating digital tool access. The originality of this research lies in the sharing in the context of high school, university, and city, a previously underexplored area within educational studies. The social and practical implications drawn from this research emphasize the need for meticulous planning in managing both physical and digital resources. Moreover, the findings advocate for developing educational communities that bridge secondary and tertiary education, fostering collaboration across educational levels.

Keywords

University campus, high school, sharing, case study.

1 INTRODUCTION

The urgent need for sustainable use of resources is more pressing than ever. Recent studies highlight the unsustainable rate at which global resources are consumed, far surpassing the Earth's capacity to regenerate annually (World Bank, 2022). This highlights the urgent need to further develop innovative approaches to the use buildings, as the built environment is one of the major resource consumers. For example, according to World Green Building Council (2021) “40-50% of the resources extracted for global materials are used for housing, construction and infrastructure”. Sharing is recognized as one of the pathways for more efficient resource use (e.g., Acharya et al. 2020, Lundgren et al. 2022). In the field of education, an intriguing sharing solution has emerged in the Helsinki Metropolitan Area (HMA), where two high schools have integrated into university campuses, aiming to leverage shared spaces and resources effectively. This sharing model not only promises reduced resource consumption but also offers a more integrated and cooperative learning environment, aligning perfectly with global sustainability goals.

This strategic colocation of educational institutions is not merely about cost-saving; it represents a significant shift in educational paradigms. By sharing university facilities like advanced laboratories and extensive libraries, high school students gain early exposure to higher-level resources, enriching their learning experience and smoothing their transition to university education (United Nations, 2022). Moreover, this integration fosters a culture of collaboration and innovation, potentially leading to new educational models and curriculum advancements that prepare students more holistically for future challenges (Pietrabissa & Simpson, 2020).

However, the implementation of this sharing model introduces its own set of disadvantages. Phenomenology highlights the need to understand the nuanced experiences of individuals within these shared spaces, emphasizing the management of resources and scheduling to avoid conflicts (Smith, 2005). The socio-economic disparities that could potentially be exacerbated by such

integrations also demand careful management to ensure that all students advantages and disadvantages equally from shared resources (Jiang et al., 2023).
Addressing these challenges requires an approach to balance the evident advantages with the potential disadvantages. As such, the objective of this study is to conduct a comprehensive SWOT analysis of the colocation of the two high schools on university campuses, to evaluate both the positive and negative outcomes of this sharing arrangement. By doing so, this research aims to contribute valuable insights into whether sharing educational spaces can effectively support global sustainability goals and reduce the consumption of resources in built environments, ultimately leading to more sustainable and equal educational practices.

2 Literature review

Sharing, also known as collaborative consumption, has emerged as a significant economic model in recent years. It is characterized by the sharing of resources, goods, services, and skills among individuals, typically facilitated by digital platforms. This literature review critically examines the advantages, disadvantages and requirements of sharing, highlighting the key contributions and gaps in the existing research.

One of the primary advantages of sharing is its ability to optimize the use of underutilized assets. This optimization leads to increased economic efficiency by reducing costs and providing broader access to goods and services (Bardhi & Eckhardt, 2012). Furthermore, sharing platforms create new income streams for individuals, offering economic opportunities that were previously inaccessible (Acquier et al., 2017). The enhanced accessibility of services and goods is another significant advantage, making these resources available to a wider audience (Rifkin, 2000).

From an environmental perspective, sharing promotes the sustainable use of products by reducing resource consumption and waste (Firnkorn & Müller, 2011). Additionally, it facilitates social interactions and community building, fostering a sense of collaboration and social bonding among participants (Benkler, 2017). This social interaction is further supported by the community engagement encouraged by sharing initiatives (Richardson, 2015). Sharing also drives market innovation by efficiently connecting suppliers and consumers, leading to the development of new markets and entrepreneurial ventures (Sundararajan, 2016).

Despite its many advantages, sharing faces significant regulatory challenges. These platforms can operate in legal grey areas, which can lead to potential legal issues and hinder their growth (Edelman & Geradin, 2015). Trust issues are also prevalent, as users may have concerns about the reliability and safety of sharing resources with strangers (Acquier et al., 2017). Economic inequality is another critical disadvantage. Sharing may recreate or exacerbate existing inequalities, benefiting a small number of individuals while others remain marginalized (Schor et al., 2016). Furthermore, participants may become economically dependent on these platforms, reducing their autonomy (Carboni, 2016; Redfearn, 2016). The dominance of a few large platforms can stifle competition and innovation, leading to market monopolization (Evans & Gawer, 2016). Additionally, the efficiency gains of sharing may lead to increased overall consumption, a phenomenon known as the Jevons Paradox, potentially offsetting environmental advantages (Demailly & Novel, 2014). Worker exploitation is another concern. Gig economy workers often face poor working conditions, lack of job security, and inadequate legal protections (Carboni, 2016). The potential for labor exploitation and unfair working conditions further exacerbates these issues (Hirsch & Levin, 1999)

For sharing to be successful, several requirements must be met. Trust and reputation systems are essential for building trust among users and ensuring reliable exchanges (Acquier et al., 2017). Robust and user-friendly technological infrastructure is crucial for facilitating sharing and enhancing transaction efficiency (Srineck, 2016). Clear regulatory frameworks are necessary to address legal challenges and ensure fair competition (Edelman & Geradin, 2015). Active community participation and engagement are also vital for fostering a sense of ownership and ensuring the success of sharing initiatives (Bradley & Pargman, 2017). Additionally, addressing data privacy concerns is critical, as issues related to data security can deter users from participating (Benkler, 2004).

Sharing presents a mixed set of advantages, disadvantages and requirements. While it offers significant economic, social, and environmental advantages, it also poses substantial challenges, particularly in terms of regulation, trust, and economic inequality. Addressing these challenges through robust technological infrastructure, clear regulatory frameworks, and active community engagement is essential for realizing the full potential of sharing. This literature review highlights the need for continued research to explore these dynamics and develop strategies to harness the advantages while mitigating the disadvantages .

3 RESEARCH methods

This research uses a qualitative approach, studying two case campuses (Case A and B), where a high school is moved to a university campus. A two-tail case study allows for selecting cases that differ to some extent to better understand the studied phenomenon (Yin, 2014). In other words, this study lets us see sharing at the campus from the perspective of the high school starting from two different situations. In both cases, the high school is specialized: in Case A, the sports-oriented high school moved to the campus to use its sports facilities, while in Case B, the math and natural sciences-oriented high school was attracted by the opportunity for close collaboration with the university. The starting point for sharing was also different: In Case A, an existing campus building was transformed to the main school building of the high school, and the high school was planned to also use university facilities like laboratories, classrooms, and sports facilities. In Case B, a new building in close vicinity of the collaborating university for the high school, handling most learning events except for some shared activities at the university.

The data was collected through four preliminary interviews held on May 8, 2023, May 13, 2023, September 4, 2023 and September 29, 2023 followed by a collaborative peer-to-peer workshop on December 11, 2023. The interviews aimed to gain insights into the cases, particularly from the high school perspective. The workshop included participants from high schools, universities, the city, and other experts, totaling 15 individuals, alongside two researcher-facilitators. A purposive sampling technique was utilized to engage relevant stakeholders from both cases (see Table 1 for details). A representative from the city was unavailable for case A. The data analysis follows a content analysis identifying the strengths, weaknesses, opportunities, and threats (SWOT) due to sharing from the high school perspective.

Table 1 Workshop participants (P = participant)

Case A	Representative	Case B	Representative	Common	Representative
P1	High school	P5	High school	P12	Service provider
P2	University campus	P6	University campus	P13	Researcher
P3	University campus	P7	University teaching	P14	Senior researcher
P4	University teaching	P8	City	P15	Senior researcher
		P9	City		
		P10	City		
		P11	Service provider		

4 RESULTS

This section first presents the SWOT analysis per case and then compares the cases.

Case A. Based on the analysis, three key strengths of Campus A were identified: high-quality resources, collaborative educational opportunities, and networking and community building. First, co-locating at Campus A, the high school has access to high-quality laboratories and extensive libraries, thus broadening the educational experience beyond that of a typical high school. Second, Campus A facilitates joint lectures and projects between high school and university students, thereby supporting collaborative education. It was especially seen beneficial that the high school students are exposed to university teaching to be better able to envision their future study possibilities. The third strength is that the shared campus setting enables social interactions and professional networking opportunities, particularly between high school and university teachers. This collaboration benefits both educators and students by fostering deeper academic connections across different courses and lectures.

Similarly, the analysis identified three main weaknesses. Firstly, resource constraints are evident as the rising student population puts pressure on the functionality of the existing high school building. For example, originally, the high school building was planned to have a lounge area. However, the lounge area was replaced with classrooms during the planning phase due to the increased student number. Secondly, logistical challenges emerge from discrepancies in academic calendars and the inadequate integration of booking systems, which create scheduling conflicts and discourage the effective use of shared spaces. The third weakness is that the capacity of public transportation was not increased despite the growing number of students on campus. This leads to commuting challenges for students when many of them need to use the buses during peak hours.

The analysis identified two significant opportunities for sharing. The first refers to a more dynamic use of shared spaces. For instance, allowing auditoriums to serve dual purposes for events from different educational tiers can lead to greater efficiency in space usage. Presently, the limitations of the high school's dining area prevent the accommodation of communal events for the entire student body due to size constraints. The second opportunity focuses in on-campus services. Sharing between educational institutions encourages a diverse range of service providers to locate at the campus and this potentially improves the quality of life and broadens the selection of amenities at the campus. At present, the campus has a limited number of private-sector service providers, such as eateries or convenience stores.

The analysis identified two main threats. Firstly, increased sharing involves new risk management issues. The unique nature of a shared campus, which is a relatively new concept in Finland, brings challenges in clearly defining responsibilities and obligations. For instance, if a high school student slips on the university's icy grounds, the question of liability and duty of care arises. The second threat is the potential for social segregation. Ineffective integration can exacerbate socio-economic disparities. In this case, if public transportation is insufficient and students are unable to reach the campus, this impedes the sharing model's advantages and can lead to the high school being inaccessible to individuals such as people who do not have a driver's license.

Case B. Four main strengths were found in the analysis of sharing at Campus B. First, similarly as in case A, by co-locating at the campus the high school has access to high-quality facilities. For example, the sports-oriented high school has easy-access to the sports halls and fields at the campus. The second identified strength is new teaching collaboration with the university. University teachers and researchers have given lectures to the high school students. The third strength is social and professional engagement in which the communal environment on campus fosters interaction among high school students and the university. Notably, the natural movement of high school students during the school day across the extensive campus has been observed to instill a sense of stature and maturity, potentially motivating them to aspire to further education. In addition to these strengths, Campus B advantages from advanced public transportation. Compared to Campus A, Campus B is well-served by an extensive transportation network, which is accommodating the increased demand from a growing high school and university student population. The strength of this multimodal transport network — encompassing trams, a metro system, and buses — highlights the significance of integrating various public transport forms to sustain the growth and accessibility of educational facilities.

The analysis also found two main weaknesses. First, the increasing student numbers in both the high school and university have discouraged sharing at the campus from the perspective of the high school. Additionally, the shared learning spaces can be farther apart, resulting in more walking for the high school students between classes. Originally, the high school defined that space more than 1.5 km away is not feasible for the students and teachers. The second weakness refers to the scheduling and coordination challenges between the two educational institutions. The standard day timetables between the high school and the university do not match. For example, the first class in high school does not start at the same time as the first lecture at university, and the duration of these activities are not the same. This causes challenges in effectively allocating contact teaching in the same locations in the same day.

As opportunities, the analysis identified two topics: enhanced utilization of shared spaces, improvement of campus amenities and last the seamless academic transitions. Firstly, co-location creates an opportunity to share space. Effective collaboration in scheduling was seen as an opportunity to enhance shared space use. Secondly, upgraded on-campus services can markedly improve daily life for students and staff, potentially drawing more users and service providers. For example, students are currently experiencing extended waiting times in lunch queues. The idea of a private service provider within the main building offering lunch options — albeit not free like the school's own canteen — was positively received.

In terms of threats, the analysis highlights that the growing student numbers will remain a threat in the future. If the demand for the same learning space increases in both educational institutions, the high

school, with less bargaining power, has limited chances of accessing the shared spaces that would still support its teaching schedule.

The comparison between Case A and B. The comparison identifies three conclusions. First, public transportation seems to play a major role in facilitating sharing. At Campus A, the development of a public transportation system is lagging compared to Campus B, where several transportation options have developed in the past years. The easy access to Campus B enables sharing among students. In contrast, at Campus A, public transportation has greater challenges in accommodating student travel during peak hours. Second, the pedagogical starting point differs between cases. In case A, the envisioned close collaboration in natural sciences education has not (yet) been fully realized, resulting in a gap between expectations and reality. On the other hand, in case B, without explicit educational expectations, the high school is experiencing pedagogical support that has become an emergent strength. Thirdly, the increasing student numbers are creating pressure in both cases. Although the space in both cases can be shared, the sharing requires a more comprehensive approach than solely focusing on physical access to the space. Sharing requires operational alignment, for example, in scheduling, organizational cohesion, for example, in effective communication and smooth commuting, and digital collaboration, for example, in the use of digital tools allowing sharing, to name a few.

To summarise, the success of shared resource models within educational settings is contingent upon several factors: infrastructure support, pedagogical alignment, and proactive facilities management. The comparison between Campus A and Campus B reveals that while shared campus models present opportunities for enhanced educational experiences, they also require thorough planning and the ability to adapt to evolving educational needs and circumstances. The findings underline the need for educational institutions to approach resource sharing with careful consideration of these critical aspects to ensure the realization of the intended advantages and the avoidance of potential pitfalls.

5 DISCUSSION

The relocation of high schools to university campuses in the Helsinki Metropolitan Area (HMA) illustrates a practical approach to sustainable development in education. This innovative model not only improves efficiency in infrastructure use but also aligns with broader international sustainability objectives by fostering a cooperative and sustainable learning ethos. Our findings from the SWOT analysis present a nuanced view of this educational integration, highlighting both opportunities and challenges.

Support for Advantages: The literature widely acknowledges the advantages of sharing, such as optimizing underutilized assets, creating new income streams, and enhancing access to goods and services (Bardhi & Eckhardt, 2012; Acquier et al., 2017; Rifkin, 2000). Our findings support these claims. For instance, high school students benefited significantly from access to university facilities, such as advanced laboratories and extensive libraries, enhancing their educational experience and smoothing their transition to higher education.

From an environmental standpoint, the literature emphasizes that sharing reduces resource consumption and waste (Firnkorn & Müller, 2011). Our study corroborates this by demonstrating that shared use of university spaces reduced the need for additional high school facilities, contributing to sustainability goals (Acharya et al., 2020; Lundgren et al., 2022).

Social disadvantages, including fostering collaboration and community building, are also highlighted in the literature (Benkler, 2017; Richardson, 2015). Our research found that shared campuses encouraged social interactions and professional networking among students and teachers, reinforcing these disadvantages.

Contradictions with disadvantages: Despite these advantages, the literature identifies several disadvantages of sharing, such as regulatory challenges, trust issues, and economic inequality (Edelman & Geradin, 2015; Acquier et al., 2017; Schor et al., 2016). Interestingly, our study did not find significant regulatory challenges. Trust issues were also not prominent, likely due to the structured and supervised nature of the educational environment.

Economic inequality, a critical disadvantage noted in the literature, was addressed through careful management of resources, and scheduling to ensure equal access to spaces for the high school. This suggests that proactive management can mitigate economic disparities, leading to more equitable sharing outcomes.

Unique Challenges: Our findings highlight unique challenges not extensively covered in the literature. For example, logistical challenges related to coordinating academic calendars and integrating booking systems were significant. These challenges, while not broadly discussed in the literature, are crucial for the practical implementation of sharing in educational settings. The capacity of public transportation also emerged as a significant factor, with inadequate transport infrastructure leading to commuting challenges for students. This underlines the need for integrated planning that considers all aspects of shared resource use, including transportation.

Based on our findings, we recommend that educational institutions considering similar resource-sharing models focus on four practical implications: First, ensure robust physical and digital service to support the handling of increased demand. Second, align educational schedules and curricula to maximize the advantages of shared resources. Third, develop clear protocols for managing and scheduling shared spaces to avoid conflicts and ensure equitable access. Finally, collaborate with local authorities to improve public transportation options, ensuring easy access to shared campuses. These practical implications are essential for realizing the full potential of sharing in educational settings, ensuring that the advantages are maximized while mitigating the disadvantages.

6 Conclusion

The integration of high schools into university campuses in HMA showcases a promising model for sustainable development in education. While our findings support many advantages highlighted in the literature, such as enhanced resource access, pedagogical integration, and strengthened social connections, they also reveal unique challenges related to logistics, scheduling, and transportation. Addressing these challenges through robust infrastructure support, pedagogical alignment, proactive facilities management, and improved transportation planning is essential for maximizing the advantages of sharing models in educational settings. Further research is needed to explore these dynamics and develop strategies to harness the full potential of sharing while mitigating its disadvantages. This study contributes valuable insights into the potential of sharing educational spaces to support global sustainability goals and promote more sustainable and equitable educational practices.

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Session 2C: Activity based working: theory & practice

Satisfaction Assessment of ABW work settings

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ABSTRACT

Research on perceived indoor environment quality has identified several aspects of the material, ambient, and socio-spatial environment that affect users' health, well-being, satisfaction, and work performance. However, these aspects are often assessed on a general level of work environments (such as office floors), thus neglecting differences between work settings as offered in ABW environments and the different patterns of office workers' use of the different settings.

We collected data on Overall Work setting satisfaction (OWS) and satisfaction with environmental features of workplace settings in ABW in 5 office buildings (n = 455) using online questionnaires.

Participants indicated that within ABW their most preferred setting were open space workstations (136), medium-sized meeting rooms (69), informal multipurpose rooms (46), and other settings (14). This indicates that individual references may differ when filling in a satisfaction survey. Furthermore, participants switch between different workplace settings: 59 per cent of participants indicated that they switched 2-5 times per day and further 14 per cent answered that they switched 6-10 times a day.

The assessments of environmental features of the workplace settings differed to some degree in satisfaction between the settings. Overall, the results show that satisfaction assessments for preferred and frequently used settings in ABW are generally similar.

Keywords

Workplace management, Work settings, User satisfaction, Activity based working, Switching behavior

1 INTRODUCTION

Various research on the perceived quality of indoor environments has identified a multitude of aspects related to the material, ambient, and socio-spatial environment that have an impact on the health, well-being (Colenberg & Jylhä, 2021), satisfaction (Hoendervanger et al., 2018; Van der Voordt & Jensen, 2023), and overall work performance of the users (Van der Voordt & Jensen, 2023). However, assessments of these aspects are often collected on a rather general level, typically focusing on broad categories of work environments such as office type (Bodin Danielsson & Bodin, 2008; Candido et al., 2018; Masoudinejad & Veitch, 2022). This approach, however, tends to overlook the differences that exist within office types, i.e., different implementations of the same office type. This is particularly important in Activity-Based Working (ABW) environments (cf. Stojanovic et al., 2024). ABW offices can be found in very different forms in terms of quality and quantity of the work settings they provide (see Iurilli et al., 2024). ABW environments are designed to provide a variety of settings to support different office activities (Becker, 2004, Stone & Luchetti, 1985). The diverse patterns of office workers' use of these different work settings, which can significantly influence their experience and performance, are often not adequately considered in assessments of ABW environments.

To examine whether these differences play a role in assessment, this study explores usage patterns and perception of environment features of different work settings in ABW environments.

2 Theory

In activity-based working environments, instead of personally assigned workstations, employees have a variety of different work zones at their disposal that are dedicated to different activity patterns and are used temporarily depending on requirements and the tasks at hand. Activity-based working offices are suitable for concentrated individual work (e.g., individual workstations, silent areas, thinking cells, reading areas/libraries) as well as for interactive work in groups (e.g., project rooms, meeting rooms, multifunctional rooms, informal meeting places such as lounges, espresso bars, etc.) and offer opportunities for rest and regeneration. Accordingly, different work settings are provided, which include differently designed work options that can be implemented as furnishing objects (e.g., standard workstations, room-in-room objects) or zones (e.g., work lounges, meeting zones, library). The work settings are set up and equipped in such a way that the activities that are to be carried out there are supported in the best possible way.

In such non-territorial office concepts, employees do not have a personally assigned workstation, but look for their workstation depending on their task or personal preference and mood. By switching between work settings, employees can create or adjust the fit between the environment and their needs (Hoendervanger et al., 2022) or the fit between preferences and work setting (Babapour Chafi, Harder, & Bodin Danielsson, 2020). It can therefore be assumed that the fit between person and

environment should generally be high (cf. Bäcklander & Richter, 2022). However, this is not generally the case and empirical findings on user assessment of ABW have been mixed (e.g., Engelen et al., 2019). There are several possible reasons for these mixed findings: a) ABW environments studied may not have provided optimal quantity and/or quality of work settings (cf. Iurilli et al., 2024), b) office users may not have switched between work settings and therefore may not have achieved the best fit between task and environment (Bäcklander & Richter, 2022; Häne & Windlinger, 2022), or c) office users may have referred to their currently used work setting or to their preferred or to most frequently used work setting instead of the overall ABW environment when giving their assessment.

3 Methodology

As part of a research project on workplace benchmarking, we conducted an online questionnaire to measure user's assessment of the office environment. We aimed at examining whether work setting within ABW are assessed differently by users and how assessments of work setting features affect overall work setting satisfaction (OWS).

Participants

The questionnaire respondents are office workers five different buildings across three organisations. The facilities range in size from 700m^2 to 35'500m^2, and the headcount ranges from 64 to 3000. A total of 455 respondents from three organisations participated in the online questionnaire. Two organisations are large organisations, and one is small organisation. One organisation is at a national level (391 participants) and two are at a multinational level (64 participants). The organisations belong to different industries, including banking and insurance (41 participants), logistics (391 participants), software development and telecommunications (23 participants). All organisations are located in Switzerland. Four buildings from three organisations are headquarter/subsidiary (372 participants) and one building in a branch/regional office (83 participants). The four buildings from two organisations are in an activity-based office (414 participants) and one building from one organisation is in a multi-space office (41 participants).

Data collection

The survey was conducted from July to September 2022. Participants were recruited through three organisations that participated in the workplace benchmarking projects. An e-mail invitation and a project information flyer were sent to the contact person from each organisation, and they shared invitation link and project information to users of 5 assessed buildings.

Data on satisfaction on environmental features of workplace settings was collected with 14 items in five office buildings (n = 455) using online questionnaires. A 5-point Likert scale was used to measure satisfaction (1 = very unsatisfied, 5 = very satisfied) with environmental features of workplace settings. Additionally, OWS (overall work setting satisfaction) was collected (1= very unsatisfied, 5= very satisfied). For the questionnaire, workplace settings were identified by their exact names as used in the respective companies. Furthermore, floor plans of representative workplace settings were included in the questionnaire, thereby enabling participants to know what work setting we meant in the questionnaire. Due to the length of the questionnaire, not all settings could be evaluated by all participants. We therefore invited participants to assess their current, most preferred, and 2nd most preferred work setting.

Data analysis

To aggregate data from the five buildings, the names of the workplace settings were standardized using the ZHAW space classification, which was developed as part of the workplace benchmarking project (Häne et al., 2023, see also Iurilli et al., 2024 for further information). Following the standardization by ZHAW space classification, the 'Think tank' in building 2 and the 'Focus room' in building 4, for example, were reclassified as 'Multipurpose room'. Prior to the merging of data from five buildings, a comparison of the variances was necessary to demonstrate that the data from the five buildings were not disparate. Consequently, an ANOVA was conducted, which revealed that the values of the data from the five buildings were not significantly different. Consequently, all the data were merged into a single dataset. Following the merging of the data from the five buildings, descriptive analyses were conducted to analyse switching behaviour, the current, most preferred, and second preferred work settings, and OWS score. Subsequently, descriptive analysis was undertaken to present the satisfaction of 14 environmental features of the workplace settings. Finally, linear regression analyses were conducted to determine the relationship between OWS score and the satisfaction with 14 environmental features.

4 ResultS

Descriptive analysis

Switching behavior

For switching behavior, data from 280 participants could be analyzed. The descriptive analysis revealed that 59% of the respondents reported switching 2-5 times a day (n=165), followed by 6-10 times a day (n=39), once a day (n=31), and 3-4 times a week (n=30).

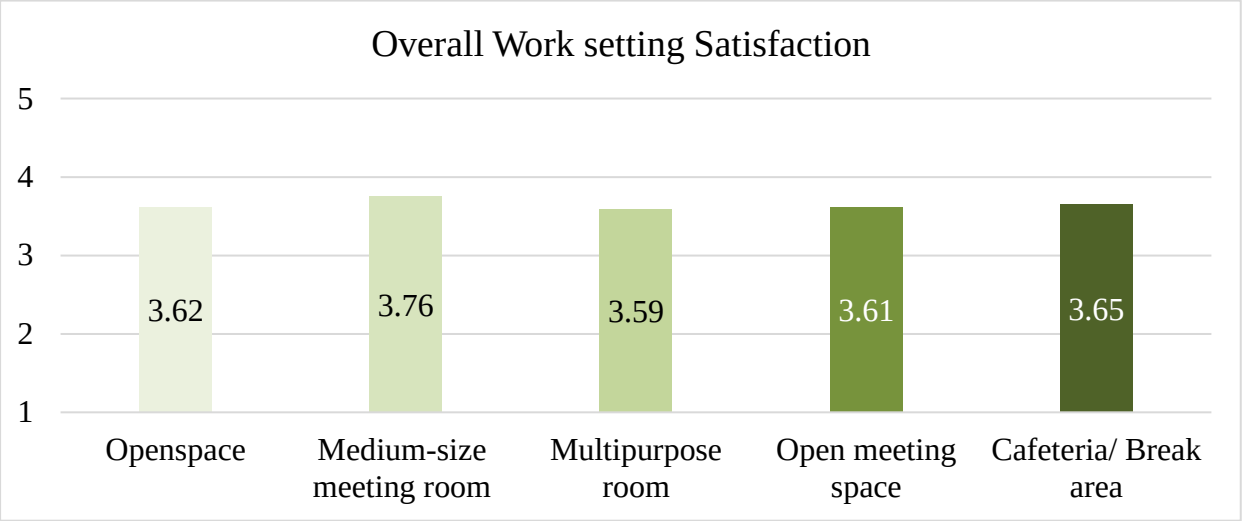
Current setting, and most preferred/second preferred setting

The descriptive analysis presented in Table 1 identified that open space was reported as the current and most preferred/second preferred setting (n=377). Medium-size meeting room (n=138) and multipurpose room (n=114) follow. The open meeting space (n=22) and cafeteria/break area (n=16) were identified as the most preferred or second preferred settings by a smaller number of respondents, but not as the current setting.

Table 1. Current setting, most preferred, and second preferred setting.

	Current	Most preferred	Second preferred	Sum	Rank
Open space	153	136	88	377	1
Medium-size meeting room	4	69	65	138	2
Multipurpose room	6	46	62	114	3
Open meeting space		8	14	22	
Cafeteria/break area		6	10	16	

Figure 1. OWS score (Valid n = 151)



Overall Work setting Satisfaction(OWS) Score

The OWS score was measured on a scale of 1 to 5, with 1 being very unsatisfied and 5 being very satisfied. Visual inspection of the data (see figure 1) shows that the OWS scores for each setting did not vary substantially. Figure1 shows the mean OWS score each setting.

Satisfaction of environmental features of each setting

A descriptive analysis was conducted to present the satisfaction of 14 environmental features in workplace settings. The results showed that in open spaces, access to an outside view from where to sit, access to daylight/natural light, and size of setting were found the most satisfied features. Further, degree of enclosure, amount of noise, level of privacy for conversation were shown to be the least satisfied environmental features.

Table 2. Satisfaction of environmental features in open space

Open space **Environmental features**	**N**	**Mean**	**SD**
Access to an outside view from where you sit	356	4.17	0.94
Access to daylight/natural light	355	4.15	1.03
Size of setting	350	4.07	0.86
Quality of lighting	358	4.04	0.9
Distance between you and other people sitting around you	357	3.87	0.99
Temperature	357	3.55	1.07
Amount of background noise (excluding speech) you hear	358	3.54	1.12
Air quality	357	3.52	1.09
Ability to adjust the physical workspace (e.g., layout, light, temperature)	355	3.43	1.04
IT Infrastructure	358	3.42	1.14
Not being interrupted by other people	357	3.41	1.03

Degree of enclosure by walls, screens or furniture	352	3.37	1.11
Amount of noise	358	3.27	1.13
Level of privacy for conversation	357	3.24	1.13
Valid N (listwise)	327		
Average		3.65	

Table 3. Satisfaction of environmental features in medium-size meeting room

Medium-size meeting room			
Environmental features	**N**	**Mean**	**SD**
Access to daylight/natural light	116	4.11	0.87
Access to an outside view from where you sit	116	3.99	0.86
Size of setting	115	3.97	0.87
Quality of lighting	116	3.95	0.94
Not being interrupted by other people	116	3.89	1.13
Distance between you and other people sitting around you	115	3.85	0.94
Amount of background noise (excluding speech) you hear	116	3.81	1.07
Degree of enclosure by walls, screens or furniture	116	3.73	1.12
Amount of noise	114	3.68	1.19
Level of privacy for conversation	115	3.66	1.28
IT Infrastructure	116	3.54	1.11
Ability to adjust the physical workspace (e.g., layout, light, temperature)	115	3.51	0.99
Temperature	117	3.49	1.04
Air quality	117	3.24	1.16
Valid N (listwise)	105		
Average		3.74	

The study determined the satisfaction of environmental features in the multipurpose room. The findings indicated that not being interrupted by other people, size of setting, level of privacy for conversation as the most satisfied features in the multipurpose room. The least satisfied features were found to air quality, IT infrastructure, ability to adjust the physical workspace.

Table 4. Satisfaction of environmental features in multipurpose room

Multipurpose room **Environmental features**	**N**	**Mean**	**SD**
Not being interrupted by other people	88	4.09	0.98
Size of setting	89	3.91	0.82
Level of privacy for conversation	90	3.83	1.16
Distance between you and other people sitting around you	88	3.81	0.95
Quality of lighting	89	3.8	0.93
Amount of background noise (excluding speech) you hear	88	3.76	1.11
Amount of noise	90	3.67	1.23
Access to an outside view from where you sit	89	3.65	0.95
Degree of enclosure by walls, screens or furniture	88	3.63	1
Access to daylight/natural light	89	3.56	1.1
Temperature	89	3.38	1.02
Air quality	91	3.35	0.99
IT Infrastructure	89	3.28	1.18
Ability to adjust the physical workspace (e.g., layout, light, temperature)	89	3.27	1.01
Valid N (listwise)	81		
Average		3.64	

Regression analysis

A multiple linear regression was conducted to predict the OWS score from the satisfaction ratings for 14 environmental features in the open space. This resulted in a significant model, $F (14, 186) = 11.10$, $p < .001$, $R^2 = .455$. The regression analysis found that satisfaction of degree of enclosure by walls, screens, or furniture ($\beta = 0.23$, $p < .01$) and access to daylight/natural light ($\beta = 0.19$, $p < .05$) were significant predictors. Also, distance between you and other people sitting around you ($\beta = 0.18$, $p < .05$) and IT Infrastructure ($\beta = 0.13$, $p < .05$) were significant predictors of the OSW in open space.

Next, a multiple linear regression was run to predict the OWS score from the satisfaction ratings for 14 environmental features in medium-size meeting room. The regression analysis found satisfaction of size of setting ($\beta = 0.34$, $p < .01$), IT infrastructure ($\beta = 0.28$, $p < .001$), distance between you and other people sitting around you ($\beta = -.25$, $p < .05$), degree of enclosure by walls, screens, or furniture($\beta = 0.22$, $p < .05$) to be significant predictors of the OWS score in the medium-size meeting room with $F(14, 48) = 6.47$, $p < .001$, $R^2 = .654$.

Subsequently, a multiple linear regression was run to predict the OWS score from the satisfaction ratings for 14 environmental features in multipurpose room. This resulted in a significant model ($F(14, 30) = 2.11$, $p < .05$, $R^2 = .50$). Further examination of the individual predictors identified that satisfaction of quality of lighting ($\beta = 0.48$, $p < .05$) was the only significant predictor.

5 Discussion

The present study aimed to assess the usage patterns and perceptions of environmental features in different work settings within ABW environments. Regarding the usage of settings, the results indicated that users switched between different settings on average 2-5 times per day. This finding aligns with the fundamental underlying assumption of ABW, which suggests that different settings are offered for different activities within the office (Becker, 2004, Stone & Luchetti, 1985). This result also aligns with a previous study (Häne & Windlinger, 2022). The most frequently used settings were the open space, medium-size meeting room, and multipurpose room. This was consistent across different buildings, indicating that many office users do not use various settings in ABW but rather only certain settings. This supports the results of Kratzer (2020), who found that three settings are used daily: personal workstation, meeting/conference rooms, and places for informal interaction.

The mean OWS scores of the settings did not vary substantially, with an overall mean of approximately 3.6 (on a scale of 1 to 5, with 1 being very unsatisfied and 5 being very satisfied). The daylight/natural light, access to an outside view from where to sit, and size of the setting were found to be the top three most satisfied environmental features for both the open space and the medium-size meeting room. The least satisfactory features identified in both the medium-size meeting room and multipurpose room were air quality and the ability to adjust the physical workspace (e.g., layout, light, temperature). Furthermore, the regression analysis demonstrated that the degree of enclosure, distance between individuals sitting around you, and IT structure significantly influence the OWS score in both open space and medium-size meeting room. Access to daylight/natural light significantly influenced the OWS in open space, and the size of the setting substantively impacted the OWS in medium-size meeting rooms. The quality of lighting significantly influenced the OWS in multipurpose rooms.

In this study, we attempted to standardize workplace settings that had been labeled differently across five distinct buildings. By aggregating data from these various settings, we sought to facilitate comparisons. Our findings shed light on how usage patterns and perceptions of environmental features diverge across different work settings. This underscores the importance of considering these differences between work settings in workplace assessment.

It is important to note that the sample size per building was relatively small, which limits the ability to draw robust conclusions when comparing across buildings. Furthermore, amount of data for the multipurpose rooms was small, thus limiting the statistical power of the regression analysis. Future research should address these limitations by either expanding the sample size or exploring alternative methodologies.

6 conclusion

This study extends the focus of some previous research on workplace assessment by assessing not only the entire office level but also the setting level. Additionally, this study assessed the usage patterns and perceptions of environmental features in different work settings within ABW environments. The results showed that users across various buildings switch 2-5 times a day and use mostly three specific work settings in ABW: open space, medium-size meeting room, and multipurpose room. The analyses show that the assessment of the overall work setting satisfaction was similar for open space, medium-size meeting room, multipurpose room, and cafeteria / break area. The association of satisfaction with work setting environmental features and overall work setting satisfaction differed to some degree in size and content with degree of enclosure, distance to other

people, and IT infrastructure being common significant predictors for open space and medium-size meeting rooms and access to daylight/natural light being a unique predictor for OWS of open space, size of setting for medium-size meeting room, and quality of lighting for multipurpose room. To summarize, the results show general agreement in the assessment of work settings in ABW with some hints for differences between work settings that should be further explored. By studying workplace assessments that account for the unique characteristics of each setting and combining these with occupancy data, organizations can create more tailored and effective work environments for their employees, e.g., by designing for flexibility of settings and overall layout or by optimizing quality of environmental features. The findings of this study can provide valuable insights for workplace assessment, particularly for those engaged in workplace management or facility management. By understanding their employee's usage behaviors better, these professionals can apply these insights to workplace design. Future research on workplace assessment is required to consider differences in various settings in ABW.

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Assessing the Activity Based Workplace (ABW) concept based on different work collocated business units.

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ABSTRACT

Activity Based Workplace (ABW), which was developed based on the concept of 'non-territoriality', aims to optimize different types of activities and cross disciplinary collaborations in a workplace, with the activities varying depending on the functional requirements of their business units. Additionally, the ways of conducting workplace activities were influenced by the recent COVID-19 pandemic and, to date, limited post occupancy studies have been conducted after COVID-19 lockdown period, to analyse the relationship between an ABW and the functional requirements of the different business units in a workplace. To address this knowledge gap, this study conducted 13 interviews on an ABW at an Australian university, that accommodates 133 non-academic workers from 9 different business units. Following a qualitative approach, thematic analysis was conducted to analyse the interview data using an iterative and inductive method. The study found that, during the post-occupancy period workers have deviated against the intended non-territoriality and adapted to a neighbourhood (territorial) style of working, based on their business units. The unsuitability of non-territoriality for functional requirements of business units, such as (i) collaboration, (ii) confidential work, (iii) identity, and (iii) managing teams, was found to be the key reason behind this deviation. In comparison, neighbourhood arrangement was found to be supportive of these four functional requirements of the business units. However, it was found that some workers were still operating a non-territorial, activity-based working style within the territory of their neighbourhoods, based on task and personal preference. Thus, organisations need to assess feasibility of 'non-territoriality' for the functional requirements of their different work portfolios and identify an efficient combination of business units, if they are planning for an ABW transformation. Further, for established ABW environments organisations need to conduct post-occupancy reviews at frequent intervals to understand the evolving working styles and functional requirements of their business units.

Activity Based Workplace (ABW), Non-territoriality, Business units, Functional requirements, Collaboration.

1 INTRODUCTION

In ABW environments, business units (or teams) are not accommodated in their own territories and the workers are offered the opportunity to work from a setting of their choice in the workplace. This workplace arrangement encourages staff to sit next to workers from other business units to enhance collaboration (Appel-Meulenbroek et al.,2020, van den Berg et al., 2020). However, there is growing evidence that this intended purpose is not always followed.

1.1 Literature Review

Based on a longitudinal interview study conducted in an engineering company, Wohlers and Hertel (2018) found that inter-team relationships, social interaction, cross-disciplinary communications, and collaboration increased due to the opportunity received by the workers to sit next to colleagues and managers from other business units in the ABW environment. Employees have appreciated the ability to interact from both social and work perspectives and with different levels of the management in the organisation, based on a qualitative study conducted using thematic analysis of interviews in a local government organisation in Victoria, Australia (Arundell et al.,2018). A longitudinal survey conducted based on an Australian Federal Government organisation found that ABW increased the success of cross-portfolio joint projects and fostered knowledge sharing between the different business units (Divett, 2020).

In contrast, since the members of a business unit are not guaranteed to be seated in the same area in the workplace, intra-team collaboration, communication, cohesion and sense of belonging were found to be decreasing in the ABW environment. This was found through a natural intervention study in a large Swedish Government Agency including four ABW environments (Haapakangas et al.,2019). Further, a case study built on interviews and observational studies from a Norwegian organisation found that identity threat, created by team distancing, as a barrier to efficient ABW environments (Skogland, 2017). Employees have complained that the time wasted in locating team members reduced their overall productivity level (Divett,2020) and has led towards losing the sense of community due to the de-attachment from other team members (Arundell et al., 2018,Haapakangas et al.,2019, Wohlers et al., 2018). Further, based on an occupant survey from Building Occupant Survey System Australia (Kim et al., 2016) management suffered due to reduced visibility and proximity to team members in the ABW arrangement, .

Therefore, workers have perceived various experiences in functioning their business units within non territorial ABW environments.

1.2 Research Gap

COVID-19 has accelerated the adoption of Working from Home (WFH) method across various industries (Bhave, et al, 2020) and they continue to be embedded into various workplace environments. Following the COVID-19 lockdown period, limited post occupancy studies have been conducted to assess the relationship between an ABW and the functional requirements of their different business units. Thus, it is important to review how these complexities in ABW are affected in the post COVID-19 lockdown period.

The COVID-19 was considered in this study as a context to define the timeline, assuming the work style changes induced by the COVID-19 pandemic would have had a major impact on the functionality of business units in an ABW environment.

1.3 Research Question and Aims

This study aims to answer the question: What is the relationship between the ABW concept and the functional requirements of different business units in a workplace, in the post COVID-19 lockdown period? Additionally, this study aimed to examine the various impacts of the non-territorial arrangement in an ABW on the functionality of the business units and the reasons behind those implications through the perspective of the workers. To address the research question and aims, this paper used data collected through a series of interviews that were conducted as part of a broader research project.

2 research design

This study followed a qualitative approach and recruited workers from multiple work portfolios in an ABW environment, which was located within an Australian University, and it focused on the professional working environment (not on academic working environment).

2.1 Research Method

Semi-structured interviews were used in this study, as the pre-planned questions worked as guidelines in developing in-depth discussions with the workers to comprehend the negative and positive impacts of ABW on their functional requirements in different business units. Further, interviews were used to enable an understanding of the reasons for different implications and ask follow-up questions based on interviewees' responses to the pre-planned questions (Yin, 2014, Sarvimäki, 2018).

2.2 Sample and its characteristics.

The chosen workplace had transformed from a traditional arrangement to ABW in early 2020 (prior to the COVID-19 lockdown) and currently accommodates 133 staff members from 9 different non-academic disciplines. The study aimed to engage at least one employee from each business unit, based on the request letters sent to the managers of the 9 business units. In total, 13 interviews were conducted with more than one employee volunteering from certain business units. In the instances where there was more than one interviewee from a business unit, they were found to conduct different roles in their teams, thus considered in this study to capture their different perspectives.

The scope, number of staff and the interviewees of these 9 business units are listed in Table 1.

Table 1. Scope, size, and number of interviewees of the business units

No.	Business Unit	Scope of the business unit	No. of Staff	Interviewee ID
1	Quality Assurance	Managing institutional quality assurance aligned against the Higher Education Standards Framework /threshold standards. This includes managing compliance, processes, and Information Technology Management.	02	Interviewee 9
2	Service Experience and Improvement	Managing the developments in the campus, innovation, services improvements and change management	10	Interviewee 6
3	Learning and Teaching	Managing the learning and teaching of student's staff and external stakeholders. Focusing on scanning the market for new products, improving processes and problem resolution.	05	Interviewee 10
4	Commercial	Managing releasing and acquisitions on behalf of the university	06	Interviewee 1
5	Project Team	Plan and deliver digital projects, on behalf of Digital Information Technology Management (DITM).	04	Interviewee 3
6	Finance and Business Services	Managing the whole Financial Management, Management accounting and Business Services of the university	33	Interviewee 4 Interviewee 13
7	Data, Analytics, and Insights	Overlooking the university's enterprise data warehouse, business intelligence reporting, management dashboards, variety of data related requests, market research, surveys, corporate performance, and the insights function for the university.	20	Interviewee 2
8	Future Students (Global Student Recruitment)	Responsible for all forms of local and international student acquisition.	50	Interviewee 5 Interviewee 7
9	Strategic Program Office	Central coordinating office for any investment logic or investment decision of the five faculties across the university, which involves sensitivity around information management. This includes enabling services, uplifting the capability and the capacity of the university around projects, programs, and portfolio management.	03	Interviewee 8 Interviewee 11 Interviewee 12
	Total		**133**	**13 interviews**

The participants were interviewed to critically analyse the various types of functional requirements of their work portfolios and the impact of the ABW environment on them. The interviews were conducted from November 2022 to April 2023 using a mix of in-person and virtual (Microsoft Teams) methods.

2.3 Method of Analysis

Thematic Analysis was selected as the method of analysis. The inductive process of thematic analysis leads to categorizing the recurring comments derived through the interviews and critically analysing the perceived experiences of the workers in detail beyond just assessing the explicit or surface meaning (Braun & Clarke, 2006). The themes were identified following an iterative reading of transcripts, excluding irrelevant data, and identifying recurring themes (Attride-Stirling, 2001, Braun & Clarke, 2006).

3 ANALYSIS OF FINDINGS

3.1 Transformation towards neighbourhood arrangement for each business unit

According to the thematic analysis, the most significant global theme that recurred in multiple interviews was the deviation of all the business units from the originally developed non-territorial ABW arrangement towards a neighbourhood (territorial) style of working for each work portfolio. Comments received through certain employees are presented in Table 2.

Table 2. Interviewees' comments on forming the neighbourhoods.

Interviewee ID.	Business unit	Comment
Interviewee 2	Data, Analytics and Insights	My business unit tends to use the same desk every day. So, they're not really moving around as such in terms of that activity-based element.
Interviewee 3	Projects (Digital Information)	Originally there was this idea that you would move and potentially sit with other teams to do work. And I don't really see that happening instead of sitting with their own team
Interviewee 5	Future Students	Honestly on a day-to-day basis, it (neighbourhood) is something we've gotten used to. This setup helps me have a visual sense of how the team's feeling

Even though the overall ABW has deviated towards a neighbourhood style of working, some employees were still found to be operating a non-territorial method within the neighbourhoods of their business units, shifting between the desks as required to benefit specific tasks and managing teams. For example, the following comments were received:

"To be honest, I probably move around most in my team because I wait to see who's in and then I choose the desk that makes more sense to be sitting at" (Interviewee 3)

"I'm within the same area. But each day I try to go to a new desk. I'd say a few people try to mix it up and sit somewhere else" (Interviewee 9)

According to the thematic analysis the main reason (most recurred secondary theme) behind the deviation towards a neighbourhood style of working was 'unsuitability of non-territorial arrangement

in ABW for the functionality of certain business units', thus this became the focus of the analysis in this paper. Even though the impacts of WFH imposed during COVID-19 lockdown period was identified as a reason for the deviation towards a neighbourhood style, this secondary theme has recurred only in limited instances (than the main reason) during the interviews, thus will not be analysed in this paper.

3.2 Unsuitability of non-territorial arrangement in ABW for the functionality of certain business units

The thematic analysis found four (4) main impacts of the ABW environment on the functionality of their business units.

i. Impact on collaboration.

This study found that having the team members seated in multiple locations in the ABW without being in a specific team area / territory made the collaborative works inefficient and ineffective.

Interviewee 2 preferred the ability for personal interaction with the colleagues in the neighbourhood opposed to the ABW arrangement as the Data, Analytics, and Insights team engaged in much research, reporting and analysing works collaboratively.

"I think it's a preference thing that the team has just naturally gravitated to that collaboration, as well as the cohesion between the team is better in person."

To conduct those activities, proximity with the team members was a key requirement for many business units including the Strategic Program Office. According to interviewee 11, as a central coordination team in the university, this business unit was involved in strategic discussions and decision making, which were not effectively facilitated by the ABW arrangement.

"It's easier to have an area where you sit with your team so you can actually talk about work and share and brainstorm. That's what's missing in an activity-based work area."

Many workers and business units have benefited from the deviation from the original ABW concept to the neighbourhood arrangement due to the ability to easily communicate and collaborate with their team members. According to interviewee 1,

"Because you just walk up to someone and you can see them and you can hear them, definitely intra-team collaboration has improved after moving to the neighbourhood."

In addition, during the post COVID-19 lockdown period, workers had to arrange a hybrid working policy which included a combination of days to work from home and office. On the days that they come to the office, workers and managers had a strong operational need to sit with their team within the territory of their business units for better collaboration which they were unable to succeed effectively during working from home. According to interviewee 10,

"...if we are in the office, because we want to collaborate with the team, I want to sit where the team is. I don't want to sit on another part of the floor."

Nevertheless, in contrast there were strong arguments made by certain employees that the neighbourhood approach does not serve the purpose of enhancing inter-team collaboration and

meshing the ideas between different teams and have been unable to focus on synergy of parallel work with other business units, compared to ABW.

"...it's more a consequence of just being in the same space with a new team, that you get to know those people, you find synergies and you start to say, 'Oh, you're doing that I'm doing this, or let's work on this together'." (Interviewee 12)

Further, neighbourhood arrangement has been found to be removing the opportunity for spontaneous collaboration which could lead up to new process improvements.

"...you might increase productivity, because then you might say to someone, 'I see you've got a graph there of a financial chart, what's that mean?' And then you might have a conversation around that, which might lead to a process improvement". (Interviewee 10)

ii.Impact on confidential work.

The Finance and Business Services team mainly work with sensitive numerical data and reporting thus demands a high level of confidentiality in their working area. Non-territorial behaviour in an ABW triggered a major risk of leaking critical financial information to the staff (from other business units) who were not authorized to receive such details. Indeed, it was stated:

"Accountants are creatures of habit, and we all tend to move to our 'regular desks' which enables us to deal with sensitivity and our issues within our small team environments" (Interviewee 4); and

"Particularly at budget time, we're sitting there talking about budgets and levels of people, what they're being paid. And you really have to look around and check who's listening and whatever". (Interviewee 13)

This functional requirement of the Finance and Business Services team has led them to deviate from the original ABW concept and establish a neighbourhood environment with allocated desks.

The workers in the Strategic Program Office have also undergone the same operational issue and argued that the ABW did not facilitate confidential discussions and sensitivity of the type of information they needed to discuss in their business unit.

"It's very difficult to have a conversation in that open space, especially when we are talking due diligence, assurance, business case development and financials." (Interviewee 8)

The sensitive information overheard or witnessed by other workers could become the subject for workplace gossiping, creating a risk of breaching confidentiality and miscommunication of information, according to interviewee 8

"Someone else who's passing, they'll hear part of the conversation, and that conversation is taking with possibly out of context and gone to another business unit, and that is disgust, it also feeds that kind of workplace gossip as well."

iii.Impact on the identity of business units.

The Strategic Program Office displayed work-related signboards/posters such as workflow charts on the walls within their designated office spaces while they were accommodated in the previous

traditional workplace. The traditional workplace behaviour has supported their work processes, communication, and learning within the business unit. Nevertheless, following the transformation to ABW, the physical environment has not facilitated that requirement due to the absence of territories and walls to demarcate different business units.

"...we've got workflows and all that we'd like to put on the wall for training of staff. So, there's no space and walls to do that." (Interviewee 8)

Workers believe that these work-related signboards and posters created an identity for a business unit and became symbols that represented their business unit to other staff. Thus, the non-territorial arrangement of ABW has led towards losing their identity. External stakeholders and new staff members who visited this workplace have found it challenging to locate a particular business unit or a worker that they wanted to meet for collaboration, or any official matter.

"Here, we can't do any of that (display of signboards). And so, in a sense, you could walk around and not have any idea regarding what someone is about, or what their work is about. Because there's no evidence of what they do around them." (Interviewee 10)

"We should have our own office, so that people will know where to go, if they need to see us." (Interviewee 11)

iv.Impact on managing teams.

Team leadership had started to face many difficulties in managing their business units due to the trouble in locating the team members who were based in different work locations in this ABW and other administrative buildings in the university.

Managers of business units have complained that they were unable to have quick discussion with a team member due to the ABW arrangement. They had to send an email or a message through Microsoft Teams or organize an online / in-person meeting with their team members who were seated on a different side of the work floor to sort out even a minor work-related matter.

"ABW arrangement did not help in building strong, high performing teams. it's almost paramount for people to be able to put their head up and just ask a quick question and have to the subject matter experts so that's sort of an escalation referral." (Interviewee 5)

Interviewee 11 explained that some of the staff members in their business units were located in other administrative buildings thus staff still has to commute between buildings or contact virtually for planning and decision-making tasks.

"I have most of my people that I meet with in other buildings, not in this workplace floor. Having situated in this building, we have to go to different buildings for project planning meetings".

and

"...., you still have to walk to other buildings, if you really want to collaborate."

In contrast, working together with the team members in the neighbourhood has increased the Directors' ability to be available to solve issues, support and monitor the team.

“I personally quite like being in the office and I like to be with the team, and I'd like to be there to support them and be available.” (Interviewee 2)

4 DISCUSSIONS

Addressing the research question, the non-territoriality of the ABW environment was found to be less supportive for the functional requirements of certain business units of this workplace in the Australian university. This has become the main reason for the deviation of the studied ABW to a neighbourhood style of working. Even though the study was conducted in the post COVID-19 lockdown period, the impact of COVID-19 induced workstyle changes was not found to be the main reason for the deviation of the original ABW towards a neighbourhood arrangement.

According to the literature, due to the unfavourable nature of the switching policy in ABW, some workers have started to personalize the desks and adapt to territorial behaviour in the workplace (Skogland,2017, Babapour et al.,2018). Nevertheless, this study found that the territorial behaviour extended beyond a few workers and the whole ABW has totally transformed into personalized neighbourhoods based on business units. This novel finding of the study challenges some key strategic principles of the ABW concept such as non-territorial seating of the workers and switching (between different work setting) policy.

In contrast, several employees were still found to be operating a non-territorial working style within their neighbourhoods reflecting the fact that working style becomes a personal preference at times in conducting tasks.

Addressing the aims of this study, thematic analysis found that non-territorial arrangement of ABW has mostly negatively impacted (i) collaboration, (ii) confidential working, (iii) identity of business units and (iv) managing business units. In comparison, neighbourhood arrangement has positively impacted these four workplace activities of the business units. Even though various impacts of ABW have been explored in the current literature, the comparison of relationships of these four workplace activities (collaboration, confidential working, identity of business units and (managing business units) between the non-territorial and neighbourhood arrangements is a novel finding of this study.

5 Conclusion

Successful implementation of an ABW in an organisation could depend on the functional requirements of their business units. This study reflects that organisations should conduct detailed pre-occupancy analysis prior to introducing the ABW concept to investigate its suitability for the functionality of their different business units. If an organisation decides to implement the ABW concept, they should identify the optimum combination of business units to be accommodated in the workplace appreciating their functional connections. Further, organisations need to conduct post-occupancy reviews at frequent intervals for established ABWs to help understand the evolving working styles and the functional requirements of their business units.

Future studies are recommended to conduct behavioural observations to understand how an ABW is being occupied by the workers from different business units. Further, investigating the perspective and objectives of the organisational management, in conjunction with the interviews with the workers will lead to a holistic analysis regarding the impact of the ABW on the functionality of business units.

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What We Know and What We Should Know About Activity-Based Work Environment Consequences: A Meta-Analysis

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ABSTRACT

Purpose: As more companies implement cost-effective, space-saving office designs, assessing their effects on employee well-being, social relationships, and performance becomes essential. This article conducts a meta-analysis on how activity-based work environments (ABWEs) influence well-being (physical activity, sedentary behaviour, privacy, control over work, fatigue, cognitive strain), social relationships (contact, communication, and relationships with co-workers and supervisors), and performance (productivity, distraction).

Theory: Using the Conservation of Resources (COR) theory, this study connects disparate findings on office resources and strains and considers contextual factors to explain variability in previous results.

Methodology: The Bayesian random-effects meta-analysis includes 26 studies involving 7,454 individuals across various industries and countries.

Findings: The results indicate that ABWEs may enhance physical activity, co-worker contact, and productivity. However, they may slightly degrade supervisor relationships. The moderator analysis showed differences between studies in private versus public sectors, showing more unfavourable outcomes in the latter, and that the comparison office design may matter for some of the outcomes.

Originality/value: This study extends current knowledge by providing the first comprehensive and interdisciplinary meta-analysis on potential ABWE consequences. The discussion includes alternative explanations for the mixed results and underscores the need for more uniform and rigorous research standards.

Keywords

Meta-analysis, activity-based work, office design, employee outcomes, boundary conditions, reporting standards

1 INTRODUCTION

Today's organizations have increased space-sharing by 30% and adapted to support hybrid work styles by increasing collaboration spaces by 44% globally since 2021 (Wasmund and Nam, 2023). One office layout that supports such a setting is an activity-based work environment (ABWE). ABWEs contain a main open office environment with flexible desk arrangements and additional common-use activity-related working locations (De Been and Beijer, 2014; Wohlers and Hertel, 2017a). Typical activity-based working features include individual workstations, team desks, break-out areas, telephone and meeting rooms, and informal lounge areas (Engelen et al., 2019a). ABWEs often demand a new approach to working and managing, which can be challenging for many, prompting important questions about the impact on employees, managers, and overall organisational effectiveness.

The literature on office design is fragmented, stemming from diverse disciplines, like management (Wright et al., 2023), psychology (Masoudinejad and Veitch, 2023), and real estate (Appel-Meulenbroek, 2016), with different methodological approaches and often contradictory results from commonly used case studies. Although Wohlers et al. (2019, p. 167) claimed that "empirical tests [of ABWEs] are rare", the last decade has provided insightful studies regarding these innovative work environments. Still, the generalisability of most empirical findings on ABWE consequences is problematic due to varying effect sizes and occasionally conflicting results.

Building on the conservation of resources (COR) theory (Hobfoll, 1989), this meta-analysis attempts to integrate the current literature and resolve some contradictions by addressing the following research question: **How do ABWEs influence employees' well-being, social relationships, and performance?** In doing so, we contribute to the literature in three major ways. First, we extend recent narrative reviews (Engelen et al., 2019b; Gerlitz and Hülsbeck, 2023; Masoudinejad and Veitch, 2023) by providing the first quantitative meta-analytic review of potential ABWE consequences for well-being, social relationships, and performance across disciplines. Second, guided by the COR theory, we conceptualise and test a set of substantive moderators that might exacerbate or mitigate the zero-order meta-analytic effects. Specifically, we investigate the moderating effects of contextual and methodological factors (i.e., public versus private sector, comparison office design, cross-sectional versus longitudinal research designs applied) influencing ABWE-outcome linkages. Third, delving deep into the current empirical ABWE literature, this study reveals a potential for improvement regarding the reporting of study settings and findings and provides the basis for recommendations regarding future methodological standards. In doing so, this meta-analysis offers insights into what we already know about ABWE consequences, what we should know more about, and how we can obtain this knowledge, concluding with specific recommendations to guide future workspace study and practice.

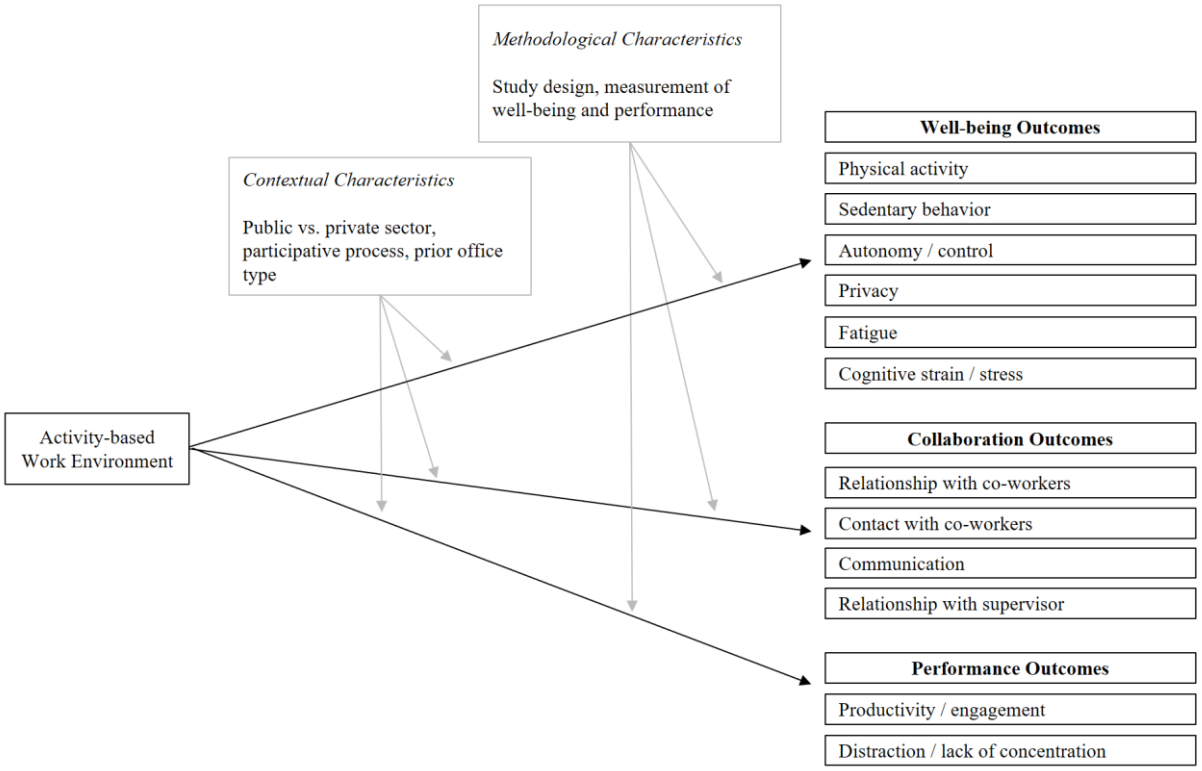
2 THEORY

2.1 Conservation of resources in ABWEs

According to COR theory, individuals strive to obtain, retain, and protect resources, including personal characteristics, conditions, or energies (Hobfoll, 2002, 1989). These resources are fundamental not just to survival but also for well-being and satisfaction in various aspects of life, including the workplace (Ito and Brotheridge, 2003; Xia et al., 2019). The COR theory offers a robust framework for understanding these dynamics, positing that individuals are motivated to protect resources and that stress arises when resources are threatened or depleted (Halbesleben et al., 2014).

In the context of ABWEs, the physical environment plays a pivotal role in shaping employees' perceptions of resource loss or gain, thereby influencing their levels of stress and motivation and, thus, behaviour. On one hand, employees navigating ABWEs may perceive the need to invest significant personal resources, such as time and cognitive attention, to adapt to new ways of working. This investment can lead to stress, particularly if perceived costs outweigh anticipated benefits. On the other hand, ABWEs also provide various resources ranging from physical (e.g., ergonomic furniture, options to be active) to social (e.g., opportunities for collaboration) and psychological (e.g., adapting workstation to task at hand). As such, ABWEs aim to enhance flexibility and collaboration, potentially leading to resource gains, including improved social networks and increased autonomy. These gains can initiate positive spirals of well-being and performance. In addition, the role of environmental resources, as conceptualised within the COR theory, is pivotal in shaping employee adaptation and outcomes within ABWEs. The conceptual model is presented in Figure 1.

Figure 1. A moderated Activity-based Work Environment (ABWE) – Outcomes Model



2.1 ABWE consequences for well-being, social relationships, and performance

Investigating the impact of ABWEs on physical well-being, we focus on physical activity and sedentary behaviour. ABWEs encourage movement and activity by design, prompting employees to relocate based on the task at hand (Wohlers and Hertel, 2017b). ABWEs are predicated on the concept of workplace mobility, providing a resource for enhancing physical well-being by mitigating the sedentary behaviour associated with traditional office settings. Previous research has shown such significant changes to lower sedentary behaviour and increased walking (Jindo et al., 2021, 2019; Wahlström et al., 2019).

The impact of ABWEs on psychological aspects, such as control over work, privacy, and fatigue, remains underexplored. Notably, previous research emphasise the importance of visual and sound privacy (Appel-Meulenbroek et al., 2011; Kaarlela-Tuomaala et al., 2009). A recent review concluded that there is no consensus on whether ABWEs have positive or negative effects on privacy (Marzban et al., 2023). Previous research also indicates that implementing ABWEs can negatively affect employee psychological ownership (Halldorsson et al., 2024, 2021) as well as job control (Nielsen et al., 2023). Conversely, ABWEs offer individuals the opportunity to select settings tailored to specific tasks, potentially enhancing perceived autonomy and workspace control (Gerdenitsch et al., 2018; Kim et al., 2016; Wohlers and Hertel, 2017b). In summary, while there is a predominant consensus on consequences for physical well-being in terms of enhanced physical activity, the picture regarding the psychological consequences is still unclear.

ABWEs impact on social relationships may be twofold. On one hand, open spaces and shared areas are designed to boost interaction and mobility, providing diverse communication methods like face-to-face and informal chats. Building on the COR theory, this can strengthen network and support system resources and improve the ease and effectiveness of communication. On the other hand, the same features may also cause interruptions and noise, which could lead to strained relationships, conflicts, and diminished conversation quality if privacy and formal mentorship opportunities are compromised. So, while ABWEs facilitate increased communication, the quality of interactions might suffer, conversations might become superficial, and the quality of mentorship or guidance, which are important for professional development and emotional support, might decrease. Empirical findings suggest that the design elements of ABWEs, such as physical proximity and visibility, are instrumental in promoting information sharing (Appel-Meulenbroek et al., 2017; Coradi et al., 2015), fostering trust (Wohlers and Hertel, 2018), and facilitating direct communication within teams (Rolfö, 2018). Engelen et al., (2019) consolidate these observations, concluding that ABWEs generally exert a positive influence on communication and interactions at work. Thus, positive interactions and relationships can be seen as a central resource for employees' well-being at work. Conversely, a more recent literature review by Masoudinejad & Veitch (2023) points towards a potential downside of ABWEs, highlighting a comparative reduction in social support from colleagues and managers relative to cellular offices. In summary, previous research showed both positive and negative consequences of A-FOs on social relationships but indicates differences between the mere frequency and the quality of communication and relationships.

While ABWEs offer spatial diversity and are designed to support various work activities, it is crucial to consider that these environments might also introduce elements that could detract from individual performance, such as interruptions and cognitive distress. Returning to the COR theory, such performance-reducing factors could potentially lead to resource loss, even spiralling into long-term exhaustion hindering performance. In contrast, positive individual performance outcomes in ABWEs may stem from a better person-environment fit (Hoendervanger et al., 2022) or a more suitable task-environment fit (Becker et al., 2022). Employees may select spaces to optimise their surroundings for concentration, collaboration, or creativity, depending on the task at hand. As a result, the ability to choose an appropriate setting can lead to enhanced productivity. Prior studies report both positive (Bäcklander et al., 2019; Divett, 2020; Pitchforth et al., 2020; Rolfö, 2018) and negative (Bergsten et al., 2021; Morrison and Stahlmann-Brown, 2021) relationships between ABWE and job performance. In particular, the inadvertent observation of colleagues' screens or overhearing conversations can introduce significant cognitive demands (Appel-Meulenbroek et al., 2011; Danielsson & Bodin, 2008; Rolfö, 2018; Smith-Jackson & Klein, 2009). Furthermore, the literature review by Engelen et al. (2019) suggests that ABWEs may not effectively support concentration needs. In summary, while the majority of previous research finds consensus on A-FOs impairing

concentration, it is still unclear whether the high level of person-environment and person-task fit offered in A-FOs can buffer these effects.

2.2 Moderating influences: contextual factors

First, this study posits that the impacts of ABWEs are moderated by the organisational context, specifically public versus private sectors. This hypothesis is underpinned by the difference in pace between sectors: public organisations often operate with a long breath, emphasising stability and predictability, while private sectors are characterised by a faster pace aimed at efficiency and strategies for rapid adaptation to market changes (Eskildsen et al., 2004; Lyons et al., 2006). Further, a critical aspect where public and private sectors diverge is in the encouragement and space provided for creativity and innovation (Cinar et al., 2019). Rusa & Rusu (2014) argue that public sector workplaces have historically offered little room for creativity and innovation, necessitating a high intensity of face-to-face communication to complete tasks. This characteristic could limit the perceived usefulness and acceptance of ABWEs in the public sector.

Second, we differentiate between originally open-office, mixed-layout, or cell-office environments. We suggest that the perceived benefits or drawbacks of ABWEs, in terms of privacy, autonomy, and, subsequently, productivity, may depend on the comparison work environment. Moving from a cell-office, which typically provides a high degree of privacy and individual workspace, to an ABWE represents a shift towards less privacy due to the more open and shared nature of ABWEs. However, this transition potentially offers increased autonomy over where and how tasks are performed, accommodating different work styles and preferences (Hoendervanger et al., 2018; Wohlers et al., 2019). The reduction in privacy might be viewed negatively by some employees, while the increase in autonomy could be perceived as an enhancement to their work experience.

Contrary to the cell-office scenario, transitioning from open offices to ABWEs could result in increased privacy for employees, alongside the enhanced autonomy that ABWEs inherently provide. Given the often-criticised lack of privacy in open offices, this move could be seen as a significant improvement, contributing positively to both employee well-being and performance. If the prior office design was rather a mixture of both cell and open space areas in which the desks were still personalised, we suggest fewer differences in outcomes between the comparison office and ABWEs.

3 METHODS

3.1 Literature search

We conducted an extensive search to identify primary studies that have assessed ABWEs and their relationship to employee well-being, social relationships, and performance published between January 2004 and March 2024. Before, De Croon et al., (2005) conducted a comprehensive meta-analysis on office concepts and short- and long-term outcomes covering previous studies. An in-house database compiled since 2020 served as the starting point. Then, we carried out keyword searches of multiple databases and other sources such as PsychArticles, PsycInfo, PubMed, International Bibliography of the Social Sciences (IBSS), Business Source Premier, Academic Search Premier, Jstor, Web of Science, Google Scholar, and ProQuest Dissertation Express. The keyword search terms were “flex*” OR “activity-based” OR “A-FO” AND “office”, OR “work”, OR workspace”, OR “workplace”, followed by the search for outcomes, such as AND “outcomes” OR “impact” or “effect” OR “health”, OR “well-being”, OR “mental health”, OR “physical health”, OR “interaction”, OR “relationships”, OR “communication”, OR “performance”, OR “productivity”. The searches yielded 3,812 documents. We also performed a snowball search and reviewed the reference lists from relevant

narrative reviews (Engelen et al., 2019b; Gerlitz and Hülsbeck, 2023; Masoudinejad and Veitch, 2023), which resulted in nine additional articles for review.

3.2 Screening and eligibility selection

Using the online software rayyan.ai, 2,926 of 3,821 articles turned out to be duplicates, and we scanned the title and abstract of the remaining 895 articles. Several inclusion criteria had to be met. First, studies had to fit the activity-based setting, which means that they cannot cover only open office space or only desk-sharing policies (see definition by Wohlers & Hertel, 2017). Second, studies had to quantitatively assess the effects of an ABWE, which was the case for 78 studies. Third, studies had to report an outcome of interest (well-being, social relationships, or performance). Fourth, studies had to report sample sizes and sufficient information to calculate hedges' g as an effect size metric. To fulfil the last requirement, studies needed to report (a) a correlation coefficient or means and standard deviations for a control and treatment group post-ABWE implementation or (b) pre-and post means and standard deviations as well as the correlation between T1 and T2 for a single group or for both treatment and control group. Finally, studies had to be written in English to be comprehensive for the coding persons. In total, we included 26 primary studies reporting sufficient effect sizes for 24 independent samples that met all the inclusion criteria. The current sample covers a total of 7,454 individuals for which we coded effect sizes as well as contextual and methodological characteristics. Similar to other meta-analyses (e.g., Gerdiken et al., 2021; Rubenstein et al., 2018), we only included outcomes that were examined in at least four studies ($k \geq .4$). Given the high prevalence of missing information in the studies assessed, a proactive approach was adopted. When necessary data were absent, we reached out to the authors to request the information.

3.3 Analysis

We chose Hedges' g, an effect size that accounts for the sample size in the various studies and, thus, is suited also for small sample studies (Chen and Peace, 2021a). We calculated effect sizes using correlation coefficients for correlational studies and mean differences pre- and post-treatment using pooled standard deviations and correlations between T1 and T2 adjusted metrics for longitudinal studies.

We applied a Bayesian random-effects model with weakly informative priors (Normal(0,1) and half-Cauchy(0,0.3) distributions for mu and tau, respectively) to estimate the overall meta-analytic effect for each outcome. A random-effects model accounts for the heterogeneity across studies (Borenstein et al., 2010; Chen and Peace, 2021b), and a Bayesian approach has been found to outperform classical approaches, particularly when the sample is with few primary studies (Seide et al., 2019; Weber et al., 2021). Weakly informative priors also have a regularizing influence as they assign the bulk of the prior probability to reasonable values of Hedges' g. The analysis was conducted with the brms package (Bürkner, 2017) in R version 4.3.3 (R Core Team, 2024). We ran four MCMC chains with 10000 iterations each. Chain convergence (i.e., R-hat) and resolution (ESS) was satisfactory for all outcomes. Detailed code for main analysis and robustness checks with alternative priors are available upon request.

To describe posterior distributions, we report posterior medians and 95% highest density intervals (HDI). To aid inferences about effect existence and practical significance, we report the probability of direction (i.e., the certainty that an effect is in the most probable direction; pd) and the proportion of the posterior distribution falling within a predefined region of practical equivalence (i.e., ROPE), in this case between -0.1 and 0.1 on the Hedges' g metric, following Kruschke (2012). In easy words, think of ROPE as defining a "zone of no big deal." If most of the results after seeing the posterior distribution fall within this zone, then the parameter might not be practically important, even if it is statistically different from zero.

4 RESULTS

4.1 Overall effects

This meta-analysis sought to quantify the overall impact of ABWEs on various work-related outcomes. The results point to a likely positive and practically significant impact of ABWEs on physical activity. For all other well-being outcomes, direction probabilities were less certain and evidence of practical (non-)equivalence inconclusive. For social outcomes, results indicate a likely positive impact on coworker contact and a likely negative impact on supervisor relationship. The impact on coworker contact may be practically significant. Results for the two remaining social outcomes were inconclusive. In terms of performance, results suggest a likely positive impact on productivity, but uncertainty about practical significance. For distraction, the between-study heterogeneity was considerable, and thus, evidence for versus against a true effect is highly uncertain. In general, the between-study heterogeneity was prominent for several outcomes, particularly control over work, privacy, and communication.

Table 2. Meta-analysis of the direct relationships between ABWEs and employee outcomes: Main analysis

Outcome	Median	CI	pd	% in ROPE	Heterogeneity
		Well-being			
Physical activity	0.40	[0.21, 0.61]	99.86%	0.18%	0.14 [0.00 , 0.35]
Sedentary behaviour	-0.19	[-0.52, 0.11]	91.75%	20.95%	0.25 [0.00 , 0.58]
Privacy	0.19	[-0.17, 0.54]	86.67%	24.26%	0.48 [0.28 , 0.78]
Control over work	-0.14	[-0.45, 0.13]	85.53%	32.92%	0.41 [0.23 , 0.69]
Cognitive strain	-0.04	[-0.29, 0.19]	68.62%	64.81%	0.17 [0.03 , 0.43]
Fatigue	0.06	[-0.18, 0.32]	72.00%	55.00%	0.21 [0.07 , 0.46]
		Social relationships			
Coworker relationship	0.06	[-0.11, 0.24]	76.79%	67.47%	0.18 [0.06 , 0.37]
Coworker contact	0.25	[0.04, 0.48]	98.42%	6.39%	0.20 [0.05 , 0.43]
Supervisor relationship	-0.16	[-0.34, 0.01]	97.06%	18.75%	0.10 [0.00 , 0.31]
Communication	-0.05	[-0.55, 0.42]	60.30%	35.33%	0.48 [0.22 , 0.95]
		Performance			
Productivity	0.23	[-0.08, 0.50]	95.17%	12.35%	0.21 [0.07 , 0.52]
Distraction	-0.33	[-1.25, 0.59]	80.66%	12.50%	0.72 [0.24 , 1.75]

4.1 Moderating effects

The results demonstrated that effects on control over work, privacy, and communication might vary by sector (i.e., private versus public), with more unfavourable outcomes in public organizations, and more uncertainty in effects and directions in private organizations.

The results further indicated that some effects might depend on the comparison office type (i.e., cell versus open versus mixed). The effects on control over work (negative) and coworker contact and relationships (positive) were stronger and more certain when ABWEs were compared to cell offices than when they were compared to the other office types. ABWEs also seem more beneficial for privacy when compared to mixed offices than when compared to cell offices. The positive effect on productivity may be stronger and more certain when compared to open offices than when compared to mixed offices.

5 DISCUSSION & CONCLUSION

This study examined how ABWEs influence various workplace outcomes. Notable findings include a very likely positive effect of ABWEs on physical activity, likely positive effects on co-worker contact and productivity, and a likely negative effect on supervisor relationships. For the remaining outcomes, evidence was inconclusive. We found some sectorial differences, with less favourable outcomes in public compared to private organizations. Our findings also suggest that some effects may depend on whether the comparison office design was a cell or open or mixed office.

This study has several limitations. First, estimated effect sizes came from a limited number of studies. Further, the longitudinal estimates could be skewed due to varying time lags - while immediate assessments might reflect initial resistance or an immediate response, later assessments show long-term effects but may also be influenced by habituation. Moreover, the study was primarily based on subjective well-being and performance metrics. Finally, to date, there is a lack of data to test all the conceptually proposed moderators for all the outcomes.

Nevertheless, this is the first comprehensive meta-analysis on ABWEs across multiple disciplines, and it identified the most prominent linkages between ABWEs and key employee outcomes. In doing so, it expands recent narrative reviews (Engelen et al., 2019b; Gerlitz and Hülsbeck, 2023; Masoudinejad and Veitch, 2023) and synthesises workplace research findings. We utilise the COR theory to explore different contextual factors as moderators, such as office type and sectors, potentially clarifying inconsistencies in existing research. This evaluation of ABWEs and their consequences has revealed a significant deficiency in adherence to robust reporting standards across many studies; a majority failed to meet established reporting norms, for instance by omitting standard deviations despite reporting means, or not reporting correlations between the outcomes at T1 and T2. Further, there is a need for more reporting regarding the study context, especially explaining how the ABWE was introduced and communicated and what kind of organisations (e.g., organisational age and size) were assessed, to facilitate investigation into how context factors, participative processes and implementation influence outcomes. These issues underscore the urgent need for stricter reporting requirements and standardisation across research disciplines. To enhance understanding, future research should include more diverse study designs, objective performance and well-being measures, and consider individual differences such as the need for privacy and job autonomy (Hoendervanger et al., 2018), which can affect ABWE outcomes.

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Spatial indicators for systematic description of Activity Based Working and multi-space office environments

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ABSTRACT

Research on effects of Workplace Design often lacks detailed description of the environments studied. It is, however, difficult to interpret and make use of research findings if the details of the research setting are not known. We acknowledge that presentations of layouts are often not possible in research due to confidentiality limitations and present a set of spatial indicators structured in a three-level Office Work Settings Classification (OWSC) to systematically describe office environments, with a particular emphasis on Activity Based Working (ABW) and multi-space offices. Indicators are based on architectural and user-centred considerations and includes space functions, work zones and room typologies.

We tested the OWSC to 15 ABW and multi-space office environments and validate it through a systematic walk-through observation of 13 Sites. Results of the analyses show that the variation of Area type mix between the layouts is considerable. The proposed indicators therefore serve to better describe implementations of the same office type quantitatively, thus enabling a harmonized base for further evaluation and comparison of Space Diversity workplace indicators.

Keywords

activity based working, multi-space office, space classification, workplace design, interior space.

1. INTRODUCTION

Contemporary office design acknowledges that office users perform different activities that should be supported by different work settings. Thus, dedicated individual offices or desks are replaced by shared environments composed of a variety of work settings. The shift in office layouts in the past decades from open plan to combi office, multi-space office and activity-based working has sparked research (e.g., Danielsson & Bodin, 2008; Radun & Hongisto, 2023). This research, however, often treats all instances of the same office type as equal. We argue here that the definition of an office type is not sufficient to capture its characteristics and focus on activity based working and multi-space offices.

Although research offers slightly different definitions of activity based working offices, focusing on different nuances of the concept (Candido et al., 2021), the description of this type of office environments generally remains broad and unspecific in most research studies. Implementations of activity based working (ABW) offices may considerably differ in terms of size, number and configurations of work settings, layouts, and occupancy. Therefore, researchers need a classification system for description, characterisation, and comparison of implemented ABW offices.

The Office Work Settings Classification (OWSC) introduced within the paper is a three-level classification system developed based on architectural and user-centred considerations. It aims to

- define a research-oriented tool enabling a standardized, replicable, and multi-level description of physical environments, thus better capturing the traits of this ABW's pillar.
- overcome the confidentiality issue that prevents organizations from sharing floorplans in empirical studies.
- determine a harmonized basis for Key Performance Indicators (KPI) regarding Space Diversity including Area type mix, Diversity of work settings, Diversity of individual workspaces, and Diversity of collaboration spaces (Häne et al., 2023a).

In this paper, we present the development, content, and application of OWSC and illustrate its value by comparing the Area type mix of nine ABW and six multi-space offices.

2. THEORY

Current office concepts usually offer special functional zones or rooms in addition to individual workstations and meeting rooms. In the Multi-space office concept, group offices or open plan are supplemented with zones for communal use in addition to the individual, assigned desks. In these support areas, spatial settings for communication, retreat and informal encounters complement the workstation zones (Häne et al., 2023b).

ABW is intended as a significant step further than the multi-space office concept, with the creation of extensively differentiated workplace scenarios and additional offerings (Häne et al., 2023b). Activity-based working can be defined as a contemporary approach to work environments that aims at the matching of current work tasks with work settings that are specifically designed to support defined activities (Becker et al., 2022). Some of the further mentionable definitions include activity-based office concept (Appel-Meulenbroek, Groenen, and Janssen 2011), activity-based flexible offices A-FOs (Wohlers and Hertel, 2016), and New Ways of Working NWoW (De Bruyne & Beijer, 2015). According to Candido et al. (2021), and Engelen et al. (2019), this office concept is based on a holistic

approach harnessing the intersections of the three key pillars organizational (technology), human (people) and physical environment (place). Two prerequisites for this concept are high technical standards (laptops, cell phones, WLAN, etc.) to enable the possibility to switch between work settings (Staniek, 2005), and the principle that space follows activities/work patterns, intended as profiles of work tasks fulfilled and performed through individual and/or collective behaviours (Soriano, Kozusznik, & Peiró, 2015).

Research on job motivation or engagement in ABW is well rooted (Ten Brummelhuis et al., 2012; van der Voordt, 2004), with findings on higher job satisfaction for workers occupying ABW offices compared with open plan environment (Danielsson and Bodin, 2008).

Benefits of ABW for physical and mental health is equivocal (Engelen et al., 2019; Colenberg, Jylhä and Arkesteijn, 2020) and a review of the research findings about ABW from Candido et al. (2021) on 40 papers published on 2010-2020 demonstrated that no single positive or negative effect of ABW environments on occupants is in full agreement between the studies. According to Candido and colleagues (2021), reasons for the conflicting results between studies regarding IEQ in ABW environments are unclear, as detailed information about the offices has not been reported. Indeed, in research on ABW offices detailed descriptions of the environments studied – the actual research settings and context - is often missing (e.g., Bernstein & Turban, 2018; see Rolfö, Eklund, & Jahncke, 2017, for a notable exception).

3. METHODOLOGY

The study took place between autumn 2021 and 2023 as a part of a broader research and development project, focused to structure a standardized methodology to enable data-driven management of office space through KPIs and workplace benchmarking (see Häne et al., 2023a, b). The project aimed at triangulation of data from floorplans, occupancy monitoring, and user assessments.

For the development of spatial indicators for the systematic description of Activity Based Working and multi-space office environments literature was reviewed and a first version of the space classification was developed. Through an iterative process with dedicated workshops, we gathered inputs and feedbacks from practitioners to optimize the tool. The resulting version was applied to 15 sites during summer 2022. Seven organisations provided floorplans of buildings located in Switzerland and Northern Europa. Most participating companies are large organizations, working in the finance or services sector. One organization works in the media production industry. Nine buildings have an ABW concept, six have a multi-space concept. The included buildings have between 30 and 2318 standard workstations and span between 838 and 47,115 square meters. All companies have comparable workplace policies with desk sharing and flexible workplace concept in place (see Table 1).

Table 1. Overview of building sample

Company	Site ID	Office concept	Size of facility (sqm of Primary Area)	Amount of Standard Workstations	Amount of collabo-ration spaces	Work-place policy	Employees working on site (Head-count)
Company 1	Site 1A	Activity based office	27300 sqm	1565	359	Desk sharing	2300
	Site 1B	Activity based office	2100 sqm	145	25	Desk sharing	400
	Site 1C	Activity based office	2500 sqm	160	38	Desk sharing	200
Company 2	Site 2A	Multi space office	35500 sqm	2318	230	Desk sharing	3000
	Site 2B	Multi space office	1400 sqm	93	16	Desk sharing	109
Company 3	Site 3A	Activity based office	1500 sqm	99	8	Desk sharing	165
	Site 3B	Activity based office	1400 sqm	84	25	Desk sharing	93
	Site 3C	Activity based office	1400 sqm	114	28	Desk sharing	228
Company 4	Site 4A	Activity based office	700 sqm	30	7	Desk sharing	64
Company 5	Site 5A	Multi space office	3700 sqm	170	37	Desk sharing	200
	Site 5B	Multi space office	6400 sqm	359	44	Desk sharing	353
Company 6	Site 6A	Multi space office	1700 sqm	167	14	Fixed desks [1)]	167 [2)]
	Site 6B	Multi space office	8700 sqm	768	66	Desk sharing	768 [2)]
Company 7	Site 7A	Activity based office	20400 sqm	1337	184	Desk sharing	1337 [2)]
	Site 7B	Activity based office	6200 sqm	454	93	Desk sharing	454 [2)]

1) Desk sharing for some departments
2) Headcount is replaced by number of standard workstations due to missing information

The application of the classification includes converting the areas' classification from the company-based to the OWSC (see Table 2) and producing dedicated floorplans (see Figures 1 and 2). The correct assignment of spaces was validated checking the assigned typologies with walk-through observations of 13 sites. For two sites it was not possible to conduct the observation. In these cases, the organization was asked for feedback about the classification. After classification, the size of the different zones were measured in the floorplans. The measurements of each work setting was determined according to British Standards EN 15221-6 (see Iurilli, Häne, & Windlinger, 2023). The

quantities measured have been then used to systematically describe the different work environments and to calculate the KPI Area type mix (Häne et al., 2023a) thus allowing a harmonized comparison of results.

Figure 1. Conversion of pilot partners' nomenclature to OWSC Space functions and Work zones, Site 3C (ABW)

Figure 2. Conversion of pilot partners' nomenclature to OWSC Space functions and Work zones, Site 4A (ABW)

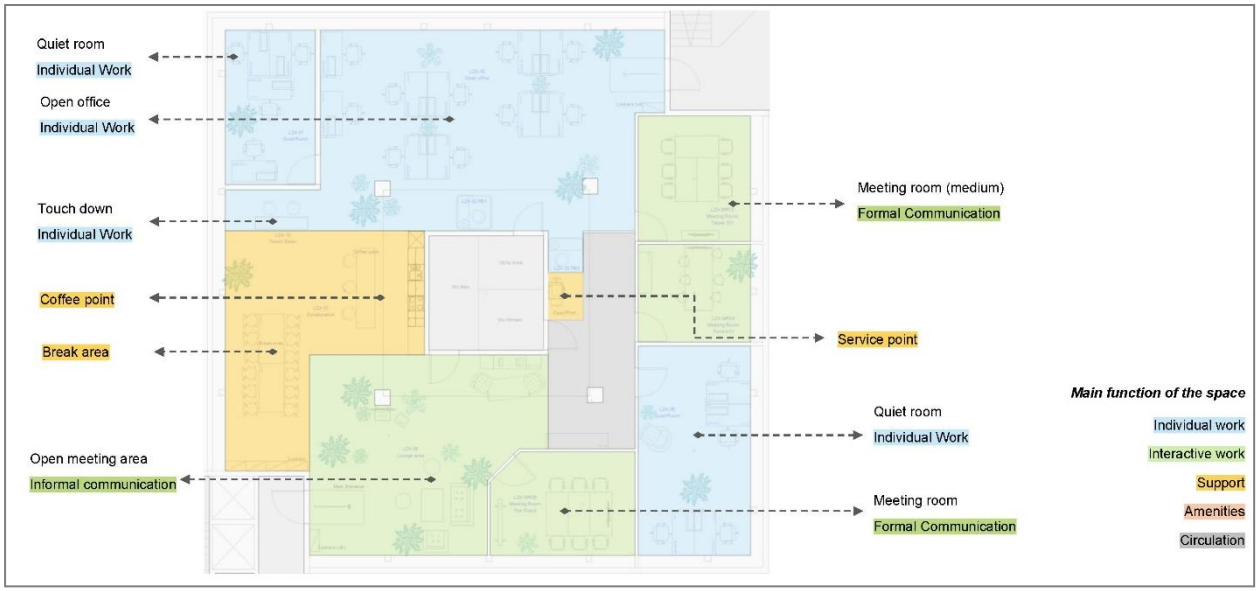


Table 2. Conversion of pilot partners' nomenclature to OWSC Room Typologies, Site 4A (ABW)

Organization's nomenclature	OWSC nomenclature
Lounge	Open meeting space
Creative arena	Multipurpose room (informal)
Studio	Multipurpose room (informal)
Quiet room	Quiet work space
Meeting room	Meeting room medium (5-10 Seats)
Telephone cabine	Phone booth
Break area	Cafeteria/break area

4. RESULTS

Office Work Settings Classification (OWSC). Spatial indicators for the systematic description of ABW and multi-space office environments have been structured in a three-level classification:

- Level I - Space functions, including 5 categories (see Table 3)
- Level II – Work zones, including 15 spatial indicators (see tables 4-7)
- Level III – Room/Space types, including 37 indicators (e.g. single office, group office, touch down)

In this paper, we present the indicators of Level I (Table 3) and Level II (Tables 4-7).

Indicators of Level III are fully described in Häne et al. (2023b).

Table 3. OWSC, Level I - Space functions

ID	Space function	Definition
1	Individual workspace	Area of the office that enables individual work. It is limited to spaces with capacity of up to one person.
2	Interactive workspace	Area of the office that enables collaborative work. It is limited to spaces with capacity of over one person. In case of multifunctional spaces, the space is to be assigned to *"collaboration/communication"* if it the regular layout provides a capacity of more than one person.
3	Support spaces	Area of the office that enables the accommodation of occupants in a building.
4	Amenities	Area of the office typically aimed to increase the attractivity of the building as a work location and for convenience of the office users.
5	Secondary circulation	Area of the office not related to a work activity but ancillary to connect them or to provide horizontal/vertical connection in a building.

Table 4. OWSC, Level II - Individual workspace work zones

ID	Work zones	Description	Room typologies
1.1	Zone for desk work (normal concentration)	These settings are designed for individual desk activities that require normal concentration. Depending on the office concept these can be found in an open space, in enclosed multi-person rooms or in semi-open spaces that offer both standard and short time workstations. These spaces offer some noise protection measures, but they are not acoustically insulated spaces; they can also offer visual privacy from the adjacent with desk dividers. Most workplaces have special policies regulating the use of these settings such as clean desk policies.	Single office (1 standard workstation) 2-person office (2 standard workstations) Group office (3-8 standard workstations) Group office (9-14 standard workstations) Group office (15-25 standard workstations) Open space Touchdown, workbench
1.2	Zone for desk work (high concentration)	These settings are designed for individual desk activities that require very high concentration. These settings can be closed or semi-open rooms that offer both standard and short time workstations Seldomly, these can be found in an open space. They are typically sound insulated spaces with individually enclosed workstations for visual privacy. Additionally most workplaces have special policies regulating the use of these spaces to restrict activities that cause noise (e.g., phone calls, conversations, eating, etc)	Quiet workspace Individual quiet room
1.3	Zone for individual virtual commu-nication (video/ telephone)	These settings are designed for individual communication activities such as phone calls or video conferences. Typically, these are implemented as small, enclosed, acoustically isolated rooms (or cabins) and are intended for very short use by only one person.	Phone booth Video booth

Table 5. OWSC, Level II - Interactive workspace work zones

ID	Work zones	Description	Room typologies
2.1	Zone for formal communication & collaboration	These settings are designed for planned, face-to-face collaboration, communication and interaction activities that require privacy. These settings are typically enclosed and are suitable for formal discussions. Additionally, these settings can be equipped with technical infrastructure to enable hybrid communication.	Project room Meeting room medium (5-10 Seats) Large conference room (11-20 Seats) Meeting room extra-large (>20 Seats)

			Multipurpose room (formal)
2.2	Zone for informal communication & collaboration	These settings are designed for spontaneous, face-to-face collaboration, communication and interaction activities with casual seating arrangements and simple infrastructure such as external screen. These settings are typically open or semi-enclosed spaces with soft seating alternatives and are differentiated through design characteristics.	Multipurpose room (informal) Open meeting space Meeting table in closed office Open interaction space

Table 6. OWSC, Level II – Support spaces

ID	Work zones	Description	Room typologies
3.1	Zone for office services	These settings are designed for practical functions in the workplace (e.g., printing, mail, archiving) that support work at the location.	Reception/lobby Service point Archive and work storage
3.2	Zone for breaks	These settings are designed to support food service during breaks in the workplace either for light refreshments or for main meals.	Personal restaurant Kitchenette/coffee line Cafeteria/Break area
3.2	Zone for office infrastructure	These settings are designed for technical support functions in the workplace and can have restricted access only for specialized service personnel (e.g., server room, security room, material storage)	Infrastructure rooms Storage and utility room Utility room / Office support area
3.4	Zone for other office support functions	All other settings designed to support functions in the workplace not included in this list.	Other support rooms

Table 7. OWSC, Level II - Amenities

ID	Work zones	Description	Room typologies
4.1	Zone for leisure	These settings are designed to support alternative, active break possibilities in the workplace.	Entertainment room Gym / fitness center
4.2	Zone for regeneration	These settings are designed to support the need for privacy, safety, and relaxation in the workplace through the provision of spaces for passive breaks and spaces for personal needs (e.g., silent rooms, praying rooms).	Relaxation or regeneration room Medical room or nurture room

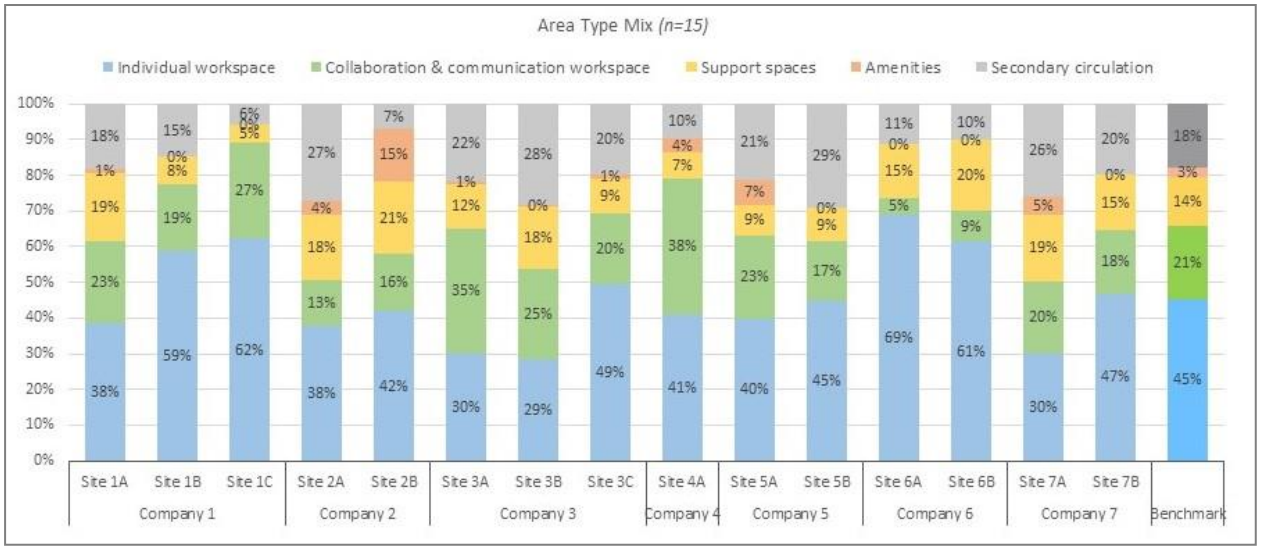
4.3	Zone for other amenities	All other settings designed to provide amenities to the employees not included in this list.	Other amenity rooms Parking space Auditorium

The systematic description of the different work environments has allowed analyses of Area type mix of the building's sample that is presented in three steps: all offices, then ABW only followed by multi-space only. The KPI Area Type Mix is intended as the number of square meters occupied by each of the five space functions defined by the space classification standard and their proportions (Häne et al., 2023b) (Figure 3).

The metrics for Area type mix and the benchmark of the ABW and multi-space office environments (*n*=15) are:

- Individual workspace: range 29-69%, proportion 1:2; benchmark 45%
- Collaboration/communication workspace: range 5-38%, proportion 1:5,5; benchmark 21%
- Amenities: range 0-15%, benchmark 3%
- Support spaces: range 5-21%, proportion 1:4; benchmark 14%
- Secondary circulation: range 6-29%, proportion 1:5; benchmark 18%.

Figure 3. Area type mix of Activity Based Working and multi-space Sites



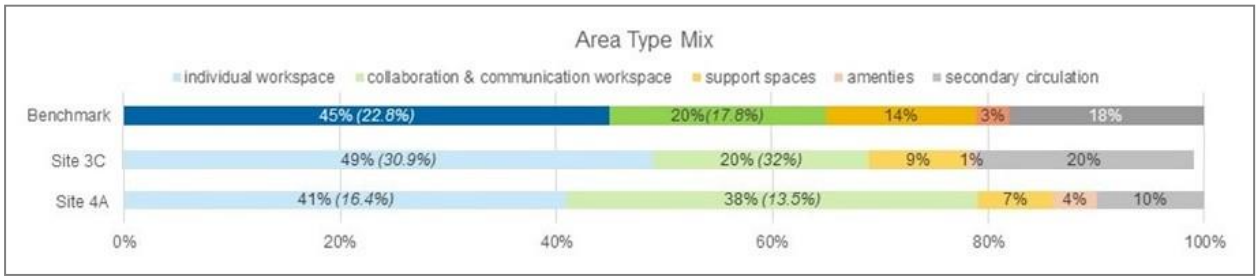
The metrics for Area type mix of Sites with an Activity-based-working office concept (*n*=9, Organizations 1, 3, 4 and 7) are:

- Individual workspace: range 29-62%, proportion 1:2
- Collaboration/communication workspace: range 18-38%, proportion 1:2
- Amenities: range 0-5%

- Support spaces: range 5-19%, proportion 1:4
- Secondary circulation: range 6-28%, proportion 1:4,5.

An illustrative comparison of the Sites 3C (1.400sqm Primary Area, 114 Workstations) (Figure 1) and 4A (700sqm Primary Area, 30 Workstations) (Figure 2), shows that the proportion of Individual workspace and Amenities is about equivalent, but Collaboration/Communication space has a range of 1:2 between Site 3C and Site 4A, and Amenities have a ratio of 1:4 (Figure 4).

Figure 4. Area Type Mix, Sites 3C and 4A (ABW concept)



The metrics for Area type mix of Sites with a multi-space office concept (*n*=6, Organizations 2, 5 and 6) are:

- Individual workspace: range 38-69%, proportion 1:2
- Collaboration/communication workspace: range 5-23%, proportion 1:5,5
- Amenities: range 0-15%
- Support spaces: range 9-21%, proportion 1:2,3
- Secondary circulation: range 7-29%, proportion 1:4.

5. Conclusion

Results of the application of Office Work Settings Classification (OWSC) show that offices of the same type (i.e., activity based working or multi-space office) vary by factor 2 to 4.5 in their configuration. In the building sample analysed, we found a range from 29-69% of space dedicated to individual workspaces, a range of 5-38% of space dedicated to collaboration and communication, and a range of 5-21% for support spaces respectively. The ratios of individual workspaces to collaboration/communication within buildings range from 13.8 to an almost balanced 1.1.

Given that selecting and switching between work settings is a basis of ABW these massive differences may translate into different experiences and perceived qualities for users. The ratios between the different functional zones may also reflect the different needs users from different organisations have related to their office environments. We therefore argue that researchers should refrain from comparing office types because they are over simplified description of actual work environments.

Rather, work environments should be described in terms of space functions, work zones, and room/space types, as supported by our OWSC system. The OWSC serves as a system for description of research objects and/or research contexts and allows to describe office environments and visualize metrics in form of chart instead of floorplans, thus overcoming issues with confidentiality of floorplans in empirical studies. In practice, the OWSC may serve to analyze and benchmark spaces that belong to different portfolios.

ACKNOWLEDGMENTS

The authors thank the project team for their feedback to set up the study, all companies participating to the Workplace Benchmarking project and the project partner Locatee. Additionally, we thank our team colleagues for their feedback on this manuscript. This research was co-financed by Innosuisse – Grant: 53085.1 IP-SBM.

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Session 3 – Abstract Only

Session 3A: Digital tools for research and practice

Digital Workspaces through the Lens of Digital Autoethnography

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Abstract

This paper delves into the emerging field of digital autoethnography, a method for understanding personal experiences in digital workspaces and cyberculture. Traditional autoethnography has focused on physical and cultural contexts, but the digitisation of life necessitates examining the new, mediated realities and identities. Building on the work of scholars like Neil (2019), Atay (2020), Dunn & Myers (2020), and Coleman (2021), digital autoethnography offers a narrative approach to explore the blend of physical and digital selves.
Digital autoethnography manifests in three distinct forms. First, it extends critical autoethnographies, providing reflexive narratives about cultural identities in digitalised spaces. These narratives engage with cyberculture, exploring digitalised human experiences. Second, it underscores interactivity and digital embodiment, focusing on how selves interact with online domains and technologies, thus merging physical and digital identities. Third, it is a multimodal, interactive form, enabling evolving, co-constructed storytelling.
The paper argues that digital autoethnography can stand out as a method for exploring digital workspaces, capturing the subtleties of these online environments. Traditional research methods often miss the complex dynamics of digital interactions, but digital autoethnography's focus on personal narratives and experiences brings the capacity for insights into the effects of digital technologies on human behaviour and social norms. That said, this approach examines digital workspaces as work-bound locations and as intricate social and cultural constructs.

Keywords
Digital autoethnography, Digital workspace, Digitalisation, Work

How the nature of work is associated with ICT demands and resources? A comparison of the hybrid and high-intensity teleworkers

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Abstract

In recent years, the landscape of remote work has been revolutionized, with over 41 million hybrid and high-intensity teleworkers in Europe and 91 million in the USA. While ICT facilitates teleworking, it introduces both demanding and motivating aspects that become integral to teleworkers' work-life (i.e., ICT demands and resources). This study aims to investigate how the nature of work, namely, work requiring intensive concentration vs. work requiring active social interactions, is associated with hybrid and high-intensity teleworkers' perceptions of ICT as a demand or a resource. Utilizing survey data from the Estonian Salary Information Agency, our empirical analysis focuses on 1495 full-time employees engaged in at least partial telework and using ICT tools for more than half of their work time. Several statistical methods, such as the principal axes factoring and regression analysis, have been implemented to test the hypotheses. The preliminary findings of the study indicate that the nature of the work is associated especially with the perceptions of ICT as a demand. Moreover, relationships between the nature of work and ICT demands/resources differ for hybrid and high-intensity teleworkers. Notably, the most negative association between the nature of work and ICT demands appeared among high-intensity teleworkers when the work requires active social interaction for more than half of the work time. Interestingly, ICT resources appear to be less impacted by the nature of the work. As our study progresses, we will conduct deeper analyses to explore whether the nature of work significantly contributes to the relationship between ICT demands and job satisfaction. Our research contributes valuable insights into the evolving arena of telework, offering guidance for organizations seeking to optimize the working conditions and experiences of their hybrid and high-intensity teleworkers in the era of pervasive ICT usage.

Keywords:
telework, hybrid work, ICT demands, ICT resources, nature of the work

Virtual Reality at Workplace: Increasing Engagement in Agile Retrospectives

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Abstract

To work effectively in autonomous teams, agile development methods use retrospectives to create opportunities to reflect on work and ideate possible improvements (Schwaber & Sutherland, 2020). The effectiveness of these retrospectives is associated with engagement (Frank et al, 2016). We propose that Virtual Reality (VR) has the potential to affect engagement by providing the ability to communicate through body language (Vidolov, 2022), the ability to interact with virtual environments (Steffen et al., 2019), and through other mechanisms.
We use Social Network Analysis to measure the level of engagement in VR versus teleconferencing using network density, degree prestige, and the number of speaking instances measures. We follow up with meeting observations and qualitative interviews with participants to uncover the mechanisms through which VR impacts engagement behaviors.
The paper shows that conducting retrospectives in VR increased engagement compared to teleconferencing in the sample studied. The engagement is boosted through improved focus, opportunities for experimentation and playfulness, meeting spatiality and deep immersion, leveraging body language, and enhanced self-expression through the avatar, thus impacting positively the conversation flow, sense of belonging, and perception of safety.

Keywords

Virtual Reality, Agile development, Social Network Analysis, Meeting Engagement, Meeting Effectiveness, Communication

Using serious gaming as a method for exploring behaviour and attitudes in the work environment

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Abstract

The rise of hybrid working has led to developments in the way of working and the work environment. As employees find their way in hybrid working, it has become more and more important to explore, identify and discuss the behavioural patterns that emerge.
To systematically explore the behaviour of employees in the physical, social and digital work environment a new tool has been developed: a gamified framework to identify and collect data on end user behaviour and reported team agreements in an engaging and insightful process.
Method. The gamified elements in the Workplace Game help to gain insight into three themes: values and norms, knowledge and information, and attitude and behaviour in the work environment. By letting employees discuss situations and scenarios on different topics regarding work and the work environment, behavioural consequences of innovations in the work environment can be identified. This knowledge will be collected in two ways: the developers of the Workplace Game will collect data in their role as game leaders. Furthermore a special website will be developed which offers players the possibility to upload the outcome of the game.
Findings This tool aims to contribute to the exploration of end user behaviour and team agreements concerning the physical, social and digital work environment by providing a gamified framework to collect data on different topics regarding innovations in the work environment. Moreover, the Workplace Game provides practitioners and end users insights in their own preferences in the hybrid work environment.
Limitations. The Workplace Game is not a controlled environment. Hence, the data collected lacks the rigor that is required for drawing generalisable scientific conclusions. However, the thorough design of the game and the clear playing instructions guarantee valuable insights with respect to both end user behaviour and reported team agreements.

Exploring the circular futures of workspaces through back casting

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Abstract

In the aftermath of the COVID-19 pandemic, many office buildings even in the most attractive central business districts suffer from high vacancy. Optimising the use of existing built assets through circular strategies such as sharing and digitalisation is crucial for the health of the economy, and our planet. We seek insights into circular futures where functional and locational obsolescence of built assets has been overcome with new types of uses. We employ the futures studies method of backcasting in three workshops with 13 topic experts. Each group of experts were presented with a circular future: 1) rural hubs have become the most popular physical workplaces outside homes; 2) hybrid and virtual spaces are the most popular workplaces overall, and 3) the remaining few offices are all in shared, collaborative use. The experts were asked to come up with actions that needed to happen, as well as actors who were needed, for the respective circular future to realise. Findings show that hubs and collaborative spaces are dependent on hybrid and virtual spaces, and that shared and virtual spaces are complimentary to one another. Our findings further suggest that technological solutions already exist to enable the circular futures. Needed are political and social advancements to make working from rural, shared, virtual, and hybrid workspaces more attractive. Organisations should align their work routines with these workspaces. Policymakers should either create incentives or impose penalties for real estate owners to encourage adapting vacant spaces to new uses. Social acceptance could be raised with digital solutions improving safety and trust, such as avatars. The workspaces should provide a 'personal trainer' in collaboration and wellbeing. The findings may work as inspiration to real estate owners struggling with vacant spaces, policymakers seeking to meet climate and economic goals, and organisations seeing over their workplace strategies.

Keywords:

Backcasting, circularity, collaborative workspaces, hybrid workspaces, rural hubs

sharing economy, virtual workspaces

Investigating the synergy between participatory design and placemaking to foster community-driven work environments

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Abstract

Placemaking inspires people to collectively reimagine and reinvent spaces as the heart of their community with the aim to strengthen the connection between people and the spaces they share. Given that a significant portion of our workday – up to one-third for some of us – is spent in workplaces, we suggest that they also represent, to a certain extent, places of belonging and community. However, placemaking is currently still a relatively underexplored area of research in workplace research. Therefore, this paper identifies promising opportunities and possibilities in the study of placemaking, specifically for the context of workplace design. Moreover, as placemaking is a collaborative effort, this raises the question of how to effectively organize the co-design process needed for collective space development in a workplace context. Potentially, participatory design can provide key strategies needed in such processes as participatory design aims to collaboratively and iteratively develop artefacts in a human-centered manner. In the context of workplace design, participatory design brings architects, designers, workplace managers and other stakeholders, including clients, future users, and community members, together to (re)invent their shared spaces. Ultimately, these spaces should support or enhance social systems to foster sense of belonging, collaboration, inclusivity and employee well-being. This paper provides a comprehensive literature review that results in practical guidelines and recommendations for implementing participatory design and placemaking principles in workplace design.

Keywords:

Workplace design, Participatory design, Placemaking, Community-driven environments

Session 3B: Inclusion and Diversity

A Guideline Review on Physical Workplace Accommodations for Neurodivergent Office Workers

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Abstract

Objectives A range of guidelines on the physical work environment have been developed to prevent work-related performance and health problems in neurodiverse workers, but little is known about the quality of such guidelines. We systematically reviewed the content and quality of workplace adjustment guidelines aiming to prevent, detect, and/or manage work-related performance and health problems.
Methods We conducted systematic online searches (e.g., charities, occupational safety and health advisory groups, building industry, design advisory groups) to identify guidelines. Eligibility criteria included guidelines recommending preventive interventions to be implemented at the workplace by employers, employees or organizational staff. Five independent reviewers assessed the quality of guidelines using the Guidelines for Research and Evaluation (AGREE II). Guidelines rated ≥65% were considered to be of good developmental quality.
Results Twenty-six guidelines are currently quality assessed. Preliminary findings suggest that guidelines mainly target employers oppose to employees and organizational staff. Few guidelines had developed recommendations of good quality; most guidelines are not based on empirical evidence. Studies documenting the effect of implementation were not yet available.
Conclusions Few guidelines have been developed with sufficient rigor to help employers prevent or manage work-related performance and health problems and evidence of their effectiveness remains scarce.

Keywords:

Neurodivergence, Neurodiversity, Workplace adjustments, Workplace design, Guidelines, Recommendations

Neuro-management Approaches to Mitigating Workplace Incivility: Unveiling Influential Factors Shaping Passive Resistance Responses among Indian Mid- and Senior-Level Managers

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Abstract

Rooted in the philosophy of nonviolence, Passive Resistance Responses (PRRs) represent a constructive and effective neuro-management mechanism aiming to humanize perpetrators in the face of workplace incivility. This qualitative study explores various individual factors influencing PRRs among mid- and senior-level managers (aged 35-45) in diverse industries in India. Conducting 18 in-depth interviews with equal gender representation, our research delves into the experiences of managers who encountered workplace misconduct, responding with nonviolent strategies to uphold organizational objectives.

This study contributes to the field of neuro-management by transcending conventional 'fight or flight' reactions to workplace misconduct, specifically focusing on the factors leading to passive resistance responses. By breaking the cycle of misconduct and incivility, our findings underscore the significance of adopting such response strategies to facilitate psychological recovery and a return to normal functioning.

This research offers a distinctive investigation into passive resistance responses, shedding light on a relatively unexplored domain within the Indian context. By adopting a comprehensive approach and scrutinizing various individual factors, the study provides a nuanced understanding of the complexities associated with passive resistance responses. The ultimate goal is to contribute to both organizational objectives and the restoration of human dignity within the framework of neuro-management.

Keywords:

Passive Resistance Responses, Neuro-management, Workplace Incivility, Human Dignity

Physical workplace adjustments to support neurodivergent workers: A systematic review

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Abstract

Originating from the concept of neurodiversity, neurodivergence encompasses conditions like Autism-Spectrum Disorder (ASD), ADD/ADHD, Dyslexia, and Dyspraxia, affecting roughly 22% of the population. Sensory challenges are common. Despite the popularity of physical workplace adjustments for neurodivergent individuals, their effectiveness remains unproven. This review evaluates the evidence on physical workplace adjustments and their impact on occupational outcomes in neurodivergent workers. Following PRISMA guidelines, we systematically reviewed English-language studies (2000-2021) meeting specific criteria: adult neurodiverse office workers, at least one physical workplace adjustment, and all empirical study designs. The study was framed within the ecological model of person-environment fit, supplemented by the ICF and environmental stress theory. Among 319 studies, 20 met eligibility criteria, primarily addressing ASD. These studies described various adjustments, with sound and light-related modifications, linked to occupational outcomes. However, methodological limitations hindered comprehensive evaluation. Despite acknowledging sensory challenges in neurodivergent conditions, empirical evidence is lacking. Given the potential of physical adjustments, there's a pressing need for more theoretically-driven and methodologically robust research.

Keywords:

Neurodivergence, Neurodiversity, Occupational longevity, Performance, Well-being, Workplace adjustments

The Role of Psychological Privacy in the Office Environment: Interactions between Psychosocial and Environmental Resources and Demands

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Abstract

This study addresses the paucity of empirical evidence concerning the influence of psychological privacy as a spatial resource within office settings. Specifically, it examines the mediation effect of psychological privacy on psychosocial factors, including social support and stress symptoms/irritation in social stress situations. Additionally, it investigates the impact of various office characteristics and the overarching role of environmental control on psychological privacy. Drawing on the job-demands-resources model and the privacy-fit model, this research employs a quantitative cross-sectional approach, conducting an online survey among participants in Great Britain (n = 327). Data analysis employs linear regression models, supplemented by the PROCESS Hayes tool.
Findings indicate that psychological privacy does mediate the relationship between social support (colleagues and managers) and stress symptoms/irritation. Furthermore, psychological privacy was associated with desk-sharing, office type and open/closeness of the design. This was in turn mediated by environmental control.
This study underscores the need for further research to elucidate the conceptual and empirical nuances surrounding the role of psychological privacy in the workplace—whether it serves as a resource or a demand—and to further explore which specific office characteristics wield influence over psychological privacy in office environments. Such investigations are crucial for advancing our understanding of workplace dynamics and their implications for employee well-being and productivity.

Keywords:

Privacy, Office, Psychosocial factors, Social support, Irritation, Stress, Environmental control, Job-demands-resources model

Campus NL: hybrid working in the university environment in the Netherlands

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Abstract

Following the Covid-19 pandemic, an increasing number of individuals are expected to engage in remote work. Consequently, the hybrid working paradigm, characterized by a combination of office-based and remote work, is gaining prominence. Despite the governments awareness of this phenomenon, comprehensive policy framework remains absent, leaving determinations to the discretion of individual sectors and entities. Whereas studies focused on diverse sectors in this matter, not much is known regarding hybrid working within the university environment. This study is part of the Campus NL project, aiming to investigate management and strategies across all the 14 universities in the Netherlands. The specific focus of this study was to examine hybrid working and its ramifications within the university landscape in the Netherlands. We asked universities to provide us with information concerning policies and financial allocations related to hybrid working, spatial utilization, energy consumption, and prospective strategies related to sustainability and mobility. Furthermore, we aimed not solely to delineate the present state of hybrid working within Dutch universities but also to enhance future strategies in this domain to provide a better working space in the universities.

Keywords:

Hybrid working, Universities, Flexible working

The Impact of Sensory Processing on Office Workers' Well-being, Burnout Symptoms, and Satisfaction in Diverse Office Environments

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Abstract

Sensory challenges at work are a growing concern with recent evidence hinting at a connection between sensory sensitivity, occupational stress, and burnout. Yet, while variable sensory sensitivity among the population is recognized, a significant knowledge gap exists regarding its link to office environment attributes and occupational health.
We conducted a cross-sectional survey involving 327 office workers across various industries in Great Britain. The study cohort, spanning ages 18 to 64 years, consisted of individuals who spent a minimum of three days per week working at their primary office location.
Regression analyses confirm our hypothesis that individuals who are sensory sensitive (with lower neurological thresholds) tend to experience a higher prevalence of burnout symptoms, reduced well-being, and diminished work environment satisfaction. The relationship varies by office type, categorized as sensory-friendly and sensory-unfriendly.
This study provides first empirical indications for the association between sensory sensitivity, office design characteristics, and severe occupational health impacts. Further research is needed. In the long term, the development of targeted interventions aimed at mitigating burnout symptoms and promoting enhanced well-being and work environment satisfaction within the diverse landscape of modern office settings is warranted.

Keywords:

Sensory sensitivity, Neurological thresholds Occupational stress, Burnout, Office, Occupational health

Session 3C: Workplace Engagement and Culture

Co-working as a potential solution for remote working challenges

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Abstract

Hybrid work is accepted widely as a way of working in the post-covid era. Since the start of pandemic there has been an increasing amount of research on advantages and disadvantages of remote working. Yet, employers' perspective on hybrid work has remained less clear. Traditionally, organizations have arranged work in corporate office environments and less attention has been paid on WFH by the employers. Although WFH is popular among employees and previous research has explored its benefits, the opportunities of WFH vary between employees. The need of workplace outside home environment remains and one solution introduced already pre-covid is co-working spaces. This study aims to explore existing co-working spaces by showcasing three cases from USA, Phoenix. They were visited in November 2023. We focus on variety of real estate aspects such as location, real estate sector, building layout, users, and services provided on site. Our results show that despite the different business approaches and strategies of co-working operators many similarities were recognized such as all of them were expanding, focusing on wide service provisions, and creating a community. Especially, the physical presence of managers on site and their involvement in grassroot level on a day-to-day basis were seen to strengthen the community spirit. Also, what stands out from the findings is the importance of recognizing the local and cultural needs of users. This study contributes to the understanding on how hybrid work can be arranged via co-working spaces. The lack of social connectiveness has been recognized as a downside of WFH. Co-working spaces hold a lot of potential in creating connection inside and outside organizations. Our findings can act as a steppingstone for further research in inclusion of co-working spaces in workplace management strategies.

Keywords

hybrid work, working from home, WFH, co-working, workplace management strategy

When your office fits your activity: office-activity (mis)fit, culture strength and job satisfaction

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Abstract

Many workers lament that their workspaces are unsuitable for their work tasks (i.e., office-activity misfit). Office-activity misfit happens when the physical layout or design of an office does not match the activities being carried out within it. This mismatch between the workspace and the nature of the tasks can lead to reduced job satisfaction. The recent increase in remote work has made this problem even worse for workers who experience office-activity misfit when working from their company's office. Organizational values and the consensus on those values (i.e., cultural strength) may reduce the alleged negative relationship between office-activity misfit and job satisfaction. However, there is not enough scientific evidence to prove whether office-activity misfit affects job satisfaction and whether cultural strength moderates this relationship. To fill this gap this study is based on data from a single organization located in Italy. Through a cluster analysis, two groups of workers have been recognized: (i) those who benefit from a workspace that fits their tasks (i.e., fit group); (ii) those who lack a workspace that fits their tasks (i.e., misfit group). The paper compares the two groups through a mixed-method approach including (i) econometric analysis of survey data and secondary data; (ii) qualitative analysis of data from semi-structured interviews and focus groups with employees; and (iii) observations. The preliminary analysis found that organizational culture strength has a positive effect on job satisfaction only in the fit group while not in the misfit group.

Keywords:

Office Type, Work Activity, Office-Activity misfit, Job Satisfaction, Organizational Culture

How can we attract employees back to the office? A survey study on office attendance in post-pandemic Australia

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Abstract

Hybrid working has become the new norm for office workers in post-pandemic Australia. Understanding the determinants of office building attendance is crucial for identifying effective measures to encourage office attendance. Office building attendance, ratings of building Indoor Environmental Quality (IEQ) factors, risk perception, co-worker practice, and demographic information were collected in an occupant survey (N=973), and univariate and multivariate multinomial logistic regression models were used to map factors associated with office attendance. The results show that primary factors for the high attendance (5+ days vs 1-2 days per week) include age, employment type, risk perception, co-worker's attendance practice, and perceived individual space, while co-worker's attendance was the only significant factor for medium attendance group(3-4 days vs 1-2 days per week). This study contribute to the knowledge of post-COVID workplace research.

Keywords:

Hybrid and flexible working, IEQ including visual, Pandemic issues, Workplace user experience

Coworking spaces in Poland: Location factors and geographical distribution

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Abstract

Coworking spaces (CSs) emerged as an attractive alternative to traditional workplaces among employees of various professions, seeking to collaborate, exchange contacts and develop knowledge. Due to their significant development over the past few years, they have become an area of study of numerous scholars, covering the topic of their spatial location along with the identification of CSs location factors. Analysis of the distribution of CSs identifies them as an urban phenomenon, reflected in the predominance of CSs presence in cities and metropolitan areas, along with their tendency to spread near major urban territories. Additionally, regarding the establishment of locational factors, importance of areas with high amenity environments was noted, including the presence of specialized enterprises, and non-productive amenities, such as the availability of services. The paper presents the newest research on spatial distribution and location determinants based on insightful spatial analysis regarding location of more than 300 CSs in Poland, supplemented by an in-depth interviews conducted between 2022 and 2023. The author discusses the distribution of CSs in Poland at two spatial scales - national and intra-urban, and identifies their location factors in three dimensions: spatial, social and economic. Primarily, the predominance of Poland's large and medium-sized cities in attracting CSs is noticeable, with the capital Warsaw being highly significant as the hub holding the largest number of CSs. Moreover, the results of CSs distribution at the intra-urban scale establish the vital role of the city center or downtown along with areas of metropolitan service concentration with accessibility to transportation arteries. High relevance of the cost of maintaining CSs was also reported, however, respondents most often indicated proximity to communication hubs, highlighting that spatial factors are dominant in the selection of location for establishing CSs.

Keywords

coworking space, location factors, national distribution, intra-city distribution, Poland

Working in open spaces, in coworking contexts: observations and impacts on coworkers

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Abstract

Coworking spaces differentiate themselves with various characteristics. These include their architecture and layout (size, number of work areas), geographical location, organization (opening hours, packages, services, and facilities offered), and social dimension (economic status, animation methods, member selection, social economy project or no specific social project, etc.). An important distinction lies in the model adopted. In a more associative and community-oriented model, managers generally aim to provide a shared workspace for independent workers. In a model closer to a business center, managers offer companies a real estate solution to relocate workstations, whether to meet the demand for telecommuting or reduce the costs of renting premises. In our research we investigated the advantages (cooperation, low cost office, attractive premises, etc.) and disadvantages (noise and visual intimacy issues in open space, etc.). of these spaces. We will present the results of interviews with coworkers and an online survey of coworkers. Understanding how coworking spaces impact the health and well-being of coworkers is important as this phenomenon is growing. While there are many self employed in these spaces, there are also more and more small companies using these office spaces, whether small companies installed in these premises or larger firms, reserving a few spaces for their employees to use occasionnally when they live rather far from the main premises. Our study looked at the well-being of workers from physical, and mental health perspectives. The data collection was conducted through an online questionnaire, with over 100 respondents, and also semi-directive interviews with managers and users of coworking spaces in the Quebec (Canada). The key elements that make a difference on the health and well-being of coworkers are : the flexibility in time use and working time, the localization within the space, the noise, visual intimacy, ambiance and ability to concentrate, and the interactions with others.

Keywords

coworking, well-being, concentration, noise, work

Session 4

Session 4A: Indoor Environment Quality 1, IEQ 1

IEQ in the context of activity-based working: Using a zone-specific post-occupancy evaluation to create a supportive working environment

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Abstract

Indoor environmental quality (IEQ) is broadly established as the composite of conditions within a building. Its influence on the satisfaction and productivity of knowledge workers is considered a prerequisite for a suitable working environment in the corporate office. However, the increasing spread of activity-based working (ABW) in the recent past raises the question of the extent to which the activity-based zones created in this context may also require a differentiated consideration of the IEQ to optimally support employees in different activities. As part of a post-occupancy evaluation (POE), 303 participants were interviewed zone-specifically at four locations of a German software company with an ABW concept incorporating five activity-oriented zones (Focus, Meeting, Phone, Group work and Refresh). Eight IEQ factors (i.e., temperature, air quality, acoustics) were assessed using the SERVQUAL methodology and analysed from two perspectives: First, a t-test revealed that users have significantly different expectations regarding specific IEQ factors for zones of different activities. Requirements for the IEQ in an ABW situation no longer appear to relate to the overall area

but require more focused consideration at the level of specific activity-oriented zones in the planning process. Second, a multiple linear regression analysis was carried out to examine the extent to which the suitability of the zones for their respective activity depends on the fulfilment of IEQ factors during operation. The results show that, depending on the function of the zone, the IEQ factors influence perceived suitability and have differential effects. This work provides a basis for taking a new approach in the scientific discussion of IEQ and the alignment of research with the changing demands of the working environment. Furthermore, it provides concrete, practical implications that support the creation of suitable working environments from planning to operation.

Keywords

Indoor Environmental Quality (IEQ), Activity-based working (ABW), Workplace suitability, Post-occupancy evaluation (POE), Corporate Office

1 INTRODUCTION

Indoor environmental quality (IEQ) has been associated with significant increases in knowledge worker satisfaction and productivity in many studies (Al Horr et al., 2016; Haynes, 2008a, 2008b; Mak & Lui, 2012; Nawawi & Khalil, 2008). There is extensive evidence that meeting user requirements for various IEQ elements, such as temperature, air quality and privacy, is a prerequisite for a healthy, productive, and appropriate work environment in the corporate office (Choi et al., 2023; Colenberg et al., 2021; Franke & Nadler, 2021; Wang et al., 2021).

At the same time, the corporate office itself is changing as part of a transformation process in the world of work (Babapour Chafi et al., 2022; Pfnür & Wagner, 2022), leading to increased temporal and spatial flexibility for today's knowledge workers (Halford, 2005; Weichbrodt & Schulze, 2020). Regarding the physical office space, we see the manifestation of this trend in the increasing use of Activity Based Working (ABW) concepts. These are designed to optimally support specific tasks by creating activity-oriented subspaces for the employee to choose from, with the aim of increasing productivity for the activities intended (Gerards et al., 2018; Jahncke & Hallman, 2020). However, the success of the concept largely depends on its implementation and utilization (Marzban et al., 2023). Well-designed ABW spaces may contribute to higher satisfaction compared to other layout options, including satisfaction with IEQ, as the flexibility gained in choosing a location that suits the employee could compensate for the lack of personal control over IEQ such as noise and temperature in the general workspace (Candido et al., 2019). This suggests that the IEQ as it pertains to the ABW should no longer be considered globally for the entire office, but rather on a zone-specific basis to accommodate individual needs.

This is supported by research indicating that individuals are aware of the elements of the IEQ and intentionally select their workplace based on their preferences (Candido et al., 2019; Hamida et al., 2023). While demonstrating that IEQ does influence utilization patterns and therefore creates demand for a variety of spaces incorporating these preferences, the research to date focusses on the differences resulting from personal preferences. However, it is argued that in the context of ABW, person-independent effects also arise due to the activity-orientation of the zones. For instance, it has been observed that suitable acoustic conditions are particularly crucial for concentration tasks (Banbury & Berry, 2005). While studies of individual factors such as noise or privacy (Banbury & Berry, 2005; Kamarulzaman et al., 2011) may suggest different requirements for a desired IEQ, a

comprehensive and comparative analysis of the significance of various factors comprising the IEQ is yet to be conducted. An holistic comparison of the relative contributions of the various factors comprising the IEQ for employee performance appears to be a limitation in previous studies (see Franke & Nadler, 2021).

To broaden the scope of IEQ research to incorporate the new framework conditions of ABW, a case study in a German software company with an ABW concept was executed and analysed in a two-stage research process. The derived research questions focus on whether (1) the individual zones in the ABW concept have different IEQ characteristics, and (2) to what extent they may affect the area's suitability for the selected activity. If there are significant differences between the individual zones, it is important to address them during the planning and design process. This is especially crucial if not meeting these IEQ factors limits the suitability of the zones. This research contributes to the incorporation of the necessary specificity of activity-oriented zones into the planning process, building on and expanding previous research.

Through this approach, the results not only provide deeper insights into the understanding of the IEQ, but also its practical implications. On the one hand differences in the demanded IEQ need to be considered in the planning process to ensure a supportive work environment for the specific activity intended. On the other hand, the knowledge of the relevant IEQ factors that limit the suitability of the activity-oriented zone in the operation phase will support companies in addressing relevant aspects more effectively.

2 Individuality of IEQ requirements in the context of ABW

A growing body of literature indicates that general assumptions about the importance of IEQ and its impact on employee performance requires an individual assessment when applied in an ABW context. The need for a differentiated IEQ assessment in ABW arises from the functional change of the area that is associated with the transformation of the space into activity-oriented zones (see Appel-Meulenbroek et al., 2011; Pfnür, 2022). Wang et al. (2021) demonstrate that various cognitive functions are affected to varying degrees by different IEQ factors. In practice, the individual IEQ requirements of users significantly influence the choice of workstation and the use of individual zones within an ABW environment, as found by Gocer et al. (2022). In flexible and shared spaces, employees often suffer from a lack of individual control over environmental qualities, which can negatively impact their health and well-being (Danielsson & Bodin, 2008). The choice of zones with different IEQ profiles may address this problem (Candido et al., 2019).

Recent years have seen comprehensive investigations into the individual factors of IEQ in office environments (see e.g., Candido et al., 2016; Graham et al., 2021; Gupta et al., 2020; Kamaruzzaman et al., 2018; Lee, 2019). However, the definition of IEQ factors at a zone-specific level is not always possible. Overarching elements, such as security, general appearance, and overall layout of the building, are not expected to be distinguishable, while IEQ factors such as lighting, air quality, furnishing, privacy, cleanliness, technical equipment, acoustic and temperature have the potential to be zone- and activity-specific (see Banbury & Berry, 2005; Herneoja et al., 2022; Porras-Salazar et al., 2022).

In recent years, post-occupancy evaluation (POE) has emerged as an effective method for assessing user perceptions of the built environment after the space has been occupied for some time (Bordass

& Leaman, 2005; Graham et al., 2021; Kinnane & Dyer, 2013). Standardised procedures have been developed (e.g., Building Use Studies (BUS), Building Occupants Survey System Australia (BOSSA) and the Center for the Built Environment (CBE)) that use standardised POE questionnaires in the evaluation process and in some cases are accompanied by physical measurements (Candido et al., 2013; Galatioto et al., 2014; Graham et al., 2021). The evaluation of office environments has been a major application for the POE (see Galatioto et al., 2014), usually evaluating the building as a whole (e.g., Asojo et al., 2021; Preiser, 1995). Since the development of the POE however, the work environment has in many cases changed from a uniform layout to ABW environments with a variety of different zones having individual IEQ requirements.

3 Methodology

The approach is based on a single case study with embedded research units (see Yin, 1984) of a German software company located at four different sites. The questionnaire used is based on the established POE methodology and has been adapted to be applicable at a zone-specific level by focusing on activity-specific IEQ factors, as discussed in Section 2.1.

The implemented ABW concept of the company is based on five activity-orientated zones: Focus, Phone, Meet, Group and Refresh. The core of the concept is the Focus Zone, which is supplemented by the other activity-orientated zones. Employees do not have a dedicated seat and a clean-desk-policy is applied. The different zones are typically characterised and implemented in the space, as outlined in Table 1.

Table 1. Descriptions of the available zones

Zone name	Intended activities	Design and Layout	Duration of use
Focus	Concentrated individual work, short conversations, short web-call	Height-adjustable desks in an open space area, arranged in rows; state-of-the-art IT equipment with 2 monitors	Primarily long term, occasionally medium term
Phone	Web-calls and telephone calls, silent work, personal conversations	Sound isolated cubes (room-in-room system within the open space area); equipped with seating and a table.	Short and medium term
Meet	Formal and informal meetings, direct and personal exchange	Separate bookable rooms with conference table and IT equipment for phone and video conferences.	Primarily medium term, occasionally long term
Group	Group work, workshops and collaboration, daily briefs, and ad hoc interaction	Spacious and versatile areas within the open space area or in a separate room; whiteboard and write-on tables, pens, sticky notes and other materials for workshops; touchscreens with camera for hybrid meetings	Short, medium and long term

Refresh	Break, informal talks, informal work with snacks and drinks, meeting colleagues	Spatially separated area with comfortable seating and tables; kitchenette; availability of coffee, tea and fruits	Short term

Note. The Duration of use was assessed within this case study (<30min = short term; 30min – 4h = medium term; >4h = long term)

3.1 Data collection and methods of evaluation

The questionnaire comprised two sections and was evaluated through a personal interview conducted on-site by a trained interviewer (electronically using tablets). The first section sought demographic information (age and gender), followed by a question about the participant's current activity, for which the conceptually intended activities of the five zones were available as response options. Participants then rated the suitability of the zone they were using on a 5-point Likert scale ('very good' to 'very bad') and indicated the duration of their intended use. The second section assessed eight IEQ factors, comprising lighting, air quality, furnishing, privacy, cleanliness, technical equipment, acoustic quality, and thermal comfort, on a dual scale. One scale measured the expectation (an exemplar formulation: Good lighting (pleasant natural and artificial light, no glare, reflections etc.) generally allows me to be able to do my work better at this spot). The other item measured perception (an exemplar formulation: I found the lighting (pleasant natural and artificial light, no glare, reflections etc.) at this spot to be a positive influence). A 7-point Likert scale ('strongly agree' to 'strongly disagree') was used for both scales. The questionnaire's structure is based on the SERVQUAL methodology and the Gap model (see Ladhari, 2009; Parasuraman et al., 1988; Parasuraman et al., 1985). As it is acknowledged that work spaces are not always used as intended (see Appel-Meulenbroek et al., 2011), the participant's self-reported activity was cross-checked with the assigned zone by the interviewer to verify correct zone usage.

The holistic view of (i) the differences in requirements due to the functional orientation of the zones and (ii) the relevance of the various IEQ factors for the respective activity in the utilisation of the zones, required different evaluation methods.

(i) To examine the extent to which different emphases are placed on the IEQ factors in different activity-oriented zones, the expectation component of the dual scale was analysed. The study employed the T-test for independent samples to determine if there were significant differences in the mean values of the individual IEQ factors between the main work area (Focus zone) and the other activity-oriented sub-areas (Phone, Meet, Group, Refresh). In cases where the variances of the samples were unequal, the Welch test was used.

(ii) Multiple linear regression was used to determine the extent to which the fulfilment of the IEQ factors determined the suitability of the space; the fulfilment was operationalised by the discrepancy (gap) between the expectation and the perception (see Parasuraman et al., 1985). Five models were constructed to analyse the zones separately. In each case, the rating of the suitability of the zone was used as the dependent variable and the discrepancy between the ratings for the eight IEQ factors as independent variables.

3.2 Sample

Data was collected during May and June 2023 at various locations throughout the day over several survey rounds. At all locations, the entire week as well as holidays and non-holiday periods, were covered. The survey was conducted with 303 individuals, of whom 239 participants remained for further analysis after applying the filter for correct zone usage. Of these respondents 193 (80.8%) are male, 45 (18.8%) are female and 1 person (0.4%) declined to provide any information. The age distribution shows a concentration on the younger age groups with 40 (16.7%) participants aged 20–29, 132 (55.2%) aged 30–39, 50 (20.9%) aged 40–49 and 10 (4.2%) aged 50–59; seven participants (2.9%) declined to provide any information. Although the distribution appears skewed compared to the general population, it aligns with the typical distribution for software companies (Nier, 2018).

Regarding the representation of the different zones, the Focus zone, which is the primary workspace with the largest area share, accounts for 116 (48.5%) of the datasets. The Phone zone was evaluated by 30 (12.6%), the Group zone by 28 (11.7%), the Meet zone by 34 (14.2%) and the Refresh zone by 31 (13.0%) of the participants.

4 Findings

The results of both evaluation methods (using IBS SPSS Statistics 27) of the two-stage evaluation process are presented below. Appendix 1 provides an overview of the descriptive statistics for all measures, including expectation, perception, and the discrepancy (gap) for each zone.

4.1 Zone-specificity of Expectations

The Levene test was used to ensure the necessary condition of equality of variance for the t-test (threshold of <0.05). In rare instances where unequal variances occurred, the corresponding equivalent, the Welch's test, was applied. The analysis, presented in its entirety in Appendix 2, indicates significant differences only for certain characteristics.

Compared to the Focus Zone, the participants place significantly higher expectations on privacy in the Phone zone ($t(144) = 3.263$, $p = 0.001$). Using Cohen`s d the effect size ($d = 0.668$) can be interpreted as medium to large (Cohen, 1988). The greatest differences in IEQ expectations were found in the Refresh Zone. Compared to the Focus Zone, significantly lower expectations were placed on lighting ($t(145) = -2.295$, $p = 0.023$, $d = -0.464$), privacy ($t(145) = -3.586$, $p = <.001$, $d = -.725$) and acoustic quality ($t(36.348) = -2.931$, $p = .006$, $d = -.774$). The effect size of lighting is small to medium according to Cohen (1988), while the effect sizes of privacy and acoustic quality are medium to large. No statistically significant differences were found for either the Group Zone or the Meet Zone compared to the Focus Zone.

4.2 Specific IEQ Factors Influence the Suitability of Activity-oriented Zones

Table 2 shows that the extent of the fulfilment (gap) of the IEQ factors investigated can significantly predict the task-specific suitability for three of the five zones. While the suitability of the Group zone (model 3) and the Refresh zone (model 5) cannot be significantly predicted using the investigated IEQ factors, the explained variance of the zones' suitability is $r^2 = 0.172$ (adj. $r^2 = .110$) for the Focus zone, $r^2 = 0.566$ (adj. $r^2 = .400$) for the Phone Zone and $r^2 = 0.531$ (adj. $r^2 = .381$) for the Refresh Zone. These three significant models provide a basis for a more in-depth consideration of the relationships and effects of the IEQ factors, as shown in Figure 1. It is precisely in these zones – which also manifest a large proportion of the associated office space – that the characteristics for IEQ are decisive. The more

these zones fulfil the requirements of their users regarding IEQ, the better the assessed suitability of the zone for the actual activity.

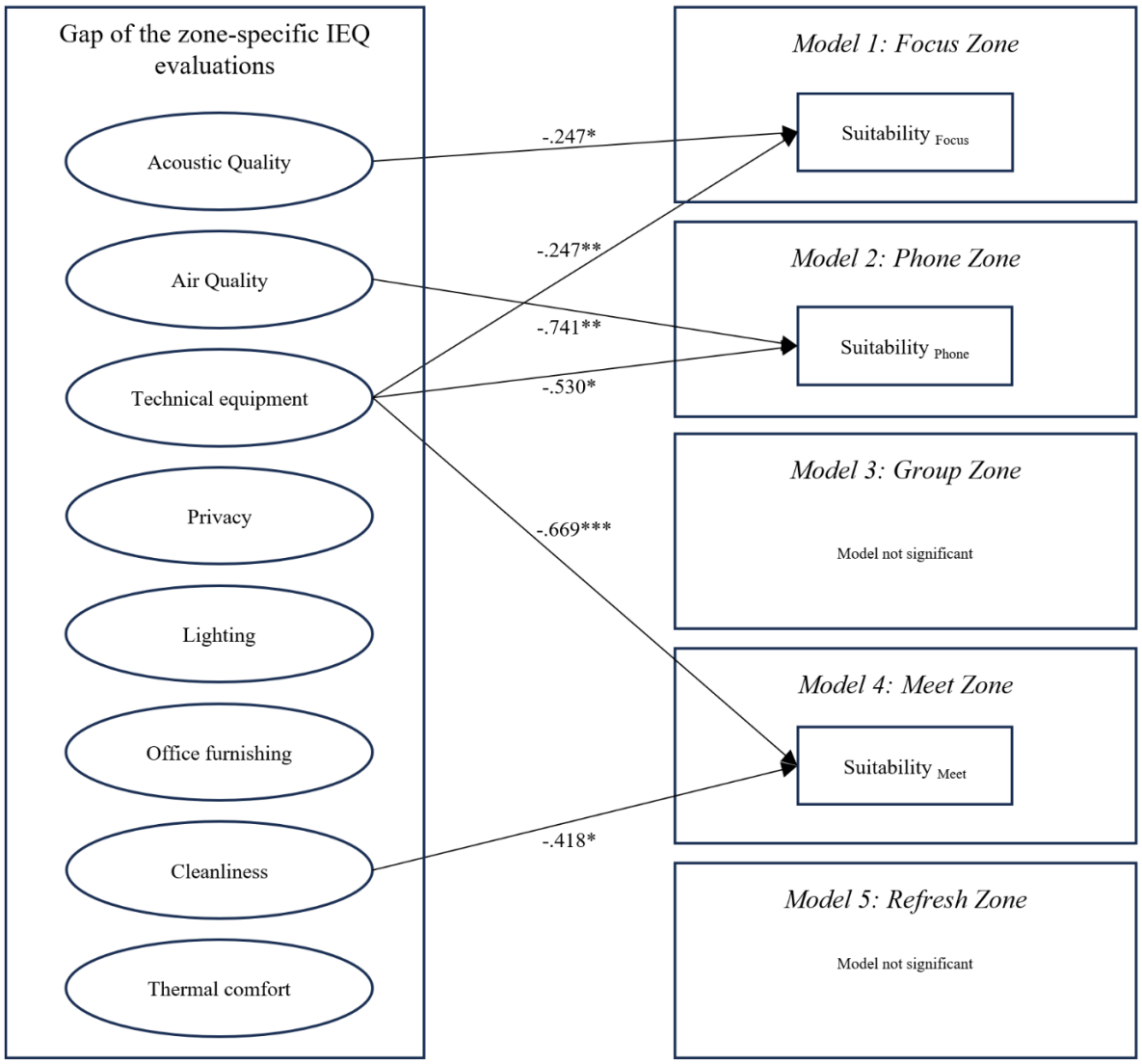
Consequently, areas that do not meet the necessary criteria are deemed less appropriate for users, which may lead them to avoid these areas even for their intended purpose and opt for an alternative. This could diminish the usability of the chosen alternative areas for other users (e.g., when the Focus zone is used for calls).

Table 2. Summary of regression models

model		R^2	adjusted R^2	F	p
(1)	**Focus zone**	**.172**	**.110**	**(8,107) 2.769**	**.008**
(2)	**Phone zone**	**.566**	**.400**	**(8,21) 3.420**	**.011**
(3)	Group zone [a]	.363	.095	(8,19) 1.355	.277
(4)	**Meet zone**	**.531**	**.381**	**(8,25) 3.544**	**.007**
(5)	Refresh zone [a]	.390	.169	(8,22) 1.762	.140

Note. [a] Excluded in the further analysis due to low significance (minimal requirement of p-value < 0.05)

Figure 1. Results of the multiple linear regression analysis



Note. Only significant relations are presented. Standardised coefficients are shown. p-value < 0.001 = ***; p-value < 0.01 = **; p-value < 0.05 = *.

5 Discussion

The study's results offer new insights into the relevance of IEQ factors from both perspectives analysed. First, in line with current literature, it was found that users expect a certain level of IEQ to be provided in the workspace. However, this study also revealed that zone-specific expectations exist regarding individual IEQ factors, as demonstrated by independent t-tests. Second, in a multiple linear regression analysis it was found that the suitability of the activity-oriented zones is determined by the extent of fulfilment of specific IEQ factors, depending on the activity for which the zone is designed.

The discovery of zone-specific expectations and their potential non-compliance in practice provides an explanation for the underperformance found in previous studies regarding aspects such as privacy or noise in most ABW applications, while at the same time positive examples do exist regarding the same aspects (see Engelen et al., 2019). To ensure the proper implementation of ABW concepts in practice, companies should consider not only fulfilling the general requirements for IEQ but also implementing zone-specific requirements into their concept. Therefore, it is important to consider

specific IEQ requirements not only during the design of individual zones, such as physically isolating the phone zone to ensure privacy, but also in the overall layout by arranging zones in relation to each other in a way to avoid interference, such as between the refresh zone (with significantly lower requirements regarding lighting, privacy and acoustics) and the other zones.

In contrast to the current literature (e.g., Gupta et al., 2020; Kamaruzzaman et al., 2018; Wang et al., 2021), the impact of the IEQ on the suitability of individual zones in this study was limited to only a few specific and zone-individual factors in the respective regression analyses. A possible explanation for this is the freedom of choice within the workplace in ABW concepts which, as studies show, allows users to select a place they like, compensating for personal control over environmental conditions (Candido et al., 2019; Gocer et al., 2022). The factors identified in the regression analysis are therefore particularly relevant for practitioners, as they do not appear to be compensated for by changing places. For instance, the user cannot avoid poor acoustics or inadequate technical equipment in the Focus zone, as it is uniformly equipped in a single open-space area. The same applies to air quality and technical equipment in the standardized telephone boxes, as well as the technical equipment and cleanliness of the meeting zone. Practitioners must consider these zone-specific IEQ factors and avoid under-fulfilment in order to maintain the activity-specific suitability of the office space. Contributing to the findings of (Marzban et al., 2023), who identified the POE as particularly important for the successful implementation of the ABW concept, this work demonstrates a feasible approach to further develop the POE to provide zone-specific insights. The analysis suggests that identifying and addressing these specific IEQ factors can lead to significant improvements in suitability. In the current debate between working from home (WFH) and return-to-office (RTO) (Ding & Ma, 2024), the occupancy of office space and associated satisfaction are crucial. Assuming a positive correlation between IEQ, satisfaction, and ultimately productivity, it follows that an area with poor IEQ would receive lower ratings from employees or even avoided altogether.

Considering the case study approach, several limitations should be taken into account regarding the specific cases and the sample. First the gender distribution was uneven, which is typical for the software industry. Second, to increase the statistical power and detect even small effects of the IEQ, the sample size could be increased (see Cohen, 1988; Ryan, 2013). Third, future research could expand on the study's findings by conducting a similar investigation of the relationships in other ABW environments and in different companies. Additionally, focusing on the relevant IEQ factors with complementary physical measurements could further refine the POE process for ABW concepts.

Conclusion

In summary, the study indicates that IEQ factors in the activity-orientated working environment require a more selective and zone-individualised approach. Individual requirements for specific IEQ factors within the zones are revealed and should be considered in the conceptualization. The suitability of the area during operation is characterised by the fulfilment of certain IEQ factors, which differ depending on the zone as well. In contrast, this study found that the majority of IEQ factors that are typically considered important in traditional office settings were not significant. This may be because the importance of fulfilling a person’s requirements at the individual workstation is substituted by the free choice of workplace in the ABW environment. The subdivision of the workspace into activity-oriented zones therefore requires a synchronous adaptation of the POE methodology to enable practitioners to address the relevant value drivers of the individual zones.

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Appendix 1

Overview of the Descriptive Statistics for all Measures

IEQ factor under investigation		Focus N=116		Phone N=30		Group N=28		Meet N=34		Refresh N=31	
		M	SD	M	SD	M	SD	M	SD	M	SD
Lighting	expectation[b]	1.85	1.09	1.77	1.28	1.96	1.23	1.76	1.16	2.39	1.36
	perception[b]	2.15	1.28	2.43	1.43	2.04	1.07	2.21	.95	2.16	1.13
	discrepancy[c]	-.29	1.24	-.67	1.06	-.07	1.09	-.44	1.42	.23	1.59
Air Quality	expectation[b]	1.69	1.07	1.63	1.19	1.68	1.06	1.71	1.22	1.81	1.20

	perception[b]	1.94	1.14	2.67	1.61	2.04	1.14	2.12	1.27	1.71	.86
	discrepancy[c]	-.25	1.04	-1.03	1.54	-.36	1.34	-.41	.93	.10	1.08
Office Furnishing	expectation[b]	1.97	1.09	2.23	1.61	2.29	1.33	2.09	1.16	2.23	1.33
	perception[b]	1.97	1.21	2.60	1.57	2.11	1.10	2.56	1.54	1.90	1.11
	discrepancy[c]	.00	1.37	-.37	1.83	.18	1.52	-.47	1.69	.32	1.62
Privacy	expectation[b]	2.78	1.49	1.80	1.42	3.11	1.34	2.62	1.62	3.94	1.93
	perception[b]	2.84	1.54	2.20	1.63	2.46	1.48	2.32	1.51	2.39	1.02
	discrepancy[c]	-.06	2.29	-.40	1.57	.64	2.28	.294	1.96	1.55	1.98
Cleanliness	expectation[b]	2.16	1.16	1.90	1.24	1.86	1.30	1.88	1.09	1.77	1.28
	perception[b]	1.77	1.15	1.53	1.17	1.43	.84	1.85	1.26	1.42	.62
	discrepancy[c]	.40	1.27	.37	1.19	.43	1.14	.03	1.49	0.36	1.31
Technical equipment	expectation[b]	1.69	.90	1.97	1.47	1.79	1.57	1.68	1.17	1.77	1.12
	perception[b]	2.61	1.50	2.33	1.54	2.29	1.56	2.41	1.48	1.90	1.19
	discrepancy[c]	-.92	1.68	-.37	1.63	-.50	1.55	-.74	1.83	-.13	1.75
Acoustic Quality	expectation[b]	1.84	1.08	1.47	1.20	1.96	1.32	1.97	1.40	2.81	1.74
	perception[b]	3.04	1.59	1.97	1.35	2.50	1.62	2.15	1.33	2.42	1.31
	discrepancy[c]	-1.20	2.00	-.50	.86	-.54	2.01	-.18	1.71	.39	2.39
Thermal Comfort	expectation[b]	1.83	1.11	1.80	1.27	1.86	1.08	2.00	1.07	2.23	1.41
	perception[b]	2.40	1.37	2.57	1.63	2.68	1.63	2.18	1.29	1.77	1.15
	discrepancy[c]	-.57	1.63	-.77	1.91	-.82	1.79	-.18	1.27	.45	1.67

Note. [b] Likert scale 1–7. [c] discrepancy between the participant's expectation and perception rating

Towards environmental analysis for indoor office spaces. Interdisciplinary approach to quantified photo analysis

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ABSTRACT

Purpose. The increase in hybrid work following the COVID-19 pandemic is strengthening the trend towards more flexible, space-efficient, and non-territorial workplace design (e.g., activity-based offices) to accommodate hybrid working. Many organisations struggle with low presence rates at the office and their consequences. The purpose of this paper is to initiate the development of a photo analysis method to advance understanding of workers' use of their physical surroundings. This can contribute to successful interdisciplinary research where design researchers, together with work environment researchers, are searching for means to understand leverage points between well-being and the multitude of environmental factors in workplace settings.

Theory. The theoretical content is related to the Environmental Demands-Resources model, a domain-specific extension of the Job Demands-Resources theory, and to Kaplan's Attention Restoration Theory from a design knowledge perspective. Gibson's Theory of Affordances enlightens the latent action possibilities the environment offers individuals. The photo analysis originates from Press Photograph Story Analysis by Kedra.

Design/methodology/approach. The indoor work environment photo analysis is based on the earlier developed outdoor version, taking advantage of machine-vision analysis. The worker's self-reported

photos will be collected using the mobile-based experience sampling method (ESM) to document workers' views of the physical environment when working hybrid. The photos provide material to analyse visually favourable affordances in the indoor office environment and to compare it to the overall diversity of view option categories.
Originality/findings. The proposed photo analysis will provide a three-dimensional understanding of the physical work environment relevant to building designers, not considered in earlier research, where, at most, the floor plan is presented. The proposed analysis, including the rating of the photographs, is still preliminary and meant to support the comparison or merging process with the quantified data sets produced by the other disciplines e.g. for the evidence of health- or well-being-related impacts.

Keywords
Knowledge work, Physical work environment, Indoor photo analysis, Interdisciplinary approach

1 Rationale

Hybrid working has increased in workplaces after the COVID-19 pandemic. With *hybrid work*, we mean combining on-site work at the workplace and teleworking (e.g., at homes, cafes, and holiday homes). By *hybrid workplace*, we refer to organizations that are now leading a larger variety of workers with different hybrid work profiles, ranging from no to full-time teleworking. A hybrid workplace poses new challenges for employers in the design of the work environment. Many organisations struggle with low presence rates at the office and their impact on collaboration, innovation, and organisational productivity. In this paper, we focus on the physical environment and its documentation and analysis.
In interdisciplinary work environment research, a need has arisen to document hybrid workplaces from the employee's perspective. Currently, the research reports, at best, present an office-furnished floor plan and a few photographs of the space's general appearance. More detailed information about the physical environment is needed to understand the employee's perspective. For example, to study linkages between the low presence rates at the office and the physical environment's deficiencies, it would be necessary to know what kinds of spaces are available and which of them the worker uses. Company premises are documentable since it is a delimited physical environment. In hybrid work, however, the employee can also choose another place, public or private, which is unknown or to which the researcher does not have (reasonable) access. In hybrid work, from the worker's perspective these workplaces located in different environments form a whole.
In interdisciplinary research, the compatibility of methods and the nature of data have also produced challenges. We have tackled how to produce quantified data from visual material analysis so that it could be combined (or be comparable) with quantitative data produced by other disciplines, but it would still be relevant for architectural researchers.
We have earlier developed a methodological approach for quantified photo analysis for workers' self-reported photographs collected from the participants by the mobile-based experience sampling method (ESM) (e.g., Beal, 2015; Hektner, 2007) for outdoor (or semi-outdoor) settings (Herneoja et al., 2023) originating from Press Photograph Story Analysis (PPSA) by Kedra (2013). The material of this analysis was then the mobile-based collected photographs i.e., visual data of the worker's view (i.e. when raising gaze from a laptop screen) of the places they are working. In this paper, we will test on a theoretical basis how this method, customised for outdoor (or semi-outdoor) spaces, would fit into

indoor settings. The labour-intensive photo analysis phase would take advantage of the use of artificial intelligence-based (AI-based) machine-vision analysis.

The theoretical content contributes to the Environmental Demands-Resources (ED-R) model (Roskams & Haynes 2020), a domain-specific extension of the Job Demands-Resources (JD-R) theory (Demerouti et al., 2001; Bakker and Demerouti, 2018). The ED-R is meant as a standalone framework to represent the complex employee-workplace relationship. Broadly, the ED-R model (Roskams & Haynes 2021) suggests that the provision of more effective workplaces relies on a combination of three broad strategies: the mitigation of environmental demands (e.g. creating silent working areas), the enhancement of environmental resources (e.g. placing interior plants within the office) and to facilitate the user-directed, bottom-up process of environmental crafting (e.g. implementing flexible working policies) (Roskams & Haynes 2021). From a design point of view (e.g., architecture and interior design), the first and second strategies of ED-R would benefit from a design inventory of space informed by professional best practices, to be advanced by affordance-based evaluations (Bradenhagen & Rodiek 2015). Affordance is not a characteristic of the environment, instead, but it is also formed in the interaction between the individual's needs and perceptions, and the environment (Gibson 1979). Individuals use affordances to regulate their emotional balance, which manifests as positive effects of being in one's favourite place on well-being, for example. (Korpela et al. 2008) The ED-R's enhancement of environmental resources will benefit from a close reading of Attention Restoration Theory (ART) (Kaplan & Kaplan 1989, Kaplan 1995) from a design knowledge perspective, not reducing it to the green plants for restorative effects. Kaplan & Kaplan (1989) describe a series of characteristics that an environment must have to provide a restorative experience, such as *fascination*, *being away*, *extent* (later using the extension), and *compatibility*. In this paper, we regard these restorative elements to see if the design knowledge perspective contributes further understanding when developing a photograph-based visual analysis method.

The third strategic point of ED-R (the user-directed, bottom-up process of environmental crafting) is not directly a design matter. However, flexible working is closely linked to the hard-to-predict usage of the organisation's premises, setting novel challenges to spatial design, too. Environmental crafting is relevant for designers in general when considering hybrid working as a continuum of places of work at company premises and other places indoors and outdoors, regardless of whether they were designed for knowledge work.

2 Theoretical framework of indoor photo analysis

In this paper, we focus on analysing occupants' self-reported photos of indoor knowledge work environments (e.g., activity-based offices, flex offices). The presumption is that they may freely choose a place or workstation to work. In the analysis, the priority is on the indoor view, but we also include the window view (from inside to outside) if there is one visible in the photograph. Initially, we started to develop photo analysis for outdoor knowledge working environments to be able to advance our understanding of outdoors and semi-outdoors in the context of hybrid working. For the outdoor work environment, we chose eight elements divided into three categories: Category 1 (Cat. 1), *Nature elements* (sky, greenery, water and ice or snow); Category 2 (Cat. 2), *Static elements* (built environment); and Category 3 (Cat. 3), *Dynamic elements* (people, vehicles and furniture). In this paper our purpose is to find out whether the photo analysis framework intended for outdoor spaces could also be applied to indoor environments. Analysing indoor and outdoor (including semi-outdoor) workplaces with similar structuring would not only advance understanding of what kind of places hybrid working takes place but also add to the range of methods used in interdisciplinary research.

We chose an AI-based machine vision analysis approach to automate labour-intensive workflows (e.g., Starzyńska-Grześ et al. 2023) for identifying the eight elements from the photographs.

In the **Nature elements** category (Cat. 1), in an outdoor context, to study restorative elements, we included well-studied **greenery** (Stoltz and Grahn 2021) (including evergreens or branches lacking foliage) together with other less-studied nature elements, such as **sky** (Sztuka et al. 2022) and **water** (e.g. Luo et al. 2021) (in the forms of **ice** or **snow** (Bao et al. 2023)). In window views (from inside to outside), all the Nature elements (Cat. 1) are visible and may be included in the indoor photo analysis. In indoor views (not including window view), most likely only greenery (e.g., living, mummified (embalmed) or silk (artificial) plants) is included in this category of Natural elements.

The **Static elements** (Cat. 2) were included to gather material to study more about the possible restorative effects of the built environment. In the outdoor context, with the **built environment**, we referred to different scales, from city spaces (e.g., views of streets, allies, plazas or squares), semi-outdoor public spaces (e.g., sheltering structures, shopping malls) to close-up photos of aforementioned contents (e.g., part of buildings, their structures or surface materials, including materials on the ground.) All these outdoor Static elements (Cat. 2) could also be seen through a window view (from inside to outside). Indoor views have Static elements of their own (e.g., floors, walls, and ceilings that form the inside spaces), which may be considered a continuum of the (outdoor) built environment. In general, the major difference is that indoor environmental quality is stable (IEQ; BS ISO 17772-1, 2017), unlike outdoor and semi-outdoor places where it is unstable (e.g. Tanabe and Nakano, 2020). In our photo analysis, we enlarge the Static elements (Cat. 2) to include both the built environment outdoors and the indoor built elements (also called an *architectural envelope* (including the fixed technical systems), (Herneoja et al., 2022) similar to the more broadly used *building envelope*, but not limited to the outside walls only (e.g. Cleveland and Morris, 2009).

In the **Dynamic elements** category (Cat. 3), in the indoor window view (from inside to outside), **vehicles** (e.g. means of public and private transportation, motorbikes, bicycles (manual or motorised), scooters, and other micro-mobility devices) are considered only as parked or moving objects (not including their inside spaces since they belong to semi-outdoor context), as possible sources of noise or visual distraction. In an indoor context (in indoor view), **people** visible in the photographs may be considered positive features as possibilities for social contact. Other people may as well be considered as a cause of adverse effects, such as visual (e.g., moving around) or auditory (e.g., talking or causing another type of noise) distractions. In window view, especially when indoor working environments are at street level, bypassing people may be a source of visual distraction. **Furniture** in outdoor (or semi-outdoor) spaces is considered in the photo analysis as an affordance of seating, a possibility for other people to be in the view (very close or farther). Outdoors, the worker may have knowingly chosen a place where other people might make social contact or at least not feel distracted by the presence of other people. Most likely, these outdoor (or semi-outdoor) spaces are not designed as places of knowledge work but just for people to spend time. However, inside work environments, interior design (e.g., furniture, non-fixed lighting fixtures, acoustic solutions, and textiles) is designed to facilitate employees' activities in office spaces to support their working and recovery during the workday (i.e., *interior orchestration* (Herneoja et al., 2022)). Indoors, in office buildings, there are also places that are not designed for working, such as coffee or lunch canteens, that may be available (and inviting) outside the times used for their primary functions. In hybrid work, when teleworking, not all spaces are most likely designed as workplaces (e.g., at homes, cafes, holiday homes). As in outdoors also in indoor spaces, furniture is an affordance for other people to be in the view either as a source of social contact or a source of visual or auditory distraction.

Summary of the eight visual elements' division into three categories, and indoor and window views.
Category 1 (Cat. 1): *Nature elements*:
- In indoor view: *greenery*
- *Through window view*: *greenery*, *sky*, *ice or snow*, and *water*.
Category 2 (Cat. 2): *Static elements*:
- In indoor view: elements of *architectural envelope* (i.e., material qualities and solutions of an architectural envelope (architectural design solution (fixed floor, wall and ceiling structures), lighting solutions, acoustic solutions & HVAC solution (Herneoja et al., 2022))
- Through window view: *built environment* visible through window view, or parts of it.
Category 3 (Cat. 3): *Dynamic elements*:
- In indoor view: *people* and *furniture*, i.e., material qualities and solutions of *interior orchestration* (furniture, non-fixed lighting fixtures, non-fixed acoustic solution and other non-fixed elements (Herneoja et al., 2022), but excluding plants and other greenery to be analysed in the Cat 1.).
- Through window view: *people*, *furniture* and *vehicles*.

3 grouping of the visual elements in indoor and window view

All photographs will be divided into seven Main Groups (MG) based on category-based division into *Nature*, *Static* and *Dynamic element* categories. In the MG 1.-3. each photo has visual elements from only one category (one visual element or all of them) (*Figure 1.*). Each category's visual elements would first be studied separately. Photographs with only one Nature element (Cat. 1.), two-, three- and all four-element combinations would be analysed separately. Similarly, Dynamic elements (Cat.3.) with only one-, two-, and all three-element combinations would be analysed separately. Category 2. (Cat. 2.) Static element is formed only by the indoor view (architectural envelope) or through the window view of the Built Environment visual element; therefore, combinations are most likely not to occur. These found one-category-based combinations would then be combined with visual elements from another category, creating the MG 4.-6. (*Figure 2.*), and combinations from all three categories, creating the MG 7. (*Figure 3.*).

Figure 1. Groups' 1.-3. photographs have elements from only one category.

MG	Visual elements from one category	Total %
1.	Cat. 1. Nature: Sky (S), Greenery (G), Water (W) and/or Ice or snow (I)	100%
2.	Cat. 2. Static: Built Environment (B)	100%
3.	Cat. 3. Dynamic: Vehicles (V), People (P) and/or Furniture (F)	100%

Figure 2. Groups 4.-6. photographs have elements from two categories.

MG	Visual elements from two categories		Total %
4.	Cat. 1. Nature: Sky, Greenery, Water and Ice or snow, xx%	Cat. 2. Static: Built Environment, xx%	100%
5.	Cat. 1. Nature: Sky, Greenery, Water and Ice or snow, xx%	Cat. 3. Dynamic: Vehicles, People and Furniture, xx%	100%
6.	Cat. 2. Static: Built Environment, xx%	Cat. 3. Dynamic: Vehicles, People and Furniture, xx%	100%

Figure 3. Group's 7. photographs have elements from all three categories.

MG	Visual elements from three categories			Total %
7.	Cat. 1. Nature element, xx%	Cat. 2. Static elements, xx%	Cat. 3. Dynamic elements, xx%	100%

3.1 Category 1, Nature elements – One-category, one- to four-element combinations

MG 1 (*Figure 1.*), in sub-groups, photographs with only one type of Nature element are probably rare indoors. Some indoor images with close-up views might have only greenery if a worker is seated right in front of a green wall composed of vegetation (or similar). In window views (from inside out), only greenery could be seen if a tree is very close to the façade or if a climber is growing on a façade. In the window view, the sky could be the only nature element if a window is placed high enough. These features could raise "soft" fascination: clouds, snow patterns, and the motion of the leaves in the breeze (Kaplan 1995).

MG 1, in sub-groups where photos have two nature element combinations, most likely concern window views (from inside out) either at the office or other indoor locations at different times of the year.

3.2 Category 2, Static elements - One-category, no combinations

MG 2 (*Figure 1.*) consists of photographs having only (100%) the Static (Cat. 2) visual elements, either parts of the architectural envelope in the indoor view or parts of the built environment in the window view. Most likely, these photos are images with a close-up view of an opposite wall (indoor or in window view), or in a window view, to a narrow alley or a small, closed urban courtyard surrounded by multi-story buildings. In this group (MG 2.), analysing the type of contexts (urban, suburban, rural), materials, and textures visible in these photographs, both on indoor surfaces and seen through window views, is also interesting. A close-up view of a white-painted drywall surface probably does not have any restorative characters raising a "sense of being away [or] compatibility with the environment" (Kaplan 1995) as, e.g., wooden or brick material could bring about (in indoor or window view). A wider view, such as a window view (from inside to outside) to an alley or a courtyard space, could arouse "extension; feeling of being able to travel through the environment in order to look for the information it provides" (Kaplan 1995).

3.3 Category 3, Dynamic elements – One-category, one- to three-element combinations

Indoor views in MG 3 (*Figure 1.*) sub-groups consist of photographs with only one type of Dynamic (Cat. 3) element, which would most likely be a close-up view of furniture. For example, if the occupant is seated in a Pod or in front of a table having an acoustic partitioning element (e.g., standing on the floor) or an acoustic panel (e.g., fixed on the side of the table) in front of them, the view might be 100% furniture (e.g., the textile surface of the acoustic panel). At least at first, it is difficult to imagine what restorative features this type of furniture could have in close-up view. Of course, the textile surface's feel of materiality or colour can evoke "a sense of compatibility with the environment" (Kaplan 1995). In window views, it is not likely to have only vehicles, people, or furniture visible other than if cars are parked, furniture is placed, or people are walking in front of the window, and the workspace is below the street level.

3.4 Two- and Three-category Combinations in indoor views and through window views in relation to Urban, Suburban, and Rural scenarios

In combinations of several categories, a wider angle of view is more likely than with visual elements of one category. In combinations of elements of two or three categories, interior views and window views have been examined as separate entities. However, it is possible, even likely (or at least desirable), that a window view is also visible, especially in wider interior views where a sense of depth is present. A wider view could evoke a sense of extension if the view would have "connection/-s between each element found in an environment" (Kaplan 1995). The wider view also includes the possibility of Dynamic elements, the other people entering the view, causing visual or auditory distraction.

In the window views, the photographs with two- and three-category combinations seem most likely to occur in Urban, Suburban, and Rural scenarios. The one-category variations (*Figure 1*.) of Nature elements (MG 1.) and Dynamic elements (MG 3.) are used when combining them with Static elements (MG 2.) (*Figure 2*.) or with each other (*Figure 3*.). Forming these two- and three-category combinations is not only mechanical since adding categories leads to wider angles and views in photographs' contents.

3.4.1 Nature – Static element combinations

In indoor views, Nature-Static element combinations mean that the photo would most likely include parts of wall or ceiling structures (or other parts of the architectural envelope) together with house plants (e.g., living, mummified (embalmed) or silk (artificial) plants. The distance from the elements and the angle of the view (close-up or wider view) also provide possibilities for restorative aspects like one-category elements.

When considering the window views, in the Urban scenario, the Static elements (the built environment) dominate the Nature elements. In the Suburban scenario, the Nature and Static elements are approximately in balance. In the Rural scenario, the Nature elements have dominance over the Static elements, and the Nature scenario may contain only very small amounts of Static elements (the built environment).

3.4.2 Nature – Dynamic element combinations

In indoor views, Nature-Dynamic element combinations mean that the photo would most likely include furniture (or other parts of the interior orchestration) or other people, who are apparently the other knowledge workers. The Nature elements in indoor settings are apparently house plants. The dynamic elements in indoor view contain a risk for distraction.

In the urban scenario, concerning window views, the Dynamic elements dominate the Natural elements. In the Suburban scenario, the Nature and Dynamic elements could, at most, be approximately in balance. In the Rural scenario, the Nature elements have dominance over the Dynamic, and the Nature scenario may contain only very small amounts of Dynamic elements.

3.4.3 Static – Dynamic element combinations

In indoor views, if only the Static - Dynamic element combinations (features of the *architectural envelope* and *interior orchestration* and people) are visible, at their best, a wider view could evoke a sense of extension if the view would “include connection/-s between each element found in an environment” (Kaplan 1995.) or sense compatibility through “characteristics found in an environment that meet the preferences and goals of a person” (Kaplan 1995). The sense of compatibility with the environment could be possible also in close-ups as well. The presence of people in indoor view poses a risk of distraction.

In window views, the Static and the Dynamic elements belong to the Urban scenario regardless of their mutual percentages. It is less likely in the Suburban scenario that only the Static (the built environment) and Dynamic elements are visible. Most likely, it would be rare to have these elements in the Rural scenario and in the Natural scenario, they do not belong at all.

3.4.4 Nature - Static – Dynamic element combinations

In indoor views, the three element combinations (Nature, Static, and Dynamic) allow for the richest affordance and widest views as described in the first paragraph of 3.4.

In window views, in the Urban scenario, the Static and Dynamic elements most likely dominate Nature elements. In the Suburban scenario, the Nature elements and the sum of Static (the built environment) and Dynamic elements are approximately in balance. In the Rural scenario, the Nature elements have

dominance over the Static and Dynamic elements, and the Nature scenario may contain only very small amounts of Static (the built environment) and Dynamic elements.

3.5 Principles for preliminary quantification of the photographs

The preliminary quantification of the photographs is based on the eight visual elements and their division to three categories: *Nature* (sky, ice or snow, water, greenery), *Static* (built environment (outdoors)/architectural envelope (indoors)) and *Dynamic* (furniture (i.e. interior orchestration), people and vehicles) visible in indoor views or window views (from inside to outside) (*Figure 4*.). The percentage of each visual element (separately) in each photograph is analysed in AI-based machine vision analysis. After the MV analysis, the photos are grouped by visual categories, each visual element belonging to one of the three categories: *Nature*, *Static*, or *Dynamic* visual element categories.

The photographs with an indoor view but without a window view are rated by the column "No window view", with low rates of 1- 2.5 on a scale where 4 is the highest grade (*Figure 4*.). In this column, the best rates are reserved for views with the dominance of the Nature category (already proved to have restorative effects) together with wider views with Static elements (most likely providing visually calm but still including features of extension) (rate 2,5). If the view would also include a window view far away or even a small one (even no visible scenario to analyse), the rating would be upgraded with 0.5 points, and the more nature-based views would be up to 4 points. On the other hand, the lowest grades (rate 1) are reserved for close-up views, with the dominance of the Dynamic visual elements (or Static elements) and lacking known restorative visual elements. Dynamic visual elements containing the other people (or non-used seatings) include risks for visual or auditive destruction. In these cases, the presence of a window view (even a very small one) upgrades the rating.

For the window view, the rating is based on the visual element combinations within one category (Nature, Static, Dynamic), visual element combinations between categories, dominance of a visual element category, or type of the views (close-up or wider view). For the window views, scenario-based outdoor (including semi-outdoors) photo analysis is applied, where photographs are divided into four scenarios (Urban, Suburban, Rural, and Nature) based on the visual element content in the photograph or the known location data (if it is available). In the quantification framework for indoors, the use of these outdoor scenarios is mostly directive and therefore, the Urban and Suburban scenarios are considered as one group, and similarly, the Rural and Nature scenarios are grouped together to form another group, the latter ones receiving higher rating (most likely more nature elements) than the former ones. The principles of the preliminary scoring of the photographs are indicated in detail in *Figure 4*.

Figure 4. Principles for preliminary quantification of the photographs, including both indoor views and window views.

Interior view Elements (Nature, Static, Dynamic) or their combinations, dominance or views (close-up or wider view)	**No window view**	**Window view to Outdoors**		
		Window view far away or small	Urban scenario/ Suburban scenario	Rural scenario/ Nature scenario
Dynamic (close-up view); Dynamic - Static (close-up view)	**1**	1,5	2	2,5
Nature – Dynamic and/or Static (dominance/close-up view)	1,5	**2**	2,5	3
Nature (dominance) – Dynamic and/or Static (wider view)	2	2,5	**3**	3,5
Nature; Nature (dominant) – Static (wider view)	2,5	3	3,5	**4**

4 Secondary application: systematic baseline documentation

The secondary application of this indoor photo analysis could also be as a researcher's tool for systematic documentation. For example, the variation of seating arrangement in the floor plan does not necessarily indicate variation in the affordance of views when lifting one's gaze from the screen. Researchers could use photo analysis to systematically analyse workplace affordances in known locations, such as specific office spaces, to gain a baseline understanding of the affordances of the existing interior settings (combination of the architectural envelope and the interior orchestration) and their relation to the window views. In this phase, the researcher would need to have a furnished floor plan, and make sure the furniture is in the same places as in the physical space. Then, the researcher would systematically be seated in each workstation and on all the other available seats and take a photograph when raising one's gaze from the screen as the occupant would do. The machine vision-based analysed photographs would then be categorized similarly to the participants' self-reported photographs. - This way, it would be possible to concretize what is the real variation in the affordance of available workstations or other places available for working, even if not designed as such.

5 CONCLUSION

In the workplace, the growth of hybrid work following the COVID-19 pandemic has led to an unwanted decrease in office attendance. In this paper, we initiated the development of an indoor photo analysis method to support documentation and analysis of the physical environment from a worker's view. Since we are conducting interdisciplinary research together, the goal of this paper was also to find out how we could produce quantified data from visual material analysis, but it would still be relevant for architectural researchers. This way, we could combine (or compare) the quantified visual material with numeric data produced by other disciplines, e.g., survey responses or data from wearable devices.

In this paper, the indoor photo analysis was developed from the outdoor (and semi-outdoor) photo analysis we have been working with earlier. In both the indoor and outdoor photo analyses, the material was thought to be the workers' self-reported photographs collected from the participants by the mobile-based experience sampling method (ESM). Both analyses originated from the existing PPSA analysis (Kedra 2013). The photo analysis phase was planned to take advantage of machine-vision (MV) analysis, which would support handling large quantities of photographs. This paper's

theoretical content is related to the domain-specific extension of the JD-R theory, the Environmental Demands-Resources (ED-R) model, and the Attention Restoration Theory (ART). The photo analysis was planned to support the ED-R strategy, which involves mitigating environmental demands and resources through a design knowledge perspective with an affordance-based approach.

In this paper, the introduced quantified photo analysis for indoors, compatible with the outdoor one, was based on eight visual elements divided into three categories: *Nature* (sky, ice or snow, water, greenery), *Static* (built environment (outdoors)/architectural envelope (indoors)), and *Dynamic* (furniture (i.e. interior orchestration), people and vehicles) visible in indoor views or window views (from inside to outside). The percentage of each visual element in every photograph would be analysed by AI-based machine vision analysis. After the MV analysis, the photos would be grouped by visual categories, each visual element belonging to one of the three categories: Nature, Static or Dynamic. The rating of the photographs would still be preliminary to (only) support the combining or comparing processes with the quantified data produced by the other disciplines. The (possible) evidence would be produced from this comparison process with the other disciplines' researchers. As a secondary purpose, we proposed that photo analysis could also be used as a researcher's tool for systematic documentation of office environments.

We are aware that the interdisciplinary research setting necessitates following national ethical guidelines by acknowledging each discipline's conventions and following the strictest. All phases of photo analysis, from collecting images to their processing and storage, as well as analysis, grouping, and combining with other materials, are necessary to evaluate in the ethical review.

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Acoustic Privacy, Personality Traits and Burnout - Potential Insight into Office Working Preferences in the UK

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ABSTRACT

The relationship between personality traits and burnout has been researched extensively. The current study aimed to investigate the relationship between acoustic privacy, personality traits and burnout in offices. Although the link between acoustic privacy and burnout is less clear, the evidence shows that acoustic privacy contributes to stress levels, distractions, the ability to concentrate and job satisfaction.

A quantitative approach with a cross-sectional correlational design was used to measure the correlations between acoustic privacy, personality traits, and burnout and the relative contributions of acoustic privacy and five dimensions of personality to reported levels of burnout in UK office workers. The assessment used the GABO (French acronym for acoustic annoyance in open-plan offices), Mini IPIP-BFM (International Personality Item Pool – Big Five Personality Model) and MBI (Maslach Burnout Inventory) scales, consisting of 57 questions, to measure acoustic privacy, personality traits and burnout.

Significant correlations were found for all three factors of acoustic privacy for the burnout dimensions of emotional exhaustion and depersonalisation. Significant correlations were found for the personality traits extroversion, agreeableness, conscientiousness, and neuroticism. Of the acoustic privacy factors, noise environment was the strongest contributor to burnout.

Overall, these findings put forward a compelling argument for considering acoustic privacy and personality traits when assessing the causes and implications of burnout in the workplace. Additional usefulness includes assessing the motivations behind preferences for working from home versus the office and implementing subsequent solutions for overall better working conditions.

Keywords

Burnout, Personality Traits, Privacy, Acoustics, Office Workers

INTRODUCTION

British businesses lose thirty-eight days per year per worker due to physical and mental health-related absences. In addition, poor mental well-being and unhealthy lifestyles account for a loss of £39 billion yearly (Vitality et al., 2020). In a meta-analysis conducted by Salvagioni et al. (2017), physical, psychological and occupational consequences of job burnout were identified, along with individual and social impacts, highlighting a significant need for preventative interventions in the workplace. Great Britain has over 20 million office workers (Office for National Statistics, 2022). The role that the

physical workplace plays in contributing to or diminishing positive well-being has been studied extensively (Daniels et al., 2021; Danielsson & Bodin, 2008; Eatough et al., 2014; Hongisto et al., 2016; Scrima et al., 2021; Seddigh et al., 2014).

Seddigh et al. (2014) investigated the interaction between a need for concentration (avoiding distractions), cognitive stress, emotional exhaustion, depersonalisation, personal efficacy and general health. The results showed that those workers who rated their jobs as requiring a higher need for concentration fared worse for distraction and stress when located in an open-plan office (Seddigh et al., 2014). Scrima et al. (2021) investigated the relationship between workplace attachment styles, privacy and exhaustion (one of the three dimensions of burnout). They found that workplace attachment was positively associated with privacy and negatively associated with exhaustion. The authors note that more research on privacy and its relationship to exhaustion would contribute to the body of knowledge (Scrima et al., 2021).

Notwithstanding, defining privacy poses challenges. This includes the inconsistent use of the term, agreed definitions, and a lack of standardised scales, which make comparison and analysis difficult (Moore, 2008; Purwaningtyas, 2019). Altman's (1975) privacy theory described privacy as 'the selective control and access to the self'. In the context of the office environment and office workers, both the physical environment (Altman, 1994; Murgolis, 1999) and the environment inside the mind (Wohlwill & Kohn, 1973) become relevant. Altman's (1975) theory on privacy addresses interpersonal boundary control (ability to regulate and temper one's interactions with others), bi-directional (input and output from oneself and others such as oral communication), and the objective physical environment (walls, doors, furniture), which was further developed by Margulis (1999). In addition, Archeas (1984) posited visual privacy as a vital component of the definition, which is particularly pertinent in the context of the prevalence of today's open-plan office environments.

Hongisto et al. (2016) studied the relationship between the physical office environment, including acoustic privacy, and job satisfaction. Their findings showed adverse effects on worker satisfaction due to increased distraction, reduced privacy, increased concentration difficulties and increased use of coping strategies (Hongisto et al., 2016). Although acoustic privacy was measured, burnout and personality traits were not. However, Lupo et al. (2021) evaluated the association between work environment and perceived burnout levels in a study of healthcare workers. High levels of emotional exhaustion were found, and the participants reported significant deficiencies in the physical environment they worked in, including the marked absence of acoustic and soundproofing privacy. Although this study found the presence of burnout and an associated lack of acoustic privacy, it did not include personality traits (Lupo et al., 2021).

Personality traits have been identified as strong predictors of noise sensitivity (associated with health) and an essential factor affecting concentration abilities (associated with performance) (Seddigh et al., 2016; Shepherd et al., 2015; Stansfeld, 1993). The multiple regression analysis, examined by Shepherd et al. (2015), showed independent effects of the Big Five personality traits (openness, conscientiousness, extraversion, agreeableness and neuroticism) on noise sensitivity. Together, the five dimensions accounted for 33% of the variance in noise sensitivity ($R = 0.57$), supporting their importance as predictors of sensitivity and related health implications such as anxiety and depression (Shepherd et al., 2015).

The WHO (World Health Organisation) classifies burnout as an 'occupational phenomenon' and is defined as a syndrome considered to result from unmanaged workplace stress (WHO, 2022). Burnout consists of three dimensions, emotional exhaustion, personal accomplishment (or efficacy) and depersonalisation (cynicism) and has been studied extensively (Alarcon et al., 2009; Bianchi et al.,

2019; Khedhaouria & Cucchi, 2019; Maslach & Leitner, 2016). Bianchi et al. (2019) demonstrated the interrelatedness of burnout and depression. Khedhaouria & Cucchi (2019) showed accordance with personality traits and burnout depending on the combinations of personality traits. Invasion of privacy was a factor in this study, which included mentoring, traceability, and surveillance, but not acoustic privacy. Significant relationships between personality and burnout are also reported in the study by Morgan and de Bruin (2010). Their study found neuroticism, extroversion, and conscientiousness contributed to the variance of all three of the dimensions of burnout, emotional exhaustion (13%), cynicism (12.8%) and professional efficacy (24.8%) (Morgan & de Bruin, 2010).

The literature supports the relationship between personality traits and burnout (Alarcon et al., 2009; Khedhaouria & Cucchi, 2019; Morgan, 2010). It is the link between acoustic privacy and burnout that needs to be clarified. The evidence does, however, show that a lack of acoustic privacy is related to reported stress levels, distractions, the ability to concentrate and overall job satisfaction (Hongisto et al., 2016; Scrima et al., 2021; Seddigh et al., 2014). Acoustics, personality traits and burnout have been identified as vital components to consider in worker health (Cutiva & Burdorf, 2015; Sharma & Gill, 2016; Berg-Beckhoff et al., 2017), well-being (Seddigh et al., 2014; Daniels et al., 2014) and performance (Hongisto et al., 2016; Daniels et al., 2021; Scrima et al., 2021). Nevertheless, there needs to be studies combining these three elements.

The current study explores the relationships between acoustic privacy, personality traits and burnout in UK office workers. This study further explores the relationships between acoustic privacy, personality traits and burnout in office workers to answer the question of the relationship between acoustic privacy in offices, personality traits and burnout in the workplace. The objectives of the study:

(1) measure the correlation between acoustic privacy, personality traits, and burnout.
(2) to measure the relative contributions of acoustic privacy and five dimensions of personality to reported levels of burnout in office workers.

DESIGN AND METHODOLOGY

This study uses a quantitative approach with a cross-sectional correlational design. Acoustic privacy, personality traits and burnout were assessed in a combined survey consisting of 57 questions. The research questions comprise three separate questionnaires: Acoustic Privacy, Burnout and Personality Traits. The cross-sectional correlational approach was chosen to allow the collection of data from a large pool of subjects and then compare correlational differences between groups.

The participant-specific demographic is UK office workers over the age of 18 years. The inclusion and exclusion criteria considered gender (male, female, other), age and the number of years working in the company.

For acoustic privacy, the GABO questionnaire (French acronym for acoustic annoyance in open-plan offices), developed by Pierrette & Chevret (2019) and included in the ISO 22955 Acoustics — Acoustic quality of open office spaces was used. In its entirety, GABO consists of 67 questions in four sections structured around an assessment of the employees' physical working environment, the noise environment and an evaluation of the consequences of this environment on the employees' health. For brevity and to better encompass the theories and definitions of privacy related to office environments, the second section, 'Assessment of the Noise Environment of your Workspace' was used as the acoustic privacy questionnaire. This section consists of 15 questions and uses a 5-point Likert scale (1 – Strongly disagree/Very dissatisfied; 5 – Strongly agree/Very satisfied), with questions such as 'Please rate your satisfaction level of the noise environment'; 'At your desk, you hear and clearly understand the conversation of your colleagues'. It consists of three factors, noise environment (high sound levels, nearby conversations, people passing by), noise disturbance (are the

sounds in the work environment disturbing) and noise type (people talking, machines, people walking by).

Maslach Burnout Inventory assesses participants' levels of burnout. The original Maslach Burnout Inventory (MBI) (Maslach & Jackson, 1981a) was used and consists of 22 items answered on a 7-point Likert scale from "never" to "daily." The MBI captures three dimensions of burnout: emotional exhaustion (9 items), depersonalisation (5 items) and personal accomplishment (8 items).

The Mini IPIP-BFM-20 (International Personality Item Pool – Big Five Personality Model) questionnaire for measuring the big five BFI personality traits was selected to reduce the brevity of the questionnaire (Donnellan et al., 2006). The Mini IPIP-BFM-20 measures five traits (Openness or Intellect, Conscientiousness, Extraversion, and Emotional Stability) and consists of 20 items. Participants rate each item on a 5-point Likert scale ranging from 1 (disagree strongly) to 5 (agree strongly). Scale scores are computed as a mean item response (John et al., 1991).

Advertisements outlining the purpose of the study and links to the online survey were posted to the flexibility.co.uk website and internet links were shared via website owners and participants themselves on LinkedIn and X (Twitter). If participants chose to click the URL link in the advert, they were directed to the JISC link containing the survey. The participants were given an information sheet with explicit procedural details and ethical guidelines, followed by the Informed Consent form.

DATA ANALYSIS

Data were analysed using SPSS 26 software. The Standard Multiple Linear Regressions were used to analyse the relationship and relative contributions of the predictor variables to the outcome variable. The predictors include acoustic privacy (AP) and the five dimensions of personality: Openness or intellect (O/I), conscientiousness (C), extraversion (E), agreeableness (A), and neuroticism (N). The outcome variables are the three dimensions of Maslach's original burnout inventory, emotional exhaustion (EE), personal accomplishment (PA) and depersonalisation (DP).

RESULTS

A total of 52 participants took part in the study, and the sample consists of females *n*= 23 (44%) and males *n*= 29 (56%). All respondents were over the age of 18 years, and work in a home and/or company office in the UK. Most of the participants, n= 34 (66%) were over the age of 45 years. See Table 1. Sixty-five percent (65%) of participants have worked in their company for five years or more (*M* = 2.54, *SD* = .699) and 31% are working in the company
office 2 days per week (*M* = 3.15, *SD* = 1.66).

Table 1

Participant Age Ranges

Age	*n*	%
18-24	1	2
25-34	6	12
35-44	11	21
45-54	16	31
55-64	14	27
65 and over	4	8

Note: n = 52

The descriptive statistics were calculated on the individual factors for each independent variable. Acoustic privacy contained three factors, noise environment (NE), noise disturbance (ND) and noise type (NT). Personality traits contained five factors, openness or imagination (O/I), conscientiousness (C), extraversion (E), agreeableness (A) and neuroticism (N). The Shapiro-Wilk test showed that all dependent variables were normally distributed. See Table 2.

Table 2

Tests of Normality - Dependent Variables

	Shapiro-Wilk		
Variable	Statistic	*df*	*p*
EE	.97	52	.210
PA	.99	52	.761
DP	.96	52	.093

Note. Normal distribution = p > 0.05

Further descriptive statistics were run, including skewness and kurtosis, where all variables were found to be normally distributed. See Table 3.

Table 3

Descriptive Statistics

Variables	*N*	*M*	*SD*	Skewness	Kurtosis	95% CI	
						UL	LL
O/I	52	3.83	.88	-0.40	-0.72	[3.59, 4.08]	
C	52	3.69	.82	-0.48	-0.47	[3.46, 3.91]	
E	52	3.03	.81	0.43	-0.76	[2.80, 3.25]	
A	52	3.93	.70	-0.41	-0.66	[3.73, 4.12]	
N	52	2.65	.79	0.18	-0.39	[2.43, 2.87]	
NE	52	2.94	.67	-0.01	-0.48	[2.75, 3.12]	
ND	52	2.59	.83	0.10	-0.63	[2.36, 2.82]	
NT	52	3.72	.98	-0.01	2.49	[3.45, 3.99]	
EE	52	3.55	1.23	0.26	-0.65	[3.20, 3.89]	
PA	52	4.43	.84	-0.23	-0.11	[4.19, 4.66]	
DP	52	2.66	1.05	0.40	-0.57	[2.36, 2.95]	

Note. CI= confidence interval, UL = upper limit, LL = lower limit. Openness/Intellect (O), Conscientiousness (C), Extraversion (E), Agreeableness (A), Neuroticism (N), Noise Environment (NE), Noise Disturbance (ND), Noise Type (NT), Emotional Exhaustion (EE), Personal Accommodation (PA) and Depersonalisation (DP). Skewness between -0.5 and 0.5 is symmetrical, between 0.5 and 1 (or -0.5 and -1) moderately symmetrical and < -1 and > 1 highly skewed. Kurtosis between - 2 and 2 is considered normally distributed.

The three dimensions of burnout were further analysed, emotional exhaustion (EE), personal accomplishment (PA) and depersonalisation (DP).

Pearson's correlations were conducted on each of the 3 dimensions of burnout to determine correlation to the independent variables. See Tables 4, 5 and 6.

Table 4

Correlations for Burnout Dimension - Emotional Exhaustion (EE)

Variable	EE	O/I	E	A	N	C	NE	ND	NT
1. EE		-.237	**-.439****	**-.383****	**.512****	-.129	**.490****	**.497****	**.367****
		.091	.001	.005	.000	.364	.000	.000	.007
2. O/I	-.237		.191	.183	-.204	-.196	-.165	-.095	-.043
	.091		.176	.194	.148	.164	.241	.504	.764
3. E	**-.439****	.191		.138	**-.355****	**.289***	**-.352***	**-.398****	-.259
	.001	.176		.330	.010	.038	.010	.003	.064
4. A	**-.383****	.183	.138		-.231	-.068	-.082	-.171	-.215
	.005	.194	.330		.100	.630	.566	.225	.125
5. N	**.512****	-.204	**-.355****	-.231		-.159	.196	.245	-.019
	.000	.148	.010	.100		.261	.164	.080	.892
6. C	-.129	-.196	**.289***	-.068	-.159		-.034	-.127	.109
	.364	.164	.038	.630	.261		.811	.370	.441
7. NE	**.490****	-.165	**-.352***	-.082	.196	-.034		**.782****	**.459****
	.000	.241	.010	.566	.164	.811		.000	.001
8. ND	**.497****	-.095	**-.398****	-.171	.245	-.127	**.782****		**.504****
	.000	.504	.003	.225	.080	.370	.000		.000
9. NT	**.367****	-.043	-.259	-.215	-.019	.109	**.459****	**.504****	
	.007	.764	.064	.125	.892	.441	.001	.000	

Note. n = 52, Significant values in bold, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 5

Correlations for Burnout Dimension - Personal Accomplishment (PA)

Variable	PA	O/I	E	A	N	C	NE	ND	NT
1. PA		.214	**.284***	**.390****	.199	**-.591****	-.171	-.244	.076
		.129	.041	.004	.157	.000	.226	.082	.592
2. O/I	.214		-.196	.191	.183	-.204	-.165	-.095	-.043
	.129		.164	.176	.194	.148	.241	.504	.764
3. E	**.284***	-.196		**.289***	-.068	-.159	-.034	-.127	.109
	.041	.164		.038	.630	.261	.811	.370	.441
4. A	**.390****	.191	**.289***		.138	**-.355****	**-.352***	**-.398****	-.259
	.004	.176	.038		.330	.010	.010	.003	.064
5. N	.199	.183	-.068	.138		-.231	-.082	-.171	-.215
	.157	.194	.630	.330		.100	.566	.225	.125
6. C	**-.591****	-.204	-.159	**-.355****	-.231		.196	.245	-.019
	.000	.148	.261	.010	.100		.164	.080	.892
7. NE	-.171	-.165	-.034	**-.352***	-.082	.196		**.782****	**.459****
	.226	.241	.811	.010	.566	.164		.000	.001
8. ND	-.244	-.095	-.127	**-.398****	-.171	.245	**.782****		**.504****
	.082	.504	.370	.003	.225	.080	.000		.000
9. NT	.076	-.043	.109	-.259	-.215	-.019	**.459****	**.504****	
	.592	.764	.441	.064	.125	.892	.001	.000	

Note. n = 52, Significant values in bold, $*p < 0.05$, $**p < 0.01$, $***p < 0.001$

Table 6

Correlations for Burnout Dimension - Depersonalisation (DP)

Variables	DP	O/I	E	A	N	C	NE	ND	NT
1. DP		-.192	-.027	**-.311***	**-.502****	**.357****	**.386****	**.345***	**.349***
		.172	.851	.025	.000	.009	.005	.012	.011
2. O/I	-.192		-.196	.191	.183	-.204	-.165	-.095	-.043
	.172		.164	.176	.194	.148	.241	.504	.764
3. E	-.027	-.196		**.289***	-.068	-.159	-.034	-.127	.109
	.851	.164		.038	.630	.261	.811	.370	.441
4. A	**-.311***	.191	**.289***		.138	**-.355****	**-.352***	**-.398****	-.259
	.025	.176	.038		.330	.010	.010	.003	.064
5. N	**-.502****	.183	-.068	.138		-.231	-.082	-.171	-.215
	.000	.194	.630	.330		.100	.566	.225	.125
6. C	**.357****	-.204	-.159	**-.355****	-.231		.196	.245	-.019
	.009	.148	.261	.010	.100		.164	.080	.892
7. NE	**.386****	-.165	-.034	-.352*	-.082	.196		**.782****	**.459****
	.005	.241	.811	.010	.566	.164		.000	.001
8. ND	**.345***	-.095	-.127	-.398**	-.171	.245	**.782****		**.504****
	.012	.504	.370	.003	.225	.080	.000		.000
9. NT	**.349***	-.043	.109	-.259	-.215	-.019	**.459****	**.504****	
	.011	.764	.441	.064	.125	.892	.001	.000	

Note. n = 52, Significant values in bold, $*p < 0.05$, $**p < 0.01$, $***p < 0.001$

The regression coefficients and analysis of variance (ANOVA) results showed N, NE and A as having the most significant effect on EE. The results suggest that the model is significant with F = 15.14, p < 0.001 and $R^2 = 0.49$ and adjusted $R^2 = 0.45$ explaining 45% of the variance. Of all the predictor variables entered in the model, only three variables significantly contributed to EE. These were N, with standardised β = 0.4, t = 3.45, p < 0.001 this suggests that for every increase of one standard deviation in N, there is a 0.4 standard deviation increase in EE. NE, with standardised β = 0.4, t = 3.75, p < 0.001 which suggests that for every increase of one standard deviation in NE, there is a 0.4 standard deviation increase in EE. Variable A results showed standardised β = -0.5, t = -2.49, p = 0.016 this suggests that for every increase in one standard deviation of A, there is a 0.5 decrease of one standard deviation in EE.

No multicollinearity was found as the VIF (variance inflation factor) for the predictor variables ranged from 1.07 to 1.04 (see Table 7).

Table 7

Multiple Regression Results - EE

	Unstandardised β	Standardised β	*t*	Sig	VIF
N	0.6	0.4	3.45	.001	1.07
NE	0.7	0.4	3.75	.000	1.05
A	-0.5	-0.3	-2.49	.016	1.04

Note. Emotional Exhaustion -EE, Neuroticism N, Noise Environment - NE, Agreeableness - A

The regression coefficients and analysis of variance (ANOVA) results showed N as having a significant effect on PA. The results suggest that the model is significant with $F = 26.78$, $p < 0.001$ and $R^2 = 0.35$ and adjusted $R^2 = 0.34$ explaining 34% of the variance. Of all the predictor variables entered in the model, only one variable significantly contributed to PA. N, with standardised $\beta = -0.6$, $t = 5.16$, $p = 0.001$ suggests that for every increase in one standard deviation in N, there is a 0.6 standard deviation decrease in PA. See Table 8.

Table 8

Regression Coefficients - PA

	Unstandardised β	Standardised β	*t*	Sig	VIF
N	-0.6	-0.6	-5.16	0.000	-

Note. Personal Accomplishment -PA, Neuroticism - N

The regression coefficients and analysis of variance (ANOVA) results showed A and NE as having the most significant effect on DP. The results suggest that the model is significant with $F = 14.53$, $p < 0.001$ and $R^2 = 0.37$ and adjusted $R^2 = 0.35$ explaining 35% of the variance. Of all the predictor variables entered in the model, only two variables significantly contributed to DP. These were: A, with standardised $\beta = -0.5$, $t = -4.17$, $p < 0.001$ this suggests that for every increase of one standard deviation in A, there is a 0.5 standard deviation decrease in DP. NE, with standardised $\beta = 0.3$, $t = 3.06$, $p = 0.004$ which suggests for every increase of one standard deviation in NE, there is a 0.5 standard deviation increase in DP.

No multicollinearity was found as the VIF for the predictor variables were 1.00 and 1.00 (see Table 9).

Table 9

Regressions - Significant Factors - DP

	Unstandardised β	Standardised β	*t*	Sig	VIF
A	-0.7	-0.5	-4.17	0.000	1.00
NE	0.5	0.3	3.06	0.004	1.00

Note. Depersonalisation - DP, Noise Environment - NE, Agreeableness - A

DISCUSSION

Upon further examination of the dataset, relationships were found amongst all the acoustic privacy factors; these included noise environment, noise disturbance and noise type, and two burnout dimensions, emotional exhaustion and depersonalisation. Relationships were also found between burnout and personality traits; these included extroversion, agreeableness, neuroticism, and conscientiousness.

Emotional exhaustion is a feeling of depleted emotional resources (Laurence et al., 2013; Maslach & Jackson, 1981). All three of the acoustic privacy factors (noise environment, noise disturbance and noise type) and the personality traits extroversion, agreeableness and neuroticism showed significant correlations with burnout. The strongest effects overall included noise environment, neuroticism and agreeableness. These results align with other studies (Laurence et al., 2013; Oseland & Hodsman, 2020; Scrima et al.,2021). The study by Scrima et al. (2021) reported a relationship between privacy and exhaustion. Their results showed that low workplace security attachment is associated with high exhaustion only when privacy is low, where privacy acts as a moderator for exhaustion. Laurence et al. (2013) used two scales of privacy, the experience of privacy and architectural privacy. They also found a negative relationship between levels of privacy on emotional exhaustion, meaning lower levels of privacy resulted in higher levels of emotional exhaustion (Laurence et al., 2013). Noise sensitivity may help to understand these relationships better. Noise-sensitive individuals, as studied by Shepherd et al. (2010), may be negatively affected by low acoustic privacy, resulting in emotional exhaustion.

The personality trait relationships showed that extroversion and agreeableness were negatively correlated, and neuroticism was positively correlated with emotional exhaustion. This relationship between introverted, less agreeable and more neurotic individuals and emotional exhaustion is supported by other studies. Khedhaouria and Cucchi (2019) reported relationships between extraversion and neuroticism and found that four out of five personality traits and burnout combinations included extraversion. In the absence of the extroversion trait, job burnout only occurred in the presence of neuroticism. As in the current study, neuroticism was also shown to predict emotional exhaustion. Neuroticism consists of high-stress responses associated with negative emotions (Barlow et al., 2014), so if the lack of acoustic privacy contributes to increased stress for those with higher levels of neuroticism, then an increase in emotional exhaustion would be a logical conclusion. Morgan and Bruin (2010) found significant correlations with extroversion, conscientiousness (negatively), neuroticism, and emotional exhaustion. The relationship results for agreeableness are less clear by comparison of the literature. Mills and Huebner (1998) found that emotional exhaustion correlated significantly with extraversion, agreeableness, and conscientiousness. However, several studies show no significant correlations between agreeableness and emotional exhaustion (Morgan et al., 2008; Enwereuzor et al., 2017; Kiffin-

Peterson et al., 2011), contradicting this study's findings. Some of the discrepancies may be explained by the use of different scales for both burnout and personality traits in the various studies.

Personal accomplishment is defined as a positive evaluation of achievement at work (Berg-Beckoff, 2017; Maslach & Jackson, 1981). Surprisingly none of the acoustic privacy factors showed significant correlations or effects with personal accomplishment. Significant correlations were found, however, for the personality traits extraversion, agreeableness and conscientiousness. Neuroticism was shown to be the only predictor of personal accomplishment, with 34% of the variance. Khedhaouria & Cucchi (2019) reported that extraversion positively correlated with personal accomplishment, and as in this study's findings, neuroticism was shown to predict personal accomplishment. In other studies, personal accomplishment was associated with more extraverted, agreeable and less conscientious individuals (Barrick et al., 1992; Kiffin-Peterson et al., 2011; Mount et al., 1998). According to Shepherd et al. (2010), extroversion, agreeableness and conscientiousness (negatively) are associated with noise sensitivity. So, it is reasonable to deduce that those individuals who are more extraverted and agreeable and less conscientious may be less affected by a lack of acoustic privacy and less susceptible to burnout.

Depersonalisation is described as attitudes of negativity and cynicism toward colleagues and work (Berg-Beckoff, 2017; Maslach & Jackson, 1981). The data results showed that all three of the acoustic privacy factors, noise environment, noise disturbance and noise type, had significant correlations with depersonalisation. Agreeableness and neuroticism had significant negative correlations, and conscientiousness showed a positive correlation. In the regression analysis, agreeableness and noise environment had the most significant effect on depersonalisation, explaining 35% of the variance. As agreeableness is associated with higher levels of interaction (Kiffin-Peterson et al., 2011; Barrick & Mount, 1991), it could be reasonably deduced that less agreeable individuals experience higher levels of depersonalisation. This was reported by Hochwälder (2006), who found a negative relationship between agreeableness and depersonalisation. The negatively correlated neuroticism may indicate that those who are more emotionally stable experience lower levels of depersonalisation. This inference is also supported in the literature (Bakker et al., 2006; Hills et al., 2004; Kokkinos et al., 2011).

Finally, the number of days worked per week was gathered as background information but has been revealed to play a potentially pivotal role. The data showed that sixty-five per cent (65%) of the respondents worked in the company office less than two days per week. Only fifteen per cent (15%) worked in the company office five days per week. This was much higher than expected. According to the Office for National Statistics (ONS, 2022), more than three-quarters (78%) of those polled said working from home improved their work-life balance, which may explain the increase. Age may be another factor. Over half, fifty-two per cent (52%), of this study's respondents were aged 35 to 54 years. The ONS (2022) study also found that people aged 30 to 45 years were likelier to hybrid work (split time between the home and company office).

LIMITATIONS

Whilst statistically significant differences were found, the effect sizes were smaller than anticipated (small and medium); this could be due to the questions incorporating home working and traditional office workspaces, where differentiating the experiences between the two environments may have been difficult for the respondents.

IMPLICATIONS FOR PRACTICE AND FUTURE STUDIES

Despite the smaller sample size, the results are indicative enough to consider the inclusion of acoustic environments, personality traits and burnout dimensions in workplace questionnaires. This

may be particularly pertinent in deciphering individual behaviours related to homeworking preferences. The inclusion of acoustic environments, personality traits and burnout in future studies would give better insights into the potential development and progression of burnout and enhance the understanding of employee experiences for workplace professionals.

CONCLUSIONS

Significant correlations were found for all three factors of acoustic privacy for emotional exhaustion and depersonalisation. However, no significant correlations were found between acoustic privacy and personal accomplishment. Of the three factors measured for acoustic privacy, noise environment was the only predictor variable for emotional exhaustion and depersonalisation. None of the acoustic privacy factors predicted personal accomplishment. Significant correlations were found for the personality traits extroversion, agreeableness, conscientiousness and neuroticism. Agreeableness and neuroticism were predictors for emotional exhaustion; neuroticism was the sole predictor for personal accomplishment, and agreeableness predicted depersonalisation.

This study supports the hypothesis that there is a relationship between acoustic privacy, personality traits and burnout. It builds on previous research, but uniquely brings together variables that had not previously been compared in one study. Overall, these findings put forward a compelling argument for considering both acoustic privacy and personality traits when assessing the causes and implications of burnout.

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Lighting control for hybrid work offices

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ABSTRACT

During the COVID-19 pandemic, many people transitioned to remote work and never returned back full-time, leaving office spaces often underutilised. Some companies now mandate dedicated office days, which creates dynamic occupancy. On quieter days, only a fraction of the office is used, leading to energy wastage from building systems.

While many building systems can adjust based on metrics related to people count such as carbon dioxide levels, the lighting energy consumption remains constant irrespective of the number of people in the space if area sensors are used. Replacing area sensors with sensors in each luminaire can lower energy consumption in sparsely populated office areas and better respond to the dynamic occupancy resulting from hybrid working arrangements.

This study examined the impact of flexible working on lighting energy usage. It aimed to estimate lighting energy consumption of different hybrid work policies including hybrid, structured hybrid, and in-person. These policies were constructed based on occupancy data from two Finnish offices. The energy consumption analysis focused on both total and utilisation-based energy consumption of the lighting system. Utilisation-based consumption was included to highlight the impact of efficient space use on relative consumption. Both area and individual lighting controls were evaluated.

The findings showed that controlling luminaires individually saved energy in all scenarios compared to area control. Growing utilisation significantly increased energy consumption in individual control in one Site. However, with group control, the consumption remained stable. The other Site on the other hand had constant consumption in all scenarios.

While the advantages of granular lighting controls are well-established in the previous literature, flexible work arrangements may present even more compelling reasons to adopt such systems. This

study provided more insights into the energy savings of granular controls by introducing utilisation-based energy consumption metrics for lighting systems.

Keywords
Flexible work, Indoor lighting, Utilisation, Energy consumption

1 INTRODUCTION

During the COVID-19 pandemic, most knowledge workers transitioned to remote work. Some of these workers never returned to the office full-time (Barrero et al., 2021; Hensher et al., 2023; Leesman, 2022a; Smite et al., 2023). For example, according to a survey conducted by the Leesman Index (2022a) 80% of the respondents were working on a hybrid basis, and less than 10% reported they were working from the office only. Similarly, in Smite et al., (2023) most respondents preferred hybrid work over in-person or remote work. Consequently, office spaces designed for higher occupancy are now often underutilised, leading to unnecessary energy use, especially in systems like ventilation or lighting designed for larger crowds.

Now that the pandemic is over, some companies are encouraging their workers back to the office (Bloom, 2022; Smite et al., 2023; Smith, 2023). To bring people back to the office while maintaining the flexibility of remote work, some companies have agreed on minimum days of the week that the workers must spend at the office (Smite et al., 2023). This policy is described as structured hybrid work by Samuels et al. (2024). Although a minimum number of days would be agreed on, the occupancy is not evenly distributed across the office days. It seems, for example, that the most popular remote days are Monday and Friday (Leesman Index, 2022b; Samuels et al., 2024).

Hybrid work has led to more dynamic office occupancy (Mantesi et al., 2022). Occupancy-based building system controls have been introduced to adjust to these changing occupancy patterns and reduce energy consumption (Anand et al., 2022). For instance, occupancy-based controls are widely implemented in lighting applications (Haq et al., 2014). These systems commonly detect presence using passive infrared (PIR) sensors, chosen primarily for their cost-effectiveness. Typically, these sensors are installed to govern all luminaires within a designated area meaning that all luminaires in the area illuminate if someone enters the space (Guo et al., 2010). Therefore, the number of people in the space does not necessarily impact the energy consumption.

To maximise energy savings of occupancy-based lighting controls, some manufacturers have begun equipping each luminaire with a PIR sensor, enabling highly granular control. Using these smaller control groups save energy as demonstrated by De Bakker et al. (2017), Galasiu et al. (2007), Rubinstein & Enscoe (2010), and Snyder (2020). The greatest energy-savings of controlling luminaires individually should be realised when office space utilisation is low. On contrary, if the space is fully occupied, all luminaires are on regardless of the control style. In addition to energy savings, granular control was found to be accepted by users by de Bakker et al. (2018). Therefore, granular lighting control has the potential to save energy and satisfy user needs. Further in this paper, granular control is denoted as individual control to highlight that each luminaire is controlled individually and has a co-located PIR sensor.

In general, remote work has been found to reduce personal carbon footprints primarily due to reduced commuting (O'Brien & Yazdani Aliabadi, 2020; Wu et al., 2024). Besides reducing commuting,

decreased office presence lowers energy consumption by using less electricity for appliances and requiring less heated water. However, according to Dooley (2011), Huovila et al. (2017), and Lindberg et al. (2020), solely focusing on total building energy consumption may encourage minimising building usage, which should not be the objective.

Although, the importance of linking energy consumption and building use have been acknowledged, most building energy consumption metrics do not consider building use. Nevertheless, some metrics include the number of users or utilisation to highlight how many people benefit from the energy used in a building. For example, an energy calculation formula proposed by Forsström et al. (2011) calculates specific energy consumption (SEC) adjusted for utilisation rate:

$$SEC_{UR} = \frac{Q}{u * A}$$

where *Q* is energy consumption, *u* is time-based utilisation defined as occupied time divided by total observation time and *A* is the floor area. A similar way of estimating the energy consumption of lighting systems is used in this study. This will be further denoted as utilisation-based energy consumption. The problem with this method is that it does not consider the number of people in the space. However, the occupancy data from lighting systems is usually PIR data that does not describe the number of people. Therefore, estimating energy efficiency based on utilisation is more generalisable.

It appears that hybrid work arrangements are becoming increasingly established, despite some companies urging employees back to the office. This study examined the impact of this hybrid work on lighting energy usage. Previous studies on granular lighting control have not discussed utilisation-based energy consumption to the authors' knowledge. In this study, the energy consumption was assessed with a focus on both the total energy use of the lighting system and the utilisation-based consumption. The research question was: how do lighting energy consumption and utilisation-based energy consumption change between different office occupancy scenarios and control methods? Introducing utilisation-based energy consumption metrics to the lighting field can illuminate how efficiently energy is used in relation to occupancy.

2 Methodology

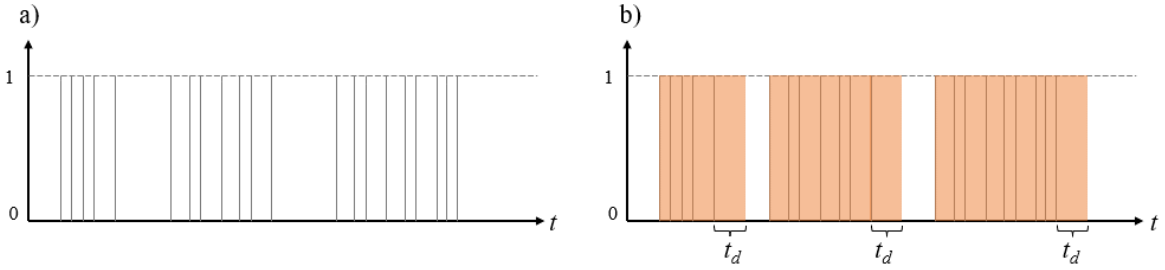
This study was conducted with real-life occupancy data as a basis for simulations. Occupancy data were collected from two office spaces in southern Finland with PIR sensors that were co-located with each luminaire. Occupancy measurements were taken over June 2023, a period in Finland known for varying occupancy due to the start of summer vacations. Weekends and other national holidays were excluded from the data and the final observation time was 21 days. As the number of luminaires in Table I suggests, Site A was a larger space than Site B with more luminaires and PIR sensors. Table I additionally details the number of control groups and luminaires per group for area control. These groups were organised based on the floor plan combining luminaires within the same working area. In total, there were 85 luminaires, each equipped with a PIR sensor with a reported 108° field of view.

Table I: Number of luminaires and lighting control zones per site.

	Site A	Site B
Number of luminaires	57	28
Number of zones	3	2
Luminaires in zones (Zone 1, Zone 2, Zone 3)	16, 25, 16	14, 17

The data comprised time-series recordings of PIR triggers in a binary format where '1' indicated occupied and '0' indicated unoccupied states. These triggers occurred at 6 seconds time delay (t_d), and if no subsequent triggers were detected within this period, the state reverted to unoccupied. In instances where two triggers occurred within the 6-second interval, they were combined to denote consecutive presence (refer to Figure 1). Consequently, even after the last trigger, the space was considered occupied for an additional 6 seconds, as illustrated in Figure 1. The data described how many times a PIR sensor had triggered. Number of people was not revealed in the data.

Figure 1: a) Time series of PIR triggers. b) After a trigger the space is interpreted as occupied for td. Triggers that are closer than time delay t_d are combined to indicate presence.



After the data were collected, office policies were constructed. These policies were based on time-based utilisation because the number of people was not revealed in the data. Time-based utilisation means that the occupied time calculated as shown in Figure 1 was divided by the total observation time. This utilisation was calculated for each day separately by calculating the average utilisation of the sensors in the space. These days were then categorized into low, medium, and high utilisation profiles. The days were put in order based on their utilisation and divided into three categories. Subsequently, the average utilisation of the profile was calculated. Each profile consisted of seven days.

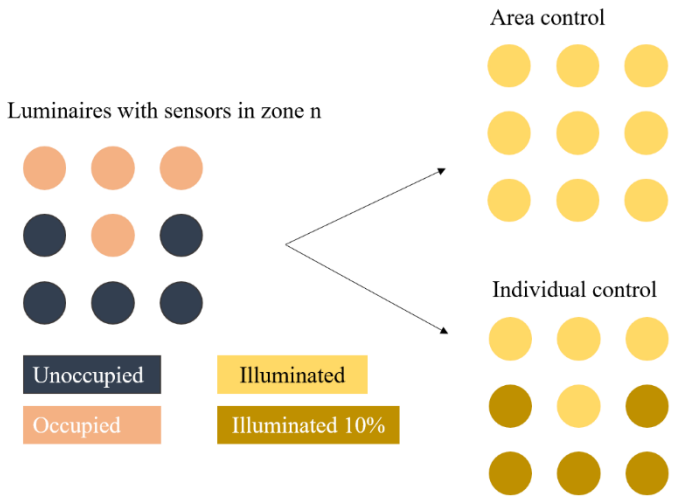
The office policy scenarios were then constructed using low, medium, and high utilisation profiles. Table II shows how a working week was constructed for each policy by using these profiles. Three scenarios were chosen for this study: (1) low presence, (2) medium presence and (3) high presence. These scenarios resembled hybrid, structured hybrid and in-person office policies. In a hybrid scenario all workers get to choose where they work; hence, the total utilisation was the lowest and the most popular office days had only medium utilisation. The medium presence policy, namely structured hybrid, was chosen to resemble two dedicated days at the office. In this scenario, the utilisation increases compared to the hybrid policy, but people still prefer to work Monday and Friday remotely. The in-person scenario was built on the assumption that at least most of the workers are at the office full time and therefore the utilisation stays consistently high.

Table II: Office policy scenarios built with the low, medium, and high day profiles.

	Monday	Tuesday	Wednesday	Thursday	Friday
Low presence/ Hybrid	Low	Medium	Low	Medium	Low
Medium presence/ Structured hybrid	Medium	High	Med	High	Low
High presence/ In-person	High	High	High	High	High

Energy consumptions were calculated based on the estimated times that the luminaires would be on according to the occupancy data in each scenario. The approach was chosen because the study did not account for different types of luminaires. In area control, if one PIR sensor in the area detected movement, all the corresponding luminaires illuminated to maximum brightness as shown in Figure 2. In individual control, only the co-located luminaire triggered to a maximum, and other luminaires in the area to 10%. This factor was included because having all other luminaires off would deteriorate lighting conditions. In both scenarios, the luminaires would remain on for an additional 5 minutes after the last trigger to prevent false-offs.

Figure 2: Area control and individual control with the same occupancy.



Lighting energy consumption was calculated following the method in De Bakker et al. (2017), estimating luminaire operating times for each scenario. The energy consumptions were calculated as follows:

$$\text{Luminaire on time (area control)} = \sum_{i=1}^{n} (t_{p,z_i} \times 1 + t_{a,z_i} \times 0)$$

$$\text{Luminaire on time (individual control)} = \sum_{i=1}^{n} (t_{p,z_i} \times 1 + t_{x,z_i} \times 0.1 + t_{a,z_i} \times 0)$$

Where $t_{p,zi}$ describes presence in lighting control zone z_i, and $t_{a,zi}$ describes the absence from the lighting control zone z_i, and $t_{x,zi}$ represents the luminaires that do not detect movement but are illuminated because at least one other luminaire detects presence in lighting control zone z_i. The weekly consumption was formulated for each policy using utilisation profiles as presented in Table II. The consumption for each profile was an average from the observation days withing that profile. Then the total weekly consumption was divided by the observation period and the number of luminaires. This is further denoted as the base consumption, and it was calculated as follows:

$$\text{Base energy consumption} = \frac{total\ on\ time\ of\ luminaires}{total\ time \times number\ of\ luminaires}$$

The utilisation-based consumption was calculated by dividing the base consumptions by the average time-based utilisation as described in Forsström et al. (2011). This utilisation-based energy consumption was calculated as follows:

$$\text{Utilisation-based energy consumption} = \frac{base\ energy\ consumption}{average\ utilisation}$$

Finally, weekly utilisation-based consumption was calculated similar to base consumption.

3 Results

Table III shows the average utilisations per day for both 24-hour periods and from 8 am to 6 pm. Including office hours allows for comparison with similar studies and reports. The data reveal that the offices had similar patterns, with Tuesday, Wednesday, and Thursday having the highest utilisations. Site B demonstrated a slightly higher average utilisation compared to Site A. Site B also had more consistent utilisation between the days. The average utilisation rose when only office hours were considered and the maximum average daily utilisation then for Site A was 14.8%, while for Site B, it was 10.3%.

Table III: Average utilisations for each weekday for office hours and entire day.

Average utilisations	Site A [%] (24 hours)	Site B [%] (24 hours)	Site A [%] (8 am – 6 pm)	Site B [%] (8 am – 6 pm)
Monday	1.9	3.4	4.1	7.2
Tuesday	2.9	4.0	6.1	8.4
Wednesday	3.9	3.7	8.2	8.1
Thursday	3.4	3.6	7.4	7.9
Friday	1.9	2.1	4.0	4.4

The utilisation profiles used for energy calculations are shown in Table IV. As noted in the table, Site A has more variation in the utilisation. The difference between low and high profiles was 3.12 percentage points for Site A, compared to 1.34 percentage points for Site B. Nonetheless, both offices displayed relatively consistent low utilisation, particularly when considering a 24-hour observation period. The 24-hour utilisation was used to calculate the utilisation-based energy consumption.

Table IV: Utilisations of the day profiles used to construct the office policies. Utilisations are calculated for 24-hour observation time and office hours to aid clarity.

	Utilisation [%]		
	Low	Medium	High
Site A (24 hours)	1.26	2.71	4.38
Site B (24 hours)	2.73	3.78	4.07
Site A (8 am-6 pm)	3.22	6.68	10.92
Site B (8 am-6 pm)	5.47	7.17	9.66

As mentioned, energy consumptions were calculated by dividing the time that the luminaires remained on by the total observation time. Therefore, the maximum base consumption was 1, indicating that all luminaires would be on all the time. Table V displays the base consumptions for all three office policy scenarios and two control methods.

Table V: Relative base consumption for sites of both sites for one week.

	Hybrid	Structured hybrid	In-person
Site A: Base consumption			
Area control	0.43	0.45	0.46
Individual control	0.24	0.29	0.33
Site B: Base consumption			
Area control	0.45	0.48	0.51
Individual control	0.35	0.38	0.40

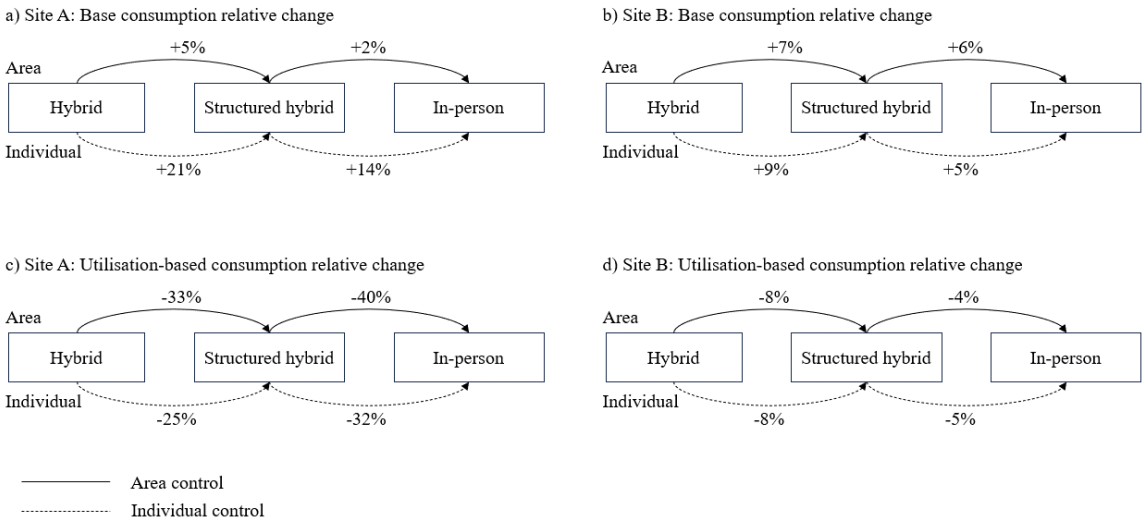
The utilisation-based energy consumptions were calculated by dividing the consumption associated with the low, medium, and high day profiles by their respective average utilisations. Hence, the utilisation-based energy could be higher than 1. Subsequently, the energy consumption was recalculated for the office policy scenarios. These utilisation-based results are presented in Table VI. The findings indicate that utilisation-based consumption tends to be lower in scenarios with a higher occupancy. Similar to base consumption, Site A shows a larger difference in energy consumption between area and individual control. On the contrary, Site B demonstrates more consistent energy consumption, even when divided by utilisation.

Table VI: Utilisation-based relative energy consumption of both sites for one week.

	Hybrid	Structured hybrid	In-person
Site A: Utilisation-based consumption			
Area sensors	26.04	17.56	10.49
Individual control	14.17	10.56	7.19
Site B: Utilisation-based consumption			
Area sensors	14.30	13.16	12.58
Individual control	11.23	10.29	9.80

The relative changes between office policies and control scenarios are illustrated in Figure 2. In Site A, the results indicate considerable differences in energy consumption between area control and individual control. Area control showed only minor variation between different policy scenarios, with an increase of only 7% from the hybrid to the in-person scenario. On the contrary, individual control demonstrated a more substantial difference, with a 38% increase in base consumption from the hybrid to the in-person scenario. Results from Site B differed from those of Site A, with no significant difference between control methods: 13% increase from the hybrid to the in-person with group control and 14% increase with individual control respectively. Nevertheless, the energy consumption of individual control consistently remained lower than that of area control. In Site A, individual control saved 28-44% of energy, and in Site B, it saved 21-22%.

Figure 2: a) and b) show the relative changes in base consumption between different office policy scenarios. c) and d) show the relative change when the utilisation factor is included. Area control is marked with a line and individual control with a dashed line. The arrows represent an increase or decrease in energy consumption from one policy to another.



4 Discussion

This study calculated the base and utilisation-based energy consumptions for individual and group lighting control for different office utilisation scenarios. The results were as expected: when spaces are used less efficiently, the energy consumption related to utilisation increases. This increase was also observed in Huovila et al. (2017).

The two sites showed different results. On one hand, Site A responded more effectively to changing utilisation levels. The difference in energy consumption between work policies was substantial when individual control was implemented, whereas it was minor with group control. On the other hand, Site B showed almost no response to the utilisation level, with consistent energy consumption across office policy scenarios. The likely reason for this disparity was that Site B had more consistent utilisation. Additionally, luminaires at Site B were situated closer to an aisle, resulting in more individuals passing by and activating the luminaires, even if they did not spend time in the area. In contrast, Site A had larger open spaces.

This study further highlighted the energy-saving potential of granular lighting controls already discussed in previous studies. For example, Snyder's study (2020) found that installing a PIR sensor in each luminaire and keeping the luminaires ungrouped resulted in approximately 29% energy savings compared to when they were grouped. Similarly, in the study by De Bakker et al. (2017), energy savings ranging from 25% to 30% were reported, depending on occupancy patterns. This current study demonstrated savings ranging from 21% to 44%, which aligns with the reported savings in previous studies. Although the savings were considerable, factors such as the time delay before luminaires turn off after the last trigger, and the brightness of other luminaires in the area, may limit these savings.

Consistent with previous studies (Huovila et al., 2017; Lindberg et al, 2017), higher utilisation-based energy consumption was observed when spaces were less utilised. In (Huovila et al., 2017) one of the findings was that occupancy levels have only a minimal effect on building energy consumption. Similar results were observed in this study with group control. However, individual control demonstrated the potential to align the energy consumption of a lighting system with occupancy levels, particularly in Site A, which demonstrated greater variability in the utilisation profiles. Although individual control has energy-saving potential, it may be more expensive to install than traditional group control because more sensors are needed. However, Snyder (2020) suggested that the payback time for such a system should be less than three years. Additionally, controlling each luminaire

individually affects lighting conditions and user acceptance. De Bakker et al. (2018) reported promising results regarding user satisfaction, but further studies are needed to ensure that individual luminaire control does not compromise lighting conditions.

This study had limitations regarding the use of utilisation levels as office policies. Some approximations were necessary due to the lack of precise data on the number of people present. Moreover, the supporting literature on office utilisation in hybrid arrangements was scarce and most of the studies concentrate on how hybrid work should be arranged (Smite et al., 2023; Yang et al., 2023). However, despite these limitations, this study provided valuable insights into how declining utilisation due to hybrid work affects relative lighting energy consumption. In future studies, more sites should be included, and a larger dataset should be collected to determine the dependency between utilisation and the energy savings of individual control. Understanding this dependency would be beneficial for evaluating the potential savings of individual lighting control at a given site.

5 Conclusion

Hybrid working has rapidly gained traction during and after the COVID-19 pandemic. Despite offices reopening, many individuals have opted to continue remote work, leading to dynamic space utilisation. While reduced occupancy can save energy in terms of absolute consumption, metrics accounting for space efficiency often reveal a different picture. This study aimed to illuminate how hybrid work arrangements impact base and utilisation-based lighting energy consumption. Additionally, the goal was to assess the differences between area control and individual control methods.

The findings indicate that reduced occupancy does not necessarily translate to energy savings when area control is employed. Site A demonstrated that individual control resulted in greater energy savings during periods of lower utilisation, leading to more consistent utilisation-based consumption. Conversely, Site B did not align with this observation and exhibited relatively consistent energy consumption across utilisation levels. Nonetheless, both sites supported the hypothesis that the introduction of hybrid work, and consequently lower utilisation, decreases total energy consumption but increases utilisation-based consumption.

The results of this study further encourage the use of individual lighting controls, as they consistently showed lower energy consumption compared to group controls. Additionally, calculating utilisation-based consumption revealed that as occupancy becomes more dynamic, the relative savings from individual control may increase more. Although utilisation-based metrics do not resemble real energy consumption they can shed light on how many people benefit from the energy used. This information is valuable for evaluating how effectively a building system responds to lower utilisation levels resulting from new ways of working.

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Session 4B: Research and Learning Spaces

A field study of space-efficiency in office arrangement for a research organisation

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ABSTRACT

The office spaces occupied by the Finnish Meteorological Institute (FMI) have been recently renovated to reduce the floor area occupied by the institute. Most of the individual 11-m^2 rooms have been converted to larger rooms, some rooms stayed intact but got more occupants, a few stayed in their original single-occupant configuration. After the COVID pandemic, a hybrid work model has been adopted by FMI, so the workers can opt for partial remote work while still having assigned seats. We performed a small study of efficiency of the office space usage after the renovation at one floor of the FMI building. Two quantitative objective measures were considered: seat utilisation rate and area efficiency (seat utilisation rate per unit floor area). Both parameters were evaluated via fraction of time a seat is occupied during working hours. The results show that the seat utilisation rate of a room decreases with the number of seats in the room, but is not affected by per-seat floor area. By far the best area-efficiency was obtained for 11 m^2 two-seat rooms and some single-seat rooms. Larger rooms have significantly lower efficiency even without accounting for the excess need for meeting spaces for people seating in multi-seat rooms. Based on the study results, several possible options of possible future arrangements have been analysed and the most efficient solution with small single-seat rooms identified. The study provides an evidence-based foundation for measures towards the targets stated in the decision of Finnish government on office space premises.
The study is an initiative project and might not reflect the position of the administration of the Finnish Meteorological Institute.

Keywords:
Activity-Based Workspace, Open-Plan Office, Utilisation Rate, Space Efficiency, Research Environment

1 INTRODUCTION

Reduction of the governmental office premises is a core part of the Finnish governmental strat- egy accepted in December 2022. The key target parameter, the effective office floor area of 10m^2 per employee, was set as the primary goal. One way to achieve it was a conversion of personalised working environment into activity-based workspaces with unnamed seats. The number of such seats was suggested to be about 70% of the total staff count. The advantage of such a type of arrangement is extensively promoted by the governmental experts and affiliated companies (Franssila and Kirjonen, 2020). On the other hand, there is a strong scientific evi- dence that a cellular office structure with assigned seats and 1-2 persons per room results in the best performance expressed in the work done per year per unit of office floor area, and in terms of employee's well being, e.g., recent meta-reviews of Haapakangas et al. (2023), Masoudinejad and Veitch (2023) and Gerlitz and Hülsbeck (2024).

Attempts of "generalization" of the office space can be traced back to a "social facilita- tion hypothesis" of the 20th century, which argued for removal of barriers from office space to increase collaboration, e.g., a review of Geen and Gange (1977). From the beginning, some motives of the social facilitation proved to be controversial (learned fear of failure, anxiety, and anticipatory frustration); objections were also raised by psychologists (Taylor, 1975). Nev- ertheless, the direction was actively supported by high-techs for its apparent lower costs per seat, construction, and maintenance (Brennan et al., 2002; Gerlitz and Hülsbeck, 2024). The theory faced numerous failures in practice when large offices brought a measurable reduction of collaboration and decrease in job satisfaction (Sundstrom et al., 1982; Kim and de Dear, 2013; Kaarlela-Tuomaala et al., 2009). It was also shown that direct financial losses in the open offices, with or without named seats, are bigger than the savings (Roelofsen, 2008; Newsham et al., 2022). The basic reason for the losses is caused by the fact that the personnel costs exceed the costs of office space at least ten-fold (about 20x in FMI). As a result, even a small reduction of the staff performance outweighs all apparent savings in the office costs.

The studies specific to the research/academic premises (Gorgievski et al., 2010; Parkin et al., 2011; Berthelsen et al., 2018, and references therein) advocate single-occupant office as most healthy and productive working environment. These studies are predominantly based on ques- tionnaires and other sociological and psychological approaches. On the other hand, the propo- nents of "modern office arrangements" stress the cost efficiency of activity based workspaces and explain the dissatisfaction of the staff with the new office structures by conservatism and reluctance to adopt the modern working practices (Franssila and Kirjonen, 2020). The bulk of these studies, however lacks objective measures for staff productivity, office attractiveness, and suitability.

The goal of the current study is to develop simple quantitative and objective criteria mea- suring an overall attractiveness of different office space organization. The study considered one floor of the FMI building as it stood after a renovation 5 years ago, which turned cellular single-occupancy offices into middle- and large-size open offices with named seats. A variety of room sizes and the number of seats allowed for direct comparison of the area efficiency of different office arrangements.

1 METHODOLOGY

1.1 Working hypothesis

Evaluation of the staff productivity in a research organisation is difficult. However, the hybrid- work model of office attendance gives a way to compare the quality of different office spaces in terms of their attractiveness for the employees. The employees have a choice: to bear costs and

inconveniences of the home office or commute to the FMI facilities and use advantages it provides. In each specific case, the decision is affected by many objective and subjective factors, but in average the seat utilization rate in different types of rooms gives a good quantitative measure of how attractive the specific office space is with respect to others. Therefore the seat utilization rate in the environment with free choice for office/remote work can be used to rank room layouts with respect to their competitiveness with remote work from home. Such ranking implies the assumption that the effect of other factors are equal among the rooms, so the absolute figures are not directly comparable among different organisations or even different times.

Since the office costs are normally quantified per unit area, just high utilization rate of a specific room does not necessarily mean the efficient usage in terms of office costs. To quantify the efficiency, one has to divide the seat utilization rate in each specific room by the area of the room. We could not find any established term for this measure, therefore defined "Space Efficiency" (SE) as the seat utilization rate in a room divided by the area of the room. The term can be extrapolated to blocks of rooms or even the whole building. This measure helps in assessing how efficiently the available space is being used with respect to the seat occupancy.

The questions we address are:

1. How the number of seats per room affects the seat utilization rate in the rooms occupied by the FMI research units?
2. Which room sizes and number of seats per room are optimal for FMI research units in terms of the space efficiency?

1.2 Overview of the considered spaces

Table 1: Inventory of rooms/seats at the 3rd floor of the FMI building

Room type	Seats	Room area, m^2	Seat density, m^2/seat	Number of rooms	Total seats	Total area, m^2
11/1	1	11.0	11.0	14	14	154.0
11/2	2	11.0	5.5	23	46	253.0
16/2	2	16.5	8.2	9	18	148.5
16/3	3	16.5	5.5	3	9	49.5
22/3	3	22.0	7.3	22	66	484.0
16/4	4	16.5	4.1	1	4	16.5
22/4	4	22.0	5.5	1	4	22.0
28/4	4	27.5	6.9	6	24	165.0
22/5	5	22.0	4.4	1	5	22.0
33/5	5	33.0	6.6	2	10	66.0
88/16	16	88.0	5.5	1	16	88.0
182/34	34	181.5	5.3	1	34	181.5
total	-	-	6.6	84	250	1650.0

The study was performed at the 3rd floor of the building occupied by several research units of the FMI. The outer building walls consist of the uniformly-sized windows, and the inner walls can only be positioned at window junctures, so the width of the room is determined by the size of the windows. Most rooms have the same depth, so there is only a limited number of room sizes possible: the sizes for most of the rooms are multiple of 5.5 m^2 . Large open-plan spaces do not have separate corridors, so to make the comparison fair we assign the floor area equal to what separate rooms would occupy

at the same place. The summary of the rooms and seats in there is given in Table 1. Hereinafter, the rooms types are labeled as XXX/NN, where XXX is the room area, and N is the number of working seats there. Thus, 11/1 is a single-seat room of
11 m^2 for the seat, 11/2 is the same 11 m^2 room but with two seats and resulting seat density of
5.5 m^2 per seat, and so on.
Apart from the offices, the 3rd floor has laboratories, meeting, and service rooms, which are not considered here.
Before the renovation and squeezing, which was completed in 2020, most of the workplaces were located in 11/1 rooms with small number of 16/2 rooms. During the renovation most rooms have been converted to larger ones. Two large open-plan spaces were arranged, some rooms stayed intact but got more occupants, and a few stayed in their original configuration. In the new configuration the employees have assigned seats, while are mainly free to chose between remote and on-site work mode. Moreover, with some negotiations people can move their workplaces to another room.

2.3 Calculation methodology

To evaluate the efficiency of the workspace usage in a room, we counted the number of occupied workplaces in each room, once or twice a day during working hours: between 10 and 11 AM and/or between 2 and 3 PM during 11–26 January 2023. During each of the observations, all 82 rooms of the 3rd floor of the FMI building were traversed and the occupied seats in each room were counted. The counting was made with a counter app by clicking a button for every ob- served occupied seat. The glass walls of the smaller rooms facilitated quick and non-disturbing observations, while for larger open-office spaces a walk-through was needed. Immediately after the study the same-type rooms were shuffled, and the samples for the same room were shuf- fled to avoid gathering personal information, thus ensuring the GDPR compliance. For each traverse, a time stamp of the last observation was recorded.
Two additional traverses were performed to collect the data on the total number of seats in each room and the area of each room. Only seats with an office chair in front of a computer desk were counted. The room area was roughly estimated from the number of windows along the outer building wall. The resulting inventory of the rooms of different sizes and number of seats is summarized in Table 1.

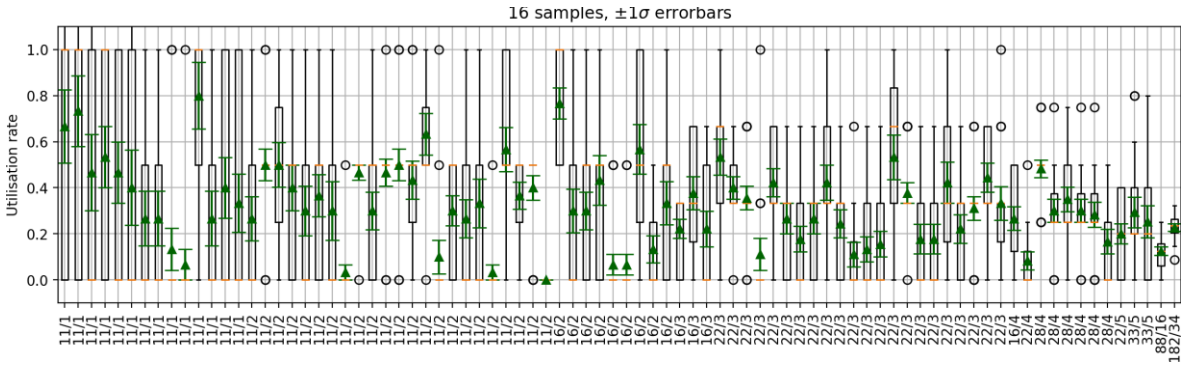


Figure 1: Seat utilisation rate for individual rooms

3 RESULTS

The seat utilisation rates was calculated as average number of occupied seats divided with total number of seats in a room. The utilisation rate during the sampling in each room is given in Figure 1. In the plot the rooms are sorted by number of seats and by the room area. The box- and-whiskers plot shows the 5th, 25th, 50th, 75th, and 95th percentile of the observed utilisation rate. The mean fraction

and its standard error are given with green triangles and error bars. The bars were estimated in the assumption of purely random sampling errors, therefore the bars are larger for room categories with smaller number of total seats.

The plot shows a rather inhomogeneous distribution of the utilisation rate among the indi- vidual rooms. For a single-seat rooms, the rate varies from less than 0.05 to more than 0.8, i.e some single-seat rooms were occupied during vast majority of the samplings, some were mostly empty during the sampling period. Utilisation rate of more than unity was registered when there were more than one person in a single-seat room. Larger rooms are somewhat less inhomoge- neous due to the lower sampling error, though there is a significant diversity of utilisation rate in all room categories.

A simple comparison of the utilisation rate between the rooms with different number of seats (Fig. 2) reveals a clear nearly monotonous tendency: the more seats are in the room the lower is the utilisation rate. The tendency does not hold only for the largest open-plan space, which has in average higher utilisation rate than the second-largest space. Since this difference is well beyond the error bars, it most likely originates from habits and/or schedules of the groups working in these spaces, i.e., a representativeness errors.

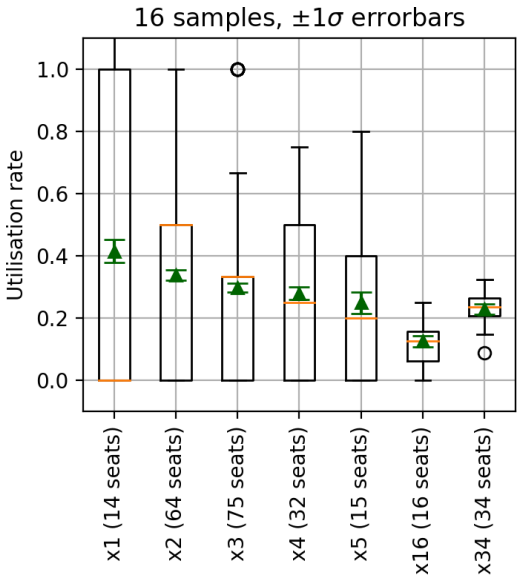


Figure 2: Average utilisation rate as a function of number of seats in the room

The same data disaggregated by room types (Fig. 3, left) indicate that the fraction of empty seats is the same for the same number of seats in a room, at least for 2-seat, 3-seat and 5-seat rooms. There are few different types of four-seat rooms in the floor, which, expectantly, led to a large scatter. Only the 28/4 room type is well represented in our sample.

The same utilisation rates normalised by the floor area of the rooms (space efficiencies) are given Fig. 3 (right). The plot clearly shows that the highest space efficiency is reached in 11/2 type of rooms. Since there are many such rooms, the sampling error is quite small manifesting robust results. A similar efficiency, but with larger uncertainty, has been reached in the most densely-packed room 16/4. However, it is a temporary office arranged for PhD students and therefore cannot be considered representative for the whole floor.

Other room types have significantly lower space efficiency, except for some single-occupancy rooms 11/1, which reached the same efficiency level as 11/2 and de-facto were occupied most of the time.

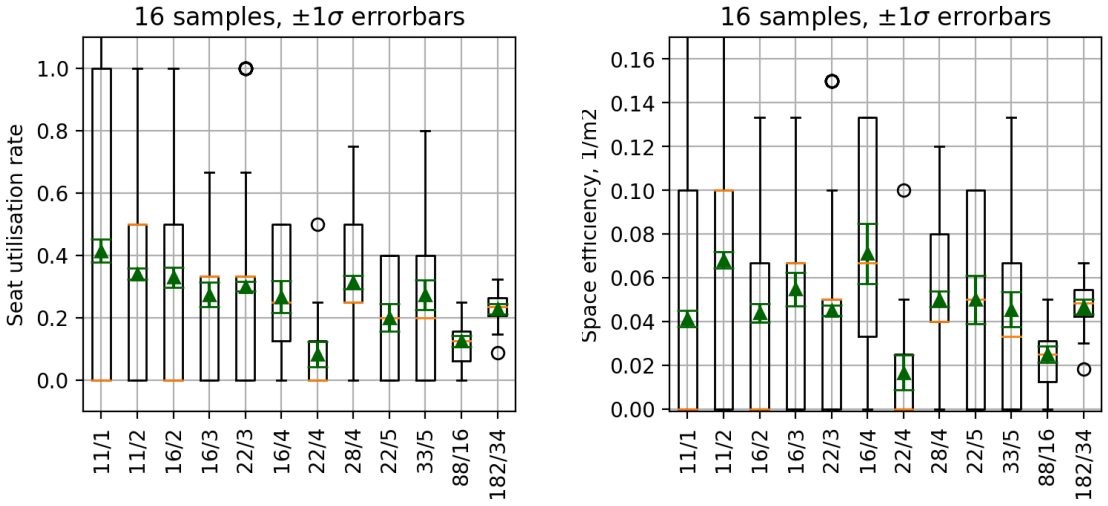


Figure 3: Utilisation rate (left) and space efficiency (right) aggregated by a room type

3 DISCUSSION AND PRACTICAL STEPS

Table 2: Data plotted in Fig. 3, uncertainties given as ± one standard deviation

Room type	Utilisation rate	Space efficiency, 1/m^2
11/1	0.414 ± 0.037	0.041 ± *0.004*
11/2	0.341 ± 0.018	0.068 ± 0.004
16/2	0.330 ± 0.032	0.044 ± 0.004
16/3	0.274 ± 0.039	0.055 ± 0.008
22/3	0.300 ± 0.015	0.045 ± 0.002
16/4	0.267 ± 0.052	0.071 ± 0.014
22/4	0.083 ± 0.040	0.017 ± 0.008
28/4	0.314 ± 0.022	0.050 ± 0.004
22/5	0.200 ± 0.044	0.050 ± 0.011
33/5	0.273 ± 0.047	0.046 ± 0.008
88/16	0.125 ± 0.018	0.025 ± 0.004
182/34	0.227 ± 0.016	0.047 ± 0.003

The results obtained above can be used to evaluate various configurations of the office space in terms of their space efficiency and/or their potential to attract employees to work from the office rather than organising home offices. Let us consider a renovation that splits and/or merges the rooms. The mean utilisation rate U in N rooms can be calculated as

$$U = \sum_{i=1}^{N} UiSi \Big/ \sum_{i=1}^{N} Si \qquad (1)$$

where Ui are utilisation rates for each of the rooms, and Si is number of seats there. The average space efficiency E is then given as a mean utilisation rate divided with total area of the rooms:

$$E = U / \sum_{i=1}^{N} Ai = \sum_{i=1}^{N} EiAi \Big/ \sum_{i=1}^{N} Ai \qquad (2)$$

where Ei and Ai are space efficiency and floor area of each of the rooms. With these equations, one can get the average parameters for any set of the rooms, if their individual utilisation rates and areas are known. The numerical data for utilisation rates and area-efficiencies plotted in Fig.2, are summarized in Table 2. Below we provide a few examples of using these data to estimate the effects of rearranging the rooms.

Table 3: Options for rearranging a 22m² room. Best and worst metrics are highlighted.

Floor plan	Total seats	Room types	Utilisation rate	Space efficiency, 1/m²
	3	22/3	0.300	0.045
	1+2	11/1 & 11/2	0.366	0.054
	2+2	2 x 11/2	0.341	0.068
	4	22/4	0.314 *	0.057*

* extrapolated figures used for 22/4 configuration, see text.

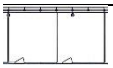
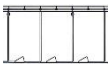
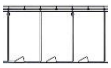
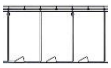
3.1 Splitting a 22m² room

Consider splitting a 22/3 room into two and arranging 3 or 4 seats in the resulting two rooms. In our notations, the 3-seat configuration is 11/1 + 11/2, and 4-seat configuration is 11/2 + 11/2. With the above equations and parameters from Table 2, one can get the effect of such renovation (Table 3). Both options result in an increased utilisation rate and area efficiency, i.e., splitting the 22m² to two

increases both metrics. The 3-seat configuration adds 20% to both scores. The 4-seat configuration boosts the space efficiency by more than 50%, while sill improving the utilisation rate by 20%. Depending on the priorities and specific jobs either of the options can be preferable, but the same construction work is required: a wall that splits the 22m^2 room to two 11m^2 ones.

For comparison, let's consider just adding one more seat to the room. In our notation it would be 22/4. There is only one such room in the analysis, and it is an outlier among the 4- person rooms (Fig 3). Therefore, we assumed that the utilisation rate is not heavily dependent on the room area, and extrapolated the utilisation from much better represented 28/4 room type, which led to efficiency of 0.057 seats/m^2 . The configuration raises the space efficiency to the same level as the 3-seat split configuration, however leaves the utilisation rate almost intact. Therefore, it is clearly a sub-optimal solution that might be used only in a case of a lack of both seats and resources to construct the wall.

Table 4: Options for rearranging two adjacent 16.5 m^2 rooms

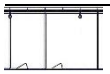
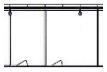
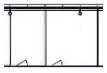
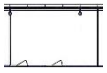
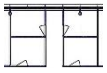
Floor plan seats	total	room types	Utilisation rate	Space efficiency, 1/m^2
	2+2	2 x 16/2	0.330	0.044
	1+1+2	2 x 11/1 & 11/2	0.378	0.050
	1+2+2	11/1 & 2 x 11/2	0.356	0.059
	2+2+2	3 x 11/2	0.341	0.068
	3+3	2 x 16/3	0.274	0.055

3.1 Rearranging two adjacent 16.5 m^2 rooms

Another example is converting two adjacent 16.5 m^2 rooms into three 11 m^2 rooms. As one can see (Table 4), the conversion to smaller rooms improves the efficiency regardless the number of seats in the smaller rooms. The gain varies from 14% in both metrics for 1+1+2 three-rooms configuration up to 50% higher area efficiency with a similar empty-seat fraction for 2+2+2 configuration. Just adding more seats into these rooms, albeit somewhat increases formal area efficiency, significantly reduces the utilisation rate. The conclusion is therefore similar to the previous example: smaller rooms lead to a higher overall office efficiency.

3.2 Small personal rooms

Table 5: Options for adjacent 27.5 m² rooms

Floor plan seats	total	room types	Utilisation rate	Space efficiency, 1/m²
	1+2	11/1 & 16/2	0.325	0.043
	2+2	11/2 & 16/2	0.378	0.054
	2+3	11/2 & 16/3	0.330	0.060
	4	28/4	0.314	0.050
	1+1+1+1	4 x 5.5/1	0.414 *	0.060 *

* extrapolated figures used for 5.5/1 configuration, see text.

Table 5 shows possible rearrangements of an area with 5 windows, an equivalent of 27.5 m² room. The space can be used to arrange two rooms with up to 5 seats with 2+3 configuration, and such a configuration allows for the maximum area efficiency. Apart from using existing room sizes one can arrange more small personal rooms in the existing space. A 4-seats configuration with four 5.5-m² rooms and a small corridor between them reaches the same area efficiency due to much higher utilisation rate in single-occupancy rooms. Probably, the 5.5-m² rooms would need a partly-transparent glass walls in between them, similar to the walls currently used between the corridor and the rooms, to improve the space feeling of their occupants. Because of the need for a corridor the formal area efficiency in such a configuration is slightly lower than for a 11/2 room, but much higher than for other options. In a context of the space-efficiency for the whole-building, the advantage of 11/2 rooms is even smaller, if any, since occupants of 5.5/1 room do not need any additional facilities to arrange remote meetings or 2-3 people face-to-face meetings (see also the next subsection). Moreover, a small space in the end of the corridor can be used for other needs.

Other possible rearrangements can be analysed in a similar manner. In all considered con-figurations, the rearrangement into smaller 1-2-seat rooms was beneficial for both metrics.

Despite the proposed analysis is based on a substantial experimental evidence and is rep- resentative for the site of the study, it should not be considered as a universal solution. Some groups might need larger rooms for work, since the workflows differ among the groups. Deci- sions should be taken on a case-by-case basis.

3.1 Overhead for additional facilities

In this section, we address a so-far poorly quantified variable: a need for additional facilities, such as teleconference rooms and small-meetings rooms, which are inevitable for multi-seat offices. Open and activity-based offices, with named or unnamed seats, were invented long before teleconferences became massive (Wiegand and Sullivan, 2011), therefore neither of them has mechanisms to efficiently exploit this new instrument. The common response to the new challenge is to create dedicated rooms, just like those for ordinary meetings. However, major differences are: (i) there must

be many such rooms, (ii) once made small, these rooms are no longer suitable for face-to-face meetings. Below, we roughly quantify the resulting overhead.

Conservative assumptions on researcher's activities behind the below computations are as follows:

1. in-average, every scientist has one teleconference per day lasting for one hour
2. in-average, every scientist has two face-to-face meetings with another researcher per day lasting for 15 minutes
3. organization of each meeting outside own office requires 10 minutes to find/reserve a suitable free place and to prepare it to the meeting
4. room size for teleconferences is 5.5 m^2
5. room size for small face-to-face meetings is 11 m^2

The first three assumptions are clear under-statements. According to our experience, actual communication activities are much higher, so as the time needed to arrange a meeting outside own office. However, according to a recent large-scale study (Dialpad, 2023), 83% of office workers have between 4 and 12 hours of teleconferences per week, mounting up to a third of their work time. This directly projects to 30-35% of employees being at teleconferences at any specific moment. The forth assumption, the room sizes, are adopted from existing rooms, i.e., realistic. From the first assumption, it immediately follows that every seven seats in multi-seat rooms require a spare teleconference room, in average. (Twice that according to Dialpad, 2023). This reduces the space efficiency of all multi-seat configurations by about 15%, thus rendering all of them highly sub-optimal. From the second assumption, every 15 seats in multi-seat rooms require a spare meeting room. This reduces the efficiency of the multi-seat rooms further by another 15–20%. A temporary migration of an employee to a meeting room for a meeting or teleconference does not reduce the need for a regular workspace: the meeting-related absence is too short to consider the main place free.

An additional complication is that, according to (Dialpad, 2023), Mondays are the most pop- ular day of week to schedule meetings, whereas Wednesdays have the longest meetings, on aver- age. On these days, the demand is higher by 5-10%. Finally, the majority of people (over 60%, https://www.goldenstepsaba.com/resources/time-wasted-in-meetings, visited 20.05.2024) do multitasking during the meetings, i.e., these rooms should provide reasonable working environment rather than being just isolated cubicles. Such a demand, if taken on-top of the main office, turns the promised 30% rent savings (fewer seats than staff count) to at least 10-20% losses, in addi- tion to all above-mentioned problems and overheads of this office organization.

The above spare-room requirements are enormous and are not met even approximately in the current facilities, causing a severe deficit of meeting rooms. This may be one of the drivers for extremely low utilisation rates and space efficiency of the current FMI office: with no chances of performing the normal work in the office, employees are forced to stay home and bear related additional costs and inconveniences, on return obtaining personal offices. From our experience, such a situation increases inequality among the employees, since arranging an efficient personal office at home is prohibitively expensive for those who do not have a spare room for that.

The assumption 3 above allows for quantifying the overhead for switching a room for meet- ings or teleconferences. With 10 minutes per switch, each day the employee would spend one hour solely for changing rooms. Given that office costs are less than 10% of the personnel costs, this overhead alone exceeds the total office costs. Calculations of financial and produc- tivity overheads is beyond the scope of the current study, but we would like to point out that those overheads are by no means negligible and are not in favour of the multi-seat rooms of any kind.

3 CONCLUSIONS

In our study, along with traditionally used utilisation rate metric, we introduced a new space efficiency criterion (a utilization rate divided by the floor area). With these two objective mea- sures, we quantified the efficiency of the office-space usage in a research institute with a hybrid working model. The third floor of the FMI office building has been used as a prominent exam- ple.

The results show that the utilisation rate of a room is higher for smaller number of seats per room. The highest utilisation rate occurs in single-seat rooms.

Somewhat counter-intuitive, the floor area of a room had little effect on the room attractive- ness: the different-size rooms with same number of seats showed nearly-same average utilisa- tion rate.

The maximum space efficiency in average was reached in two-person small rooms, and some of single-person rooms. Rooms with more seats are less efficient since their occupants more often opt for remote work or occupy additional facilities (meeting/teleconference rooms) while present in the office.

Accounting for teleconferences and small face-to-face meetings reduces the space efficiency of all non-single-occupancy rooms by at least 30%, which renders all such solutions highly sub- optimal.

We conclude that the best performance in terms of both metrics can be achieved by arranging the space in small single-person rooms. Besides having good metrics, such arrangement reduces the need for other facilities, which otherwise occupy a very significant area. Small single-person rooms provide a flexible basis for adjusting the workspace for changing needs, since they can be used with minimal adjustments as an efficient assigned workplace for those who work on-site most of their time, as an unassigned silent workspace, phone booth, or a small meeting room for those who often work remotely.

The results agree well with the findings of the studies summarised by Masoudinejad and Veitch (2023), which also suggested that 1-2-person rooms are the optimal arrangement for the office spaces

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The relevance of bricks and clicks. Research insights on strategies in context of informal learning spaces at universities

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ABSTRACT

The COVID-19 pandemic has manifested learning anytime and anywhere which may have accelerated the significance of informal learning spaces (ILS) where students learn independently and self-organised outside of class activities (Cerasoli et al., 2018; Ninnemann 2018; Ninnemann and Jahnke, 2018). In that regard, the interdisciplinary research project NIILS, New Approaches for Inclusive and Informal Learning Spaces, analyses changing needs of users regarding ILS at universities. The aim of the project is to provide data on how availability and accessibility of ILS support students' social integration and well-being.

Linking the behaviour setting theory (Barker, 1978) and models of dropout from higher education (Berger and Milem, 1999), it is assumed that ILS promote social integration (Tinto, 1975) and thereby increase students' well-being (Clark et al., 2007). Methodologically, a mixed-methods approach was integrated combining a quantitative student survey with qualitative methods like semi-standardised focus groups. Data were collected at five partner universities in Austria, Italy, Lithuania, Turkey and Germany. With this contribution, research findings of the German dataset are discussed.

The quantitative results show that the availability and accessibility of ILS are positively related to social integration and well-being. Since social integration is related to dropout rates and student satisfaction, it can be concluded that expanding investments for ILS is essential. However, the qualitative results strongly suggest a more differentiated strategy: Users stated that they did not lack the number of ILS but rather information regarding the availability and accessibility of ILS. As a solution, the development of an online-platform is endorsed by users to provide relevant information. With this approach dynamic usage data of ILS could be also gained and used to derive long-term strategies to support learning anytime and anywhere at universities.

Keywords
Informal Learning Spaces, Well-being, Social Integration, Hybrid University

1 INTRODUCTION

The 21st-century university campus consists of a range of different places such as lecture halls, seminar rooms, offices, libraries, and laboratories, but also informal learning spaces (ILS) in interspaces, such as corridors, niches, entrance areas and outdoor places, to support individual and group work of students (Oblinger, 2006; Skerlak et al., 2014; Ninnemann et al., 2020). The access to information at any time and any place as well as experiences in the COVID-19 pandemic have accelerated learning activities outside of formal learning environments. It can be stated that the increase of online teaching and learning programmes does not lead to a reduction in physical space requirements on campus. On the contrary, an expansion or repurposing of existing areas is necessary for a higher number and diversity of learning environments. This increases the pressure on multiple utilisation concepts for building infrastructures and consequently requires a more complex organisation of space requirements for an expanded repertoire of uses (Ninnemann, 2022; Wissenschaftsrat, 2022).
Against this background the international and interdisciplinary research project NIILS, New Approaches for Inclusive and Informal Learning Spaces, analyses changing user needs and stakeholder requirements of ILS at universities. The aim of the NIILS project is to provide data on ILS available for and used by students in different European countries and to develop recommendations and guidelines for learners, lecturers, university administration, and other stakeholders to mitigate existing barriers in order to support student satisfaction and well-being. Partner universities of the NIILS project, which is carried from January 2022 till June 2024, are University for Continuing Education Krems (Austria), HTW Berlin University of Applied Sciences (Germany), Sapienza University of Rome (Italy), Mykolas Romeris University (Lithuania) and Akdeniz University (Turkey). With this contribution the users' perspective on ILS is presented. Due to the lead of HTW Berlin regarding this project result, the main research findings are discussed with focus on the German dataset.

2 Theoretical Background and research question

As the NIILS partners not only have an international background but also different specialist disciplines, like architecture, facility management, psychology, education, citizen science, communication and management, it was necessary to start with a common ground regarding the definition of ILS. The NIILS project defines ILS as learning environments where students learn according to their individual needs independently and self-organised outside of class activities (Cerasoli et al., 2018; Ninnemann 2018; Ninnemann and Jahnke, 2018). ILS encompass places on the university campus, indoor and outdoor, as well as places off the campus, like home, cafés, public transport, and natural landscapes. According to the behaviour setting model of Barker (1978), physical and social environments evoke certain patterns of behaviour. Physical places that are designed to support certain activities encourage (intended) behaviour patterns and behaviour in turn maintains these places. The library or lecture hall are well-known examples, where places and behaviour stabilise each other over centuries, like being quiet and reading concentrated or being an attentive listener when lecturers speak.

Interestingly, in architecture and environmental psychology learning spaces predominantly evaluated in terms of physical criteria, like light, climate, acoustics, temperature, and furnishing (Ninnemann, 2018; Keser Aschenberger et al., 2022). Studies confirm that physical environmental aspects have an influence on studying, measured as commitment, satisfaction, and learning success (Han et al., 2019) as well as health and well-being (Clark et al., 2007; Rashid and Zimring, 2008), but have not yet been able to provide any clear indicators of the effect of the physical aspects investigated on learning processes (Higgins et al., 2005; Woolner et al. 2007; Kumar et al., 2008; Blackmore et al., 2011; Choi et al., 2013). It is stated that physical and social environmental aspects are by no means two opposing, but rather mutually interpenetrating concepts (Gothe and Pfadenhauer, 2010). However, the underlying process why and how the setting leads to the desired outcomes is unclear.

In that regard, the analysis on users' perspective in the NIILS project is utilising two overarching criteria, availability and accessibility, to link the physical and social environment for the analysis of the appropriation and utilisation of ILS. Availability and accessibility are relevant criteria in the context of education rights and learning spaces, among other aspects like acceptability or adaptability according to the 4-A-model (Tomaševski, 2001) or values, roles and responsibilities according to the model of Learning Space Organisation (Ninnemann, 2018). It is assumed that availability and accessibility of ILS are crucial to support or hinder student interaction as well as establish contact amongst peers to help each other. According to Tinto (1975), a lack of academic and social integration is the key factor of dropouts at universities; social integration reduces dropouts. Beyond that, social integration promotes commitment and satisfaction and leads to the development of relationships, the formation of similar values and attitudes and to personal development (Berger and Milem, 1999). In that regard, the first research question was: A) *Is the relationship between availability and accessibility of ILS and well-being mediated by social integration?* (see Figure 2).

As to understand barriers for inclusive ILS, a special focus lies on students with fewer opportunities (SWFO). These students face challenges regarding a) need to work for living while studying, b) economical obstacles, c) mental diseases, d) physical impairments, e) chronic somatic diseases, f) learning disabilities, g) language obstacles, h) geographic obstacles, i) cultural differences, and k) family related obstacles. Accordingly, the second research question was: B) *Are there differences in the perception of students with and without fewer opportunities regarding availability and accessibility, social integration and well-being?* (see Figure 3).

3 Methodological approach

A mixed-methods approach was integrated, combining a quantitative student survey with an explorative qualitative method (semi-standardised focus groups with students and lecturers) at all five partner universities. The online survey was conducted May – July 2022. An English version of the survey was developed by HTW Berlin and translated by every partner into the respective languages. The student survey was thematically structured as follows:

- Socio-demographic data (i.e., age, gender, living conditions, fewer opportunities) and study data (i.e., study model, full- vs. part-time).
- Focused and collaborative learning activities in ILS (i.e., availability, accessibility, use of places, barriers, satisfaction).
- Hybrid learning activities (i.e., availability of technological devices, virtual places, barriers)

University campus (i.e., commitment, social integration, well-being and satisfaction with campus).
Most of the scales were self-developed, except social integration (French and Oakes, 2004, 6 items) and well-being (Topp et al., 2015, 5 items). Data were transferred from the survey tool (Unipark) into a SPSS-file. Missing data were checked and set up the correct scale levels. Coding for most items was aligned and coded in the same direction (i.e., fully agree = 5, fully disagree = 1); well-being was measured with the WHO 5 item scale (i.e., no well-being = 0, perfect well-being = 100). Item and scale analyses included means, standard deviation, item-total correlation and reliability. Cronbach´s alpha for the central variables ranged between 0.81 – 0.89 indicating satisfying reliability.
The focus groups with 5 – 11 students (including SWFO) and 4 – 8 lecturers took place between May – July 2022. An English version of the interview guide was developed by HTW Berlin. The conceptional frame encompassed four deductive themes:

- Impact of the used ILS on students' and lecturers' knowledge acquisition and satisfaction.
- Existing barriers related to availability and accessibility of ILS conducive to learning and well-being.
- Awareness and enabling strategies to deal with existing barriers.

Final guidelines, including instructions concerning the interview process and coding, were translated by the NIILS partners into the respective languages. Data were transcribed, deductively and inductively coded, and interpreted by using content analysis (Mayring, 2002).

4 key insights quantitative approach

At HTW Berlin n = 327 students participated in the survey. The sample is representative to the student population at HTW Berlin concerning gender and age.

4.1 Descriptive analysis

Most of the surveyed students studied full-time (94%), aimed at a Bachelor´s degree (77%) and were between 21-25 years old (51%). Only 11% stated that they live in a household with minor children or persons in need of care. Many students reported to live at their parents' or relatives' house (29%) and most students commuted quite a distance to the university campus; only 17% lived close by (0 – 4 km). Students at HTW Berlin surprisingly stated a lot of personal challenges. The most prominent one is the "need to work for living while studying" (46%). Additionally, an alarming 19% reported suffering from "mental diseases". Every other challenge is experienced between 3% to 16% of the participants. Only 28% percent reported to experience "none of these" challenges. Accordingly, students reported low average well-being (M = 51.56).

Figure 3. Prominent places used for focused and collaborative learning activities.

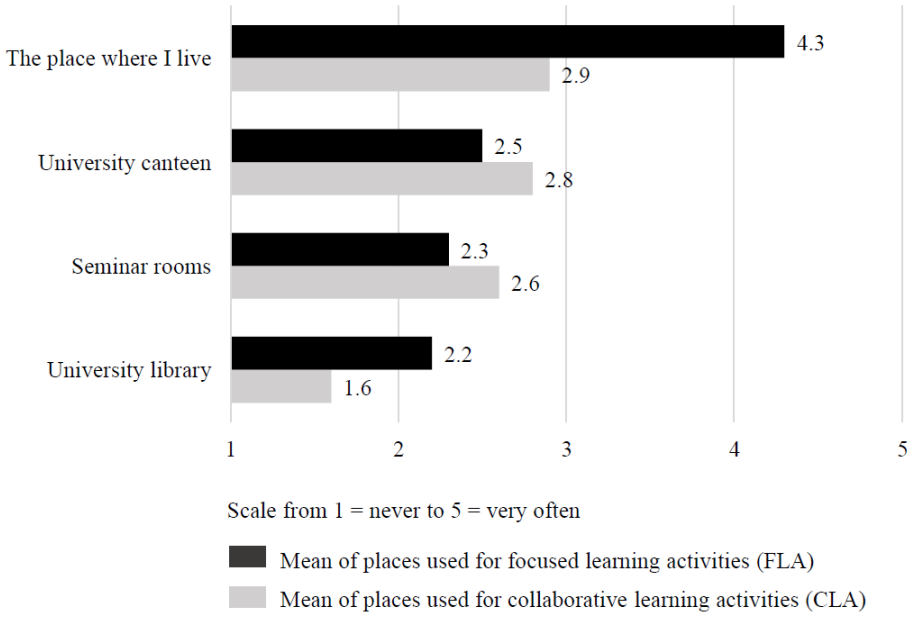


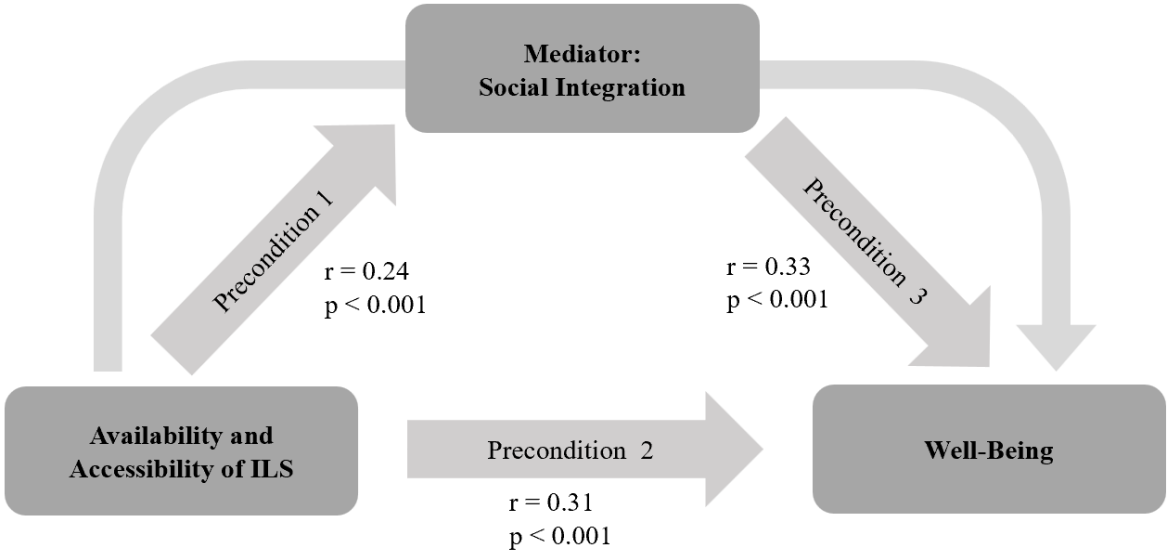
Figure 1 displays the four primary places for focused learning activities (FLA): "The place where I live" was by far the most frequently cited (M = 4.3), followed by "University canteen" (M = 2.5), "Seminar rooms" (M = 2.3) and "University library" (M = 2.2). The accessibility of places for FLA were rated slightly higher (M = 3.51) than their availability (M = 3.38). The primary obstacles of places for FLA were "limited availability (e.g., too crowded)" (64%), and "opening hours" (58%). Conversely, there was no single dominant pace for collaborative learning activities (CLA). Students reported a variety of places, with the top three being "The place where I live" (M = 2.9), "University canteen" (M = 2.8), "Seminar rooms" (M = 2.6), the same places identified for FLA. However, the "University library" was considered less prominent for CLA compared to FLA (see Figure 1). Regarding places for CLA there was almost no difference between accessibility (M = 3.37) and availability (M = 3.44). "Limited availability (e.g., too crowded)" (68%) and "Opening hours" (50%) were perceived as a barrier to use places for CLA as well as for FLA. The mean for social integration was M = 3.48, suggesting students perceive their social integration as moderate.

4.2 Inferential analysis

The first research question was: A) *Is the relationship between availability and accessibility of ILS and well-being mediated by social integration?* To test for the mediation, three preconditions had to be fulfilled, i.e. the three bivariate relationships between the variables must be significant (see Figure 2):

- Precondition 1: The better the availability and accessibility, the greater the social integration of students.
- Precondition 2: The better the availability and accessibility, the higher the well-being of students.
- Precondition 3: The higher the social integration, the higher the well-being.

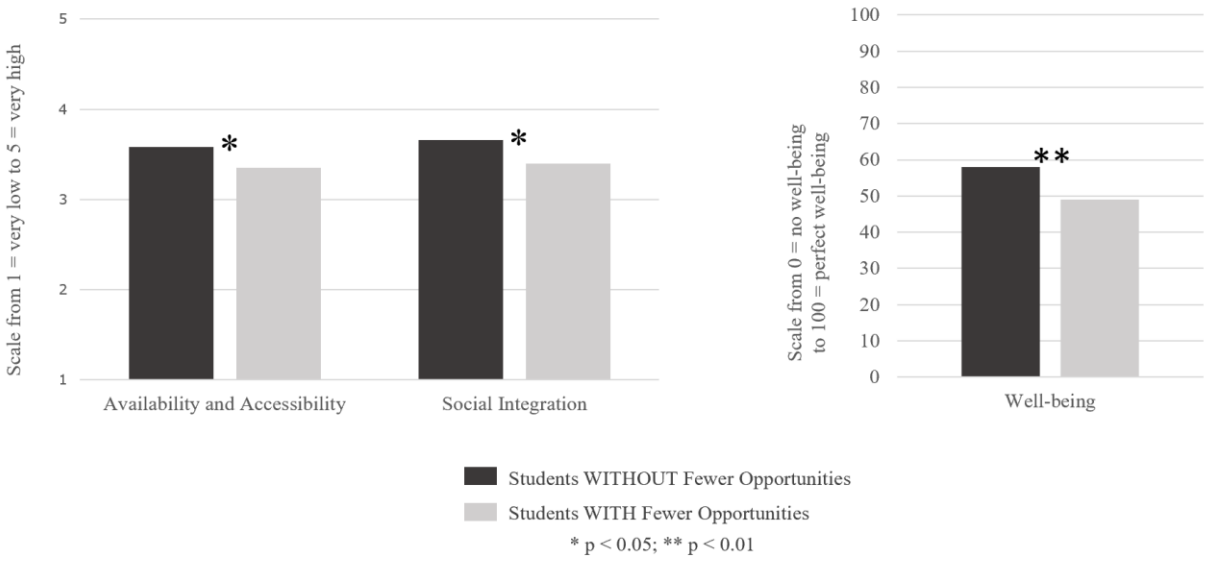
Figure 2. Results of mediation analysis regarding research question A



All three relationships are significant (see Figure 2). Subsequently, we tested for mediation by incorporating all three variables into a regression model. Indeed, the findings support the first research question. Social integration partially mediates the relationship between availability and accessibility of ILS and well-being (direct effect: $\beta = 0.31$; $p < 0.001$, $R^2corr. = 0.09$). After inclusion of the mediator variable, the effect of the independent variable on the dependent variable is reduced (indirect effect: $\beta = 0.23$; $p < 0.001$; $R^2corr. = 0.15$).

The second research question was: B) *Are there differences in the perception of students with and without fewer opportunities regarding availability and accessibility, social integration and well-being?* The data showed that students with fewer opportunities rate the availability and accessibility of ILS as well as social integration and well-being as significantly lower than students without fewer opportunities (see Figure 3).

Figure 3. Overview of results regarding research question B



student integration and foster interactions among students, ultimately promoting higher well-being. According to Tinto (1975), a higher social integration will lead to less dropout. Nevertheless, results do not imply causal relationships. It is also possible that positive social integration leads to increased ILS usage, consequently enhancing the perception of the availability and accessibility.
Looking at the key finding that the availability and accessibility of ILS are related to positive outcomes, one might think that universities should offer more ILS. However, in the qualitative focus groups, we asked for students' and lecturers' perceptions on the availability and accessibility of ILS and explored strategies to promote them, as detailed in the following chapter. For detailed quantitative results, see Geister et al. (2023).

5 key insights qualitative approach

At HTW Berlin, students (n = 5) in Master's and Bachelor's degree programmes from two different study programmes (including 3 SWFO) and lecturers (n = 4) from three different faculties participated in focus groups.

5.1 Informal Learning Spaces and existing barriers

Students identified in total six indoor ILS: seminar rooms, library, corridor spaces, (computer) laboratory, canteen/café and creative spaces, and four outdoor ILS: park/green areas, outdoor-canteen/café, outdoor/inside-yard, beach. Whereas the outdoor spaces can be used for focused learning activities (FLA) and collaborative learning activities (CLA), only three indoor spaces (seminar rooms, (computer) laboratory and creative spaces) can be used for CLA. The library was identified as a place that works only for FLA, and hallway-seating/corridor space and canteen/café only for CLA.
Like in the students' focus groups, the lecturers seemed to have similar knowledge of ILS that students use on campuses (six indoor and four outdoor spaces). However, the lecturers assessed the library and hallway-seating/corridor space as places for FLA and CLA, the creative space only for CLA and the outdoor-canteen/café only for FLA. A lack of available ILS for an exchange between students and lecturers at HTW was acknowledged, leading lecturers to overcome this barrier by organising informal meetings in virtual spaces.
Students extensively addressed existing barriers and weaknesses concerning the availability and accessibility of identified ILS on campuses. Overall, students and lecturers stressed out that the key concern about ILS availability is not mainly a lack in quantity but rather a deficiency in quality due to existing barriers:

- Technological infrastructure (e.g., availability of plugs, WIFI, etc.).
- Environmental factors (e.g., occupancy, noise-level, etc.).
- Ambience (e.g., gastronomic offers, rules for drinking/eating, atmosphere, privacy, etc.).
- Differences among faculties (e.g., inequalities regarding appropriate ILS).

Students and lecturers also identified barriers in context of the accessibility of ILS:

- Restricted opening hours (e.g., library and canteen).
- Registration/controlled access (e.g., technological enhanced learning spaces).
- Restricted access to information (e.g., trial and error approaches to find open and free to use ILS like seminar rooms, lack of room booking system for students, etc.).

- Challenges for SWFO (e.g., remote location of the campus, balancing work and study, students' organisational skills to manage the day).

Given these points, it can be summarised that limited availability of ILS plus restricted accessibility of existing ILS on campus limit students' possibilities to use those places for learning activities – even with more negative effects on SWFO.

In light of this, it seems that students predominantly encounter organisational instead of physical barriers concerning availability and accessibility of ILS on campus. There seems to be a general deficiency in providing a comprehensive overview of potential ILS on campus. It was striking that nearly all students and lecturers believed they knew most of the ILS, but upon closer inquiry, they reported admitted lacking information on where to learn and how to gain information about ILS. Instead of being fully informed, they reported restricted access to information (e.g., trial and error approaches to find open and free-to-use ILS like seminar rooms, lack of room booking system for students, etc.). This gap is evident in the absence of ILS maps, informative signs, and user-friendly room-booking systems, which are not made available to students.

5.2 Awareness and enabling strategies to deal with existing barriers

Generally, students assumed that lecturers and the university administration are aware of barriers to promote ILS on campus, but suitable solutions have not yet been devised. While improvements have been noted by lecturers regarding ILS promotion, some believed the university management's investment remains insufficient. Lecturers discussed two potential factors that influencing awareness: priorities and dedication of university management and lecturers. Students' and lecturers' ideas and potential plans to break barriers and promote the use and attractiveness of ILS on campus are summarized as follows:

First, to overcome availability barriers it turned out that there is no need for additional places on campus. Instead, existing places, like seminar rooms, entrance halls and floors, should be activated as ILS. Especially, the availability of plugs and WIFI as well as furniture which supports collaborative and focused learning activities and improving ambience and gastronomic offers nearby would increase the usage of these existing places as ILS.

Second, to overcome accessibility barriers, students and lecturers did not point out physical barriers, but emphasized the need for information, transparency and knowledge regarding how, where and when ILS are accessible. Suggestions included providing information and support to find ILS on campus, like digital maps of ILS, online services for finding free/suitable ILS, updating the room booking system to a user-friendlier version, and offering bookable ILS. Long-term strategies involved creating urgency and self-initiative pilot projects to test user acceptance and experiences, strengthen sensemaking and awareness to promote ILS on campus and enhance the university's competitiveness. Also, they recommended fostering a sense of community to promote ILS visibility, to extend ILS on campus and thereby attracting students (back) to campus.

Lecturers have observed students feeling disoriented and lacking knowledge about specific campus amenities. To increase students' and lecturers' knowledge and help finding existing ILS, including their main amenities (i.e., places to conduct collaborative vs. focused learning activities, accessibility of gastronomic offers, etc.), it is strongly suggested to develop an interactive online campus map.

Comparing the focus group results between students and lecturers yields insights into the most important issues, concerns and challenges within the investigated themes:

- Fewer complaints were addressed concerning the quantity of ILS on campus, whereas the number of ILS that are appropriate were thematised in both focus groups.
- Both groups saw great potential in implementing appropriate ILS on campuses, yet its current underutilization was heavily criticised.
- Students and lecturers agreed that campus attractiveness is contingent upon diverse and easily accessible ILS.
- From various perspectives, it seems that activating places as ILS and addressing organisational barriers (e.g., lack of information) are the most prevalent obstacles in promoting ILS on campus.

It is crucial to understand that designing and providing ILS (bricks) as well as organising and communicating ILS (clicks) are both relevant and require resources. Interestingly, data analysis across all five NIILS partners yielded consistent results. For detailed qualitative results, see Geister et al. (2023).

6 conclusion and outlook

While the quantitative results show that ILS availability and accessibility are a relevant factor for social integration and well-being, the student and lecturer focus groups reveal that organisational barriers restrain students' opportunities to use ILS at HTW Berlin. These barriers lead to lacking availability and accessibility of appropriate and diverse ILS on campus. Despite perceived untapped potential, urgent action is recommended to address these implications and mitigate barriers by improving existing places as ILS in terms of (technological) equipment (e.g., diversified and creative spaces), meeting basic needs (e.g., privacy, comfort, atmosphere), extending opening hours and providing transparent information on available and accessible ILS and usage guidelines.

It can be concluded that universities do not need more places as ILS to support social integration and well-being to reduce dropouts. The focus should be on activating existing places as ILS through (minor) investments in infrastructure like plugs, WIFI, and suitable furnishings to enhance availability. Additionally, reducing organisational barriers by disseminating information about ILS and usage guidelines can improve accessibility. Students should be invited to learn on campus and be empowered to use ILS that support diverse learning activities and needs.

The key results suggest that the universities should invest not only in 'bricks and mortar' to provide ILS but also in 'clicks and bytes' to organise and manage ILS to extend and support availability and accessibility. Given the relevance to provide information and services via digital tools, campus development requires interdisciplinary responsibility with inter- and trans-departmental collaboration among (infra)structural, (information)technical and administrative experts.

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Design for Sustainable Outsourcing Strategies of Facilities Management Outsourcing Services: An Investigation In Educational Facilities

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ABSTRACT

Strategic level support is crucial for the smooth adoption of a sustainable FM supply chain. Generally, the majority of firms are willing to acquire outsourcing success, regardless of the industry within which they operate. It is useful to establish a specific outsourcing relationship model for facility management (FM) to achieve sound performance of outsourced service providers. This study aims to investigate the design of sustainable outsourcing strategies through a discussion of five theories (i.e., the Theory of Transaction cost economics, agency cost theory,

resource dependency theory, Theory of Entrepreneurial actions, and social exchange theory). Based on two types of questionnaire surveys, data were collected from 38 clients and 34 service providers. This study evaluates FM outsourcing strategies in educational facilities in Hong Kong. This is the outsourcing way forward to create a better working environment conducive for all parties that would result in better sustainability of the FM's future in terms of economic, social, and environmental values. The design of sustainable FM outsourcing strategies has not yet been discussed in terms of sustainability. The originality of this study is to explain and analyse the impact of design on FM sustainable outsourcing strategies on four commonly outsourced FM contracts, including building maintenance, security, cleaning, and catering, from the clients' and service providers' points of view through a quantitative approach. This paper explains the design of FM outsourcing strategies using five theories. The discovery is that neither clients nor FM service providers thoroughly understand the impact of design on outsourcing strategies of different outsourcing contract types on FM outsourcing performance. This may be why both parties neglect the importance of the link between FM design and outsourcing strategies for different FM outsourcing services in daily operations.

Keywords

Outsourcing services, Outsourcing strategies, Sustainability.

1.0 INTRODUCTION

The significance of outsourcing is in reducing costs in terms of scale and expenditure. Yik and Fai (2005) explained that many private and public commercial building owners have hired specialists or registered contractors through total or phased outsourcing to reduce their financial burdens. Although the amount of cost saving in outsourcing would be smaller than that of the energy cost for commercial buildings, the owner still outsources, especially the occurrence of a net benefit on a reduction in the Operation and Maintenance costs (Lai et al. (2008). The importance of FM as a means of encouraging learning has been emphasised by the majority of higher-education-related FM studies (Amaratunga and Baldry, 1999; Fianchini, 2006).

Facility services have an important and direct effect on academic performance, while other services (e.g., building design, physical layout, building fit-out, internal decoration, plants, and catering) have an indirect influence on the educational process but have an impact on staff and student satisfaction (Kok et al., 2011). Lok and Baldry (2015) stated that organisations can improve their revenue by increasing user satisfaction with FM services, thus attracting more students. Facilities management and maintenance services can create value, especially for higher education institutions (Kok et al., 2011; Vidalakis et al., 2013; Nielsen et al., 2019).

The outsourcing strategies are applied by the FM client and service provider strategists in their outsourcing contracts. The research question of this study is how sustainable FM outsourcing strategies impact the FM services of Hong Kong's higher education sector in four main types of outsourcing contracts: building maintenance, security, cleaning, and catering. In statistical terms, this study tests whether there is a statistically significant difference among the group means of the design of FM outsourcing strategies of the four kinds of outsourcing contracts. To test and analyse the hypothesis, a quantitative research approach was utilized in this study. The

categorical independent variables were the four different groups of outsourcing contracts. The quantitative dependent variable is the design of FM outsourcing strategies for the four FM outsourcing relationship dimensions for outsourcing strategies.

Sustainable FM can be incorporated into user perceptions, satisfaction, and productivity. This study aims to analyse and improve sustainable FM outsourcing relationships by investigating the design of outsourcing strategies for educational facilities from the perspectives of clients and service providers. This is because there is limited understanding of the outsourcing performance of FM service providers. This study can make a timely contribution to filling this gap and identifying successful factors for achieving satisfactory FM outsourcing services. The current study proposes that sound FM outsourcing strategies can be derived from outsourcing success factors while adding economic, social, and environmental value. A tailor-made FM framework, the Contingency Outsourcing Relationship (CORE) model, was introduced (Lok and Baldry, 2015). This model is used to identify the relationship between a client and an FM service provider in the four categories (i.e., in-house, technical expertise, commitment, and common goals) and to explain the importance of the outsourcing category of an organisation.

2.0 Literature Review

The British Standards Institution (2018) clarified that FM is a strategically important discipline for all organisations in the management, operation, and maintenance of the workplace, its assets, and operational efficiencies. Lok et. al. (2023) asserted that standardized and strategic-level support is crucial for the smooth adoption of sustainable FM practices and processes. Outsourcing can be defined as procuring services from external providers. This paper addresses the reasons for outsourcing as an effective and efficient approach to the management of resources. Understanding the designs in the context of Hong Kong's most widely implemented outsourcing arrangements for educational facilities is necessary (Lok et al., 2018). Outsourcing arrangements affect FM service providers' (Lehtonen and Salonen, 2005; Cigolini et al., 2011; Anker Jensen et al., 2012; Plane and Green et al., 2012). Strategic sustainable FM has recently and rapidly shaped the management of the built environment and FM, particularly during the Covid-19 period. Sustainable Facility Management (SFM) combines the concepts of FM and sustainable development by adopting technology and innovative business practices that balance the social, economic, and environmental impacts of business decisions (Opoku and Lee, 2022). The following sections outline the design of FM outsourcing strategies.

2.1 Critical Analysis of the Facilities Management Outsourcing Models

It is important to discuss the various possible types of outsourcing failure to develop a specific outsourcing relationship model for facility management. Barthelemy (2003) explained that one or more of the seven problems are related to most failed outsourcing efforts, and that companies are generally reluctant to complain about outsourcing failures. Hätönen and Eriksson (2009) claimed that managerial interest is the main dynamic management of outsourcing relationships. Management of outsourcing relationships with key suppliers is likely to become increasingly crucial (Kakabadse and Kakabadse, 2002). Consequently, a framework of four outsourcing relationship types (FORT) in the IT industry was proposed because of the application of the most suitable model rationale to the FM sector (Lok and Baldry, 2015).

This FORT model provides insights into the types of outsourcing relationships that exist between clients and service providers. The most critical characteristic of this model is that it investigates the evolution of organisations' outsourcing relationships. Outsourcing relationships are dynamic: they are liable to change and evolve because of changes in the external environment and clients' internal requirements (Kishore et al., 2003).

2.2 The FORT Model in Facilities Management

The FORT model, which is contingent in the context of the IT field, includes the enhancement of customer-supplier relationships and the improvement of product or service offerings. Figure 1 shows the FORT framework, which is specifically applicable to the FM industry. Lok et al. (2020) proposed a tailor-made FM framework called the Contingency Outsourcing Relationship (CORE) model. The CORE model can identify the relationship between a client and an FM service provider in four categories (i.e., in-house, technical expertise, commitment, and common goals). The rationale of the CORE model indicates the importance of the outsourcing category of an organisation.

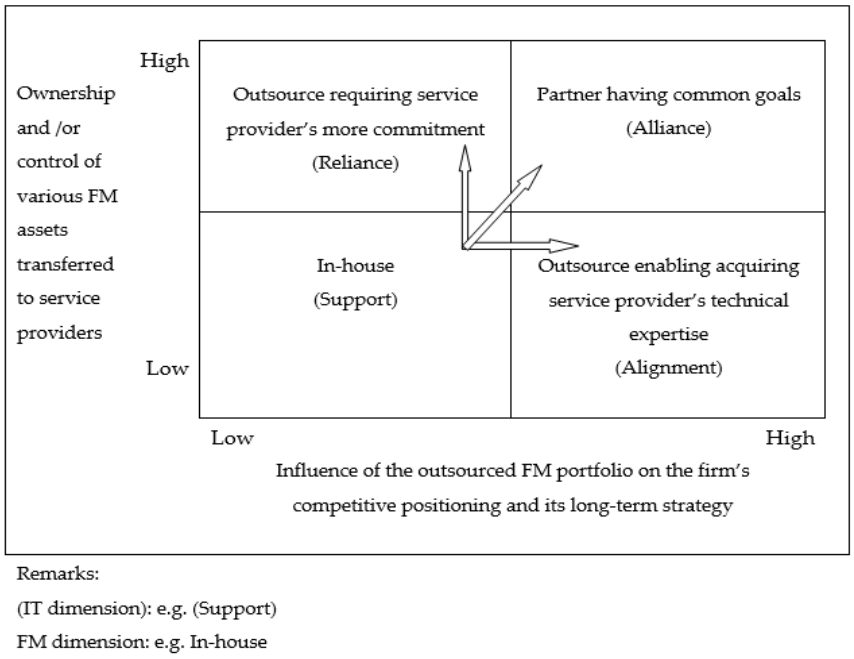

Figure 1. The evolution of the CORE model from the FORT framework

This study uses the CORE model in the context of the FM industry. Lok et al. (2020) provide a more detailed review of the dimensions of the CORE model from the X and Y axes: ownership, control, competitive positioning, and long-term strategies, including the outsourcing categories of the ownership dimension (in-house), control dimension (technical expertise), competitive positioning dimension (commitment), and long-term strategy dimension (common goals). The working mechanism of the FORT model is relevant in the FM research context. Lok et. al. (2022) used eight real case studies to verify seven outsourcing categories from industries, such as

building maintenance, property management, property development, leisure and culture, education, and exhibitions, but without details of the explanation of outsourcing strategies.

2.3 Design for Outsourcing Strategies

Five theories (i.e., transaction cost economics, agency cost theory, resource dependency theory, Theory of Entrepreneurial Actions, and Social Exchange theory) have been used to measure outsourcing manoeuvres. An analysis of the outsourcing relationship from these theoretical perspectives on the relationships between the strategic manoeuvres identified and the different dimensions of an outsourcing relationship.

The structuring of outsourcing contracts includes transaction and agency costs. The former is that organisational effectiveness depends on choosing the appropriate governance structure (internal vs. external) to minimise production and transaction costs. The level of transaction costs incurred depends on three key transaction attributes: asset specificity, uncertainty, and frequency (Williamson, 1985). In the latter, all contracts involve a principal–agent relationship characterised by goal incongruence between the principal and agent. This results in agency costs, specifically bonding costs (to achieve incentive alignment), monitoring costs (to reduce information asymmetry), and residual loss (due to risk aversion) (Jensen & Meckling, 1976).

Resource dependency theory addresses the ease of exit. Firms depend on the external environment for their resources. The resources that a firm cannot generate internally must be acquired through external acquisition. Therefore, firms must actively manage the environment and their resource flow in order to minimise dependence (Pfeffer & Salancik, 1978).

Continuous relationship management and information feedback include entrepreneurial actions and the social exchange theory. Entrepreneurship is an organisational capability that drives economic growth. Entrepreneurial actions, as a process of creative destruction, involve proactive efforts to discover and exploit market opportunities for innovation (Schumpeter, 1936). The latter is that inter-organisational relationships involve not only legal exchanges between parties, but also social exchanges based on reciprocity. This requires cooperation and giving and taking between parties (Blau, 1964). Table 1 summarises the theories and key concepts used. It is necessary to study the five theories because they can comprehensively analyse and investigate outsourcing strategies and can work in alignment with the research method analytical tools such as the Kruskal-Wallis test and one-way analysis of variance (ANOVA).

Table 1. Summary of corollaries on outsourcing relationship

Theory / Concept	**Key Concepts / Strategic Manoeuvres to Outsourcing Relationship**
Transaction Cost Economics	Reduced asset specificity by minimising customization
Agency Cost Theory	Reduced monitoring cost by enhancing process maturity Mitigation of residual loss by retaining in-house competence
Resource Dependency Theory	Diluting supplier concentration through multiple sourcing Reduced switching costs through vendor interoperability
Entrepreneurial Actions	Enhanced entrepreneurial capability through proactive sensing
Social Exchange Theory	Building relational reciprocity through enhanced partnership quality

3.0 Methodology

In this study, the selected number of FM professionals from the Hong Kong FM industry in the questionnaire surveys is the sample to be taken as representative of the whole population. There were two questionnaire surveys of clients and service providers of experienced industry practitioners. There were four parts of the relationship dimensions for both, but the number and content of the questions differed with respect to clients and service providers. This study focuses on the design of outsourcing strategies in the questionnaire. The respondents could rate the design for FM outsourcing strategies of the four types of FM outsourcing contracts (i.e., building maintenance, security, cleaning, and catering). Responses were measured using a 5-point Likert scale with 1 being "Very bad," 2 "Bad," 3 "Neutral," 4 "Good" and 5 "Very good." Various prospective respondents were from public academic institutes, private organisations, quasi-government associations, and FM professional institutes. The target respondents were three or more years of FM-related working experience through an electronic questionnaire survey. The survey strategy was random sampling of the survey through the connection of local facilities and property management professional institutes. All the respondents were local or overseas-experienced FM practitioners. This represents an overall response rate of 41.1%.

A total of 175 electronic questionnaires were sent: 92 to clients and 83 to service providers. On the client side, 38 respondents returned completed questionnaires, representing a 41.3% response rate. On the service providers' side, 34 respondents returned completed questionnaires, representing a 40.9% response rate.

3.1 Survey Details

More than 50% of client and service provider respondents had three or more years of FM-related experience. However, less than 10% of client and service provider respondents had less than three years of FM-related experience. In clients' FM professions, 18% were chartered builders, 10% were chartered surveyors, and chartered building services engineers.

Concerning service providers' FM professions, 15% were chartered builders and surveyors, and 18% were others. Registered professional housing managers and certified facility managers accounted for 12% of the respondents.

According to the clients' results, building maintenance, security, and cleaning contracts are 31%, 28%, and 25%, respectively, while 9% of the FM contracts are catering.

As for the service providers' results, building maintenance and security contracts awarded by clients are at 39% and 25%, respectively, while 17% of FM contracts are cleaning and catering.

The involvement of outsourcing contracts such as capital projects, IT, landscaping, horticulture, and high-risk waste management is very limited.

4.0 RESULTS OF SUSTAINABLE FM OUTSOURCING STRATEGIES

As mentioned earlier, four dimensions (i.e., ownership of FM assets, control of FM assets, competitive position, and long-term plan) were employed to measure the design. In this study, respondents were asked to provide opinions on and evaluate the four outsourcing relationship dimensions for the design of strategies. The descriptive statistics for the items in each category are discussed in the following paragraphs. Data were obtained for all personal data or classification variables. They were used to summarise the responses to each question and to produce descriptive information on the collected data, such as means, standard deviations, and frequencies of the responses.

4.1 Design for Outsourcing Strategies

Five theories (i.e., transaction cost economics, agency cost theory, resource dependency theory, Theory of Entrepreneurial Actions, and Social Exchange theory) have been employed to measure outsourcing manoeuvres. In this study, the respondents were asked to provide opinions and evaluate five outsourcing theories for the design of strategies. Responses were recorded on a five-point Likert scale has been used ranging from 1 = very unimportant to 5 = very important.

4.2 Theory of Transaction Cost Economics

On client, the highest mean was indicated by the FM outsourcing catering contract regarding the item "Requesting the vendor to modify its process significantly" (Mean = 4 scores), while the lowest mean was indicated by the FM outsourcing building maintenance contract regarding the item "Own unique technical skills" (Mean = 3.38 scores)"

For service providers, the highest mean was indicated by the FM outsourcing cleaning and catering contracts regarding the item "Requesting to modify its process significantly" (Mean = 4 scores), while the lowest mean was indicated by the FM outsourcing security contract regarding the item "Extensive business knowledge specific to clients' business environment " (Mean = 3.33 scores).

4.3 Agency Cost Theory

On client, the highest mean was indicated by the FM outsourcing building maintenance contract regarding the item "Documented and visible Key procedures and business rules" (Mean = 4.13 scores), while the lowest mean was indicated by the FM outsourcing cleaning contract regarding the item "Easily bring the outsourced process in-house" (Mean = 2.9 scores)".

For service providers, the highest mean was indicated by the FM outsourcing cleaning and catering contracts regarding the item “Documented and visible Key procedures and business rules” (Mean = 4.2 scores), while the lowest mean was indicated by the FM outsourcing security and catering contracts regarding the item “Clients easily bringing the outsourced process in-house" (mean = 3 scores).

4.4 Resource Dependency Theory

On the client, the highest mean was indicated by the FM outsourcing cleaning contract regarding the item “Building up relationships with a few outsourcing vendors” (Mean = 3.76 scores), while the lowest mean was indicated by the FM outsourcing catering contract regarding the item “Electronically linked and seamlessly connected application platform provided by our outsourcing vendor" (Mean = 2.75 scores).

On service providers, the highest mean was indicated by the FM outsourcing cleaning and catering contracts regarding the item “Clients building up relationships with a few outsourcing vendors” (Mean = 3.9 scores), while the lowest mean was indicated by the FM outsourcing security contract regarding the item “Offering a wide variety of information" (Mean = 3.2 scores); FM outsourcing cleaning and catering contracts regarding the item “Electronically linked and seamlessly connected application platform provided by us & Software module easily be added to, modified, or removed" (Mean = 3.2 scores).

4.5 Theory of Entrepreneurial Actions

On client, the highest mean was indicated by the FM outsourcing building maintenance contract regarding the item “Our executives always encouraging our outsourcing vendor to explore new opportunities and innovative ideas” (Mean = 3.58 scores), while the lowest mean was indicated by the FM outsourcing cleaning contract regarding the item “Our executives always encouraging our outsourcing vendor to explore new opportunities and innovative ideas" (Mean = 3.19 scores).

On service providers, the highest mean was indicated by the FM outsourcing security contract regarding the item “Clients’ executives always encouraging us to explore new opportunities and innovative ideas” (Mean = 3.93 scores), while the lowest mean was indicated by the FM outsourcing building maintenance contract regarding the item “Clients’ executives quick to alert us when new products and services" (Mean = 3.08 scores).

4.6 Social Exchange Theory

On client, the highest mean was indicated by the FM outsourcing building maintenance contract regarding the item “Mutually beneficial decisions to us and our outsourcing vendor” (Mean = 3.96 scores), while the lowest mean was indicated by the FM outsourcing catering contract regarding the item “Having compatible cultures and policies to us and our outsourcing vendor" (Mean = 3.13 scores).

On service providers, the highest mean was indicated by the FM outsourcing catering contract regarding the item “Perform our agreements and promises very well” (Mean = 4.3 scores), while the lowest mean was indicated by the FM outsourcing building maintenance contract regarding the item “Having compatible cultures and policies to us and our clients" (Mean = 3.73 scores).

The question is whether there is any statistically significant relationship between the design of outsourcing strategies and the four FM outsourcing contract types. The major research findings show that there are no statistically significant differences at a 5% significance level between "Facilities Management (FM) Clients" and "Facilities Management (FM) Service Providers" towards "Outsourcing Strategies applied in their Facilities Management (FM) Outsourcing Contracts, that is, Building Maintenance, Security, Cleaning, and Catering".

Table 2 Facilities Management (FM) Clients and Service Providers Towards "Outsourcing Strategies Applied in Their FM Outsourcing Contracts, i.e., Building Maintenance, Security, Cleaning, and Catering

Hypothesis Test Summary by Independent Kruskal-Wallis Test

	Null Hypothesis: **The same across Types of FM contract**	**Client Average Sig.[a,b]**	**Service Provider Average Sig.[a,b]**	**Decision**
1	Transaction Cost Economics (Minimising Process Customisation)	0.827	0.714	Retain the null hypothesis
2	Agency Cost Theory (Process Maturity)	0.966	0.646	
	Agency Cost Theory (In-House Competence)	0.803	0.77	
3	Resource Dependency Theory (Vendor Interoperability)	0.836	0.59	
	Resource Dependency Theory (Multiple Sourcing to vendors)	0.85	0.931	
4	Entrepreneurial Actions (Proactive Sensing)	0.857	0.827	
5	Social Exchange Theory (Partnership Quality)	0.638	0.685	

a. The significance level is .050.
b. Asymptotic significances are displayed.

5.0 Discussion

FM clients and service provider strategists should consider outsourcing relationships. However, the design of outsourcing strategies in FM contracts in terms of sustainable development strands, including economy, society, and environment, generally does not promise the success of outsourcing contract types. The design of outsourcing strategies for outsourcing contracts is key to achieving satisfactory FM outsourcing services, but outsourcing strategies are not the dominant factors in achieving successful outsourcing performance of service providers.

5.1 FM Client Survey Results

The results reveal that the important design influencing the outsourcing strategies in the four FM contracts relates to key procedures and business rules in the process maturity of the agency cost theory in the economic strand. However, the basic design influencing outsourcing strategies is the application platform in vendor interoperability of resource dependency theory in the economic and environmental strands.

5.2 FM Service Provider Survey Results

In the economic strand, the results reveal that the important design influencing outsourcing strategies in the four FM contracts relates to key procedures and business rules in the process maturity of agency cost theory. However, in the economic and social strands, the basic design influencing outsourcing strategies is updating the dynamics of the outsourcing vendor's market to take advantage of new opportunities in proactive sensing of the Theory of Entrepreneurial actions.

5.3 Research Limitations

Although the sample size was not too large, the raw data could sufficiently analyse and draw statistically valid and reasonable results. The choice of population was limited to a single industry, higher tertiary education, which tends to constrain the generalizability of the findings to other industries. The roles that FM outsourcing relationships play in related dimensions must be clarified from different industry perspectives. This study also does not use the raw financial data of FM outsourcing contracts, as it is difficult to collect highly confidential and sensitive data.

6.0 CONCLUSION

The results show that clients and service providers have no statistically significant differences in terms of the most significant factors influencing the design of outsourcing strategies in the four FM contracts. However, the design of outsourcing strategies is key to achieving success in outsourcing performance. Clients and service providers should understand the implications of effective outsourcing strategies. If outsourcing service providers can maintain close FM outsourcing relationships, clients can obtain high-quality outsourcing services. The conclusion from the findings is that both clients and FM service providers do not thoroughly understand the impact of design on the outsourcing strategies of different outsourcing contract types on FM outsourcing performance. This may be why both parties neglect the importance of the link between FM design and outsourcing strategies for different FM outsourcing services in daily operations.

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An international review of building standards and guidelines on thermal comfort and ventilation for School buildings

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This paper reviews and discusses thermal comfort and ventilation standards and guidelines in educational buildings in selected countries around the World, alongside the guidelines from the World Health Organization (WHO), the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the Chartered Institution of Building Services Engineers (CIBSE) and the Federation of European Heating, Ventilation and Air Conditioning (REHVA). Standards and guidelines are first defined followed by the inclusion and exclusion criteria of the selected countries. The chosen specific indoor elements scrutinised are detailed before the values of their standards and guidelines in educational buildings are summarised per country and for the different organisations. The values show a significant disparity in standards and guidelines about indoor elements in classrooms around the World. Some countries don't have a whole-country approach. The WHO, ASHRAE, CIBSE and REHVA have stricter guidelines. These findings highlight the heterogeneity of national guidelines or enforceable regulations related to the indoor environment of educational buildings around the World. Future research should focus on exploring the impact of these different standards and guidance on the indoor climate of various educational settings around the World.

1 - Introduction

People are spending 90% of their time indoors. Healthy indoor environments are therefore important, as they impact the health and well-being of workers (World Green Building Council, 2020). Workers mostly complain about poor Indoor Air Quality (IAQ) (International Institute of Refrigeration, 2016) and inadequate indoor temperature (Edem, Akpan and Pepple, 2017). Schools are workplaces where pupils and teachers spend hours in overcrowded enclosed spaces (Cutler, 2010) often with poor ventilation (Chatzidiakou, Mumovic and Summerfield, 2012; Bain-Reguis *et al.*, 2022) and where viruses can spread easily from noroviruses to the seasonal flu (Barker, Stevens and Bloomfield, 2001). The COVID-19 pandemic, with SARS-COVID-19 being an airborne virus (World Health Organization, 2020; CDC, 2022), has challenged the governments to provide adequate ventilation in classrooms (Scottish Government, 2021)

while maintaining acceptable thermal comfort for the occupants (Alonso *et al.*, 2021; Miranda *et al.*, 2022).

The scope of this review is to explore the different regulations and recommendations in Scotland and other countries around the World. As there is a distinction between regulations and recommendations, the following paragraphs define each term.

Standards (or regulations) are legally binding rules or directives made and maintained by a government authority. They have the force of law and are enforceable. They are often specific, and detailed, and provide clear requirements that must be followed. Failure to comply with standards can result in legal consequences, such as fines, penalties, or other enforcement actions. Standards are designed to standardise behaviour and ensure adherence to established standards.

Guidelines (or recommendations) are non-binding documents that provide advice, or best practices on how to interpret and comply with laws, regulations, or standards. They do not have the force of law. Guidelines are usually issued by regulatory agencies or other authoritative bodies. While it may reflect the agency's interpretation of the law, it does not create new legal requirements on its own. Unlike regulations, guidelines are not legally enforceable. However, organisations may choose to follow guidelines as a means of aligning with industry best practices or demonstrating compliance.

In summary, regulations are legally binding and enforceable rules that carry the weight of law, while recommendations or guidance are advisory, providing recommendations and interpretations without the force of law. Organisations and individuals are typically obligated to follow regulations, but they may choose to follow guidelines for informational or best practices purposes. Countries have regulations, guidelines or both.

This paper aims to review and discuss thermal comfort and ventilation standards and guidelines in educational buildings in selected countries around the World, alongside the guidelines from the World Health Organization (WHO), the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the Chartered Institution of Building Services Engineers (CIBSE) and the Federation of European Heating, Ventilation and Air Conditioning (REHVA).

2 - Methodology

2.1 - Selected countries and their characteristics

The chosen method of selection has been to look at the countries with similar economic development as the United Kingdom. It has been assumed that countries with developed economies have a fair and robust legislative system. Table 1 shows all the countries with developed economies.

Table 4: Developed economies, from Country Classification (UN, 2014)

Europe			Other countries	Major Developed economies (G7)
Europe Union	Non-EU member States	Other Europe		
EU-15	Bulgaria	Iceland	Australia	Canada
Austria	Croatia	Norway	Canada	Japan
Belgium	Cyprus	Switzerland	Japan	France
Denmark	Czech Republic		New Zealand	Germany
Finland	Estonia		United States	Italy
France	Hungary			United Kingdom
Germany	Latvia			United States
Greece	Lithuania			
Ireland	Malta			
Italy	Poland			
Luxembourg	Romania			
Netherlands	Slovakia			
Portugal	Slovenia			
Spain				
Sweden				
United Kingdom				

The indoor and outdoor climates are interlinked, therefore it seemed essential to take the countries' climates into consideration. Therefore, for each of the countries listed in Table 1, the Köppen–Geiger climate classification has been used to identify their specific climate. The Köppen-Geiger climate classification (recently updated) uses the type of ecosystem of a specific location using the annual atmospheric temperature (Kottek *et al.*, 2006). The Köppen-Geiger climate classification divides climates into five main climate groups, with each group being divided based on patterns of seasonal precipitation and temperature (Table 2).

Table 2: Köppen climate classification scheme symbols description table (Kottek et al.*, 2006)*

Climate Group	**Precipitation**	**Temperature**
A (Tropical)	• f (Rainforest) • m (Monsoon) • w (Savanna, dry winter) • s (Savanna, dry summer)	
B (Dry)	• W (Arid Desert) • S (Semi-Arid Steppe)	• h (Hot) • k (Cold)
C (Temperate)	• w (Dry winter) • f (No dry season) • s (Dry summer)	• a (Hot summer) • b (Warm summer) • c (Cold summer)
D (Continental)	• w (Dry winter) • f (No dry season) • s (Dry summer)	• a (Hot summer) • b (Warm summer) • c (Cold summer) • d (Very cold winter)
E (Polar)		• T (Tundra) • F (Ice cap)

Atmospheric temperature depends on solar radiation, humidity, wind, and altitude. The United Kingdom has a moderate climate (Cfb).

The new EU member states and the countries named "Other Europe" in Table 1 have been discarded because either their climate was not temperate or the standards have not been found. Table 3 shows the countries selected with their population, surface area and main climate.

Table 3: Selected countries with characteristics

Name	Population[1]	Area (2021)[1]	Main climate[2]
Units	Thousand	km^2	Koppen-Geiger
Austria	8,970	82,520	Dfb/ET
Belgium	11,618	30,280	Cfb
Denmark	5,877	40,000	Dfb but Cfb in main cities
Finland	5,541	338,460	Dfc
France	67,656	547,557	Cfb
Germany	83,001	349,380	Cfb/Dfb
Greece	10,605	128,900	Csa
Ireland	5,060	68,890	Cfb
Italy	58,936	297,730	Csa/Cfa
Luxembourg	646	2,430	Cfb
Netherlands	17,567	33,670	Cfb
Portugal	10,267	323,250	Csa/Csb
Spain	47,277	499,603	Bsk
Sweden	10,472	407,310	Dfb/c
United Kingdom	66,800	241,930	Cfb
- England and Wales	59,440	149,011	Cfb
- Scotland	5,466	78,789	Cfb
- Northern Ireland	1,894	14,130	Cfb
Canada	38,557	8,965,590	Dfb/Dfc
Japan	125,105	364,500	Cfa/Dfb
United States	333,730	9,147,420	Cf/Dfa
Australia	26,010	7,692,020	Bwh but Cfa and Cfb for main cities
New Zealand	5,160	263,310	Cfb

[1]https://databank.worldbank.org
[2]http://koeppen-geiger.vu-wien.ac.at

Due to no information nor experts found in Finland, Greece, and Luxembourg, these countries have not been studied. Despite Austria, Spain, Sweden and Canada having different climates than the UK, the standards and guidelines for these countries have been reviewed as they are either close geographically or economically.

2.2 - Selection of the parameters to review

This paper aims to review and discuss the standards and guidelines for "thermal comfort" and "ventilation" in educational buildings. Therefore, it is necessary to choose the related parameters.

Thermal comfort is a subjective measure as it is defined as *"that condition of mind which expresses satisfaction with the thermal environment"* in the ASHRAE Standard 55 (ASHRAE, 2004). There is a wide range of factors that directly and indirectly influence thermal comfort. Indoor temperature and Relative humidity are commonly measured to assess thermal conditions. Indoor air temperature is considered the best indicator of thermal comfort as it usually changes the perceived comfort levels of occupants (Wyon, Andersen and Lundqvist, 1979; de Dear *et al.*, 2015). Measuring indoor temperature in relation to other factors allows for a comprehensive analysis of the indoor environment, taking into account the preferences and needs of occupants, as well as the dynamics of the environment (Bluyssen, 2019). Relative Humidity (RH) can be defined as the ratio between the quantity of water vapour present in the air and the maximum quantity of water vapour that the air can contain at a given temperature (CIBSE, 2015b). RH in buildings does not change significantly and unlike indoor air temperature, occupants are less sensitive to changes in humidity levels (CIBSE, 2015b). However, RH can have an impact on virus transmission (Verheyen and Bourouiba, 2022) and mould propagation (Qin *et al.*, 2020)

The ventilation rates and/or air change rates define if a room has adequate ventilation. They can be calculated using the CO_2 concentration levels, the number of occupants, the dimensions of the room, their age, sex and activity levels (Persily, 2016).

Therefore, the following indoor parameters are reviewed per country:

- the ventilation rate,
- the air change rate,
- the CO_2 concentration levels,
- the minimum surface area,
- the minimum volume per person,
- the minimum and maximum indoor temperature,
- and the minimum and maximum relative humidity.

However, it is outside the scope of this work to analyse in detail the differences and the rationale of different countries to select specific values.

2.3 – Method

To find the relevant information, an extensive review of the regulations and guidelines has been completed for each country. For countries with documents written in a language other than English or French, the use of an online translator application has been necessary: Google Translate. Once collated, all findings have been checked by experts.

3 - Results

Table 4 gives the national regulations and/or guidelines for the selected countries alongside the recommended threshold drawn by the WHO, ASHRAE, CIBSE and REHVA. The information shown in **BOLD are standards** while the other ones are guidelines.

Name	CO_2 in schools	Ventilation Rates	Indoor Temperature	Indoor Relative Humidity	Min surface area	Min volume	Max occupancy
Units	ppm	l/s per person	°C	%	m^2	m^3	children/adults
Austria (*RIS - Ordinance of the Upper Austrian State Government concerning the construction and furnishing of public compulsory schools (Upper Austrian School Construction and Furnishing Ordinance 1994)*, 1994; *RIS - School Construction and Facilities Ordinance - State Law consolidated Burgenland*, 2024)	<1900 ppm (In naturally ventilated) < 800 ppm (In mechanically ventilated rooms)		about 20°C		>1.60m^2 /pupil. Classrooms >50 m^2 (primary, secondary schools or polytechnic) > 40 m^2 (Special ed)	>5 m^3 per pupil. Clear height of classrooms>3,20 m.	
Belgium (*Annexe C3 de la PEB: dispositifs de ventilation des immeubles non résidentiels*, 2008; *Cadre légal pour la qualité de l'air intérieur*, 2022)	**<900ppm**	**6 l/s i.e. 22m^3/h per person**	**20°C min (winter) 27°C max (summer)**	**20%-70%**	**4m^2/person**		
Denmark ('Executive Order No. 1615 of 13 Dec. 2017 (in force) BR18 22 Section 447 Ventilation', 2017)	**<1000ppm**	**>= 5 l/s per person + 0.35 l/s/m^2**	**23-26°C (summer), 20-24°C (winter) >= 20°C monthly average** all year.			**>6m^3/person**	50
France ('Arrêté du 27 décembre 2022 fixant les conditions de réalisation de la mesure à lecture directe de la concentration en dioxyde de carbone dans l'air intérieur au titre de l'évaluation annuelle des moyens d'aération - Légifrance', 2022)	**<800ppm**	**15 m^3/h per person i.e. 4l/s per person**			2 m^2 per child 60 m^2 min. in total		
Germany 7a and 7b (*DGUV Regel 102-601 „Branche Schule"*, 2019)	<1000 ppm		20-24°C		2.8 to 3.4m^2/pupil		

Ireland (HSE, 2023)	<1000ppm	8 l/sec per person	18°C-23°C	40-70%			
Italy (‘Norme tecniche aggiornate relative all’edilizia scolastica, ivi compresi gli indici minimi di funzionalità didattica, edilizia ed urbanistica da osservarsi nella esecuzione di opere di edilizia scolastica.’, 1975; *Linee guida sulle specifiche tecniche in merito all’adozio ne di dispositivi mobili di purificazione e impianti fissi di aerazione e agli standard minimi di qualità dell’aria negli ambienti scolastici e in quelli confinati degli stessi edifici.*, 2022; Settimo *et al.*, 2022)	<1000ppm	10l/s per person 2.5 ACH in elementary schools	20°C+/-2°C in winter	45-55% in winter	153m^2/class and 6.11m^2/pupil min in elementary schools	300cm height min	
Netherlands (*Netherland Program requirements Fresh Schools 2021*, 2021)	**1200ppm**	**6l/s per person**	**18-25°C (Winter)** **<27°C (summer)**			**2.6m (height)**	
Portugal (‘Portugal_Portaria n.º 138-G_2021’, 2021)	**<1250ppm (2013)**						
Spain (‘Real Decreto 486/1997, de 14 de abril, por el que se establecen las disposiciones mínimas de seguridad y salud en los lugares de trabajo’, 1997; ‘LA VENTILACIÓNCOMO MEDIDA PREVENTIVA FRENTE AL CORONAVIRUS SARS-CoV-2’, 2021)	<500 ppm + outdoor	12.5l/s per person	23-25°C (Spring-Summer) 21-23°C (Autumn-Winter)	40-50% (Spring-Summer) 45-60% (Autumn-Winter)	2 m^2/person >3 meters high from the floor to the ceiling	>10 m^3/person	25
Sweden (*Sweden - FoHMFS 2014:18 Folkhälsomyndighetens allmänna råd om ventilation*, 2014; *Sweden -*	<1000ppm	7 l/s per person + 0.35 L/s per m^2	20 -24°C (Heating season) 19-26°C (Cooling season)	<75%			

The Design of the Workplace, 2020)							
England and Wales (DfE, 2018a, 2018b)	**<1000 ppm, 1500 ppm for more than 20 consecutive minutes each day (Mechanical ventilation) < 1500 ppm (Natural ventilation)**	**2.3 l/s/m^2 i.e. 8 l/s per person**	**20-25°C (heating season)**		2.9m^2/pers (primary) 4.5m^2/pers (Secondary)		
Scotland (The Scottish Government, 1967, 2004, 1990; The Scottish Government, 2016; The Scottish Governement, 2017)	**<1500ppm**	**2 ACH**	**>17°C**		Consultation: Primary: Up to 231 8.5m^2 232-462 7.5m^2 463+ 6.5m^2 Secondary: Up to 400 13m^2 401-800 12m^2 801-1200 11m^2 1201+ 10m^2		
Northern Ireland (UK Government, 2018; Department of Education Northern Ireland, 2020)	<1550ppm	8l/s per person	18°C		all should be of 60m^2	minimum of 2.9m height	
Canada (National Research Council Canada, 2020; Ontario Society of Professional Engineers, 2022)	<900ppm in Ontario since 2022			35-50%	7.5m^2/person		
Japan (Ministry of Education, Culture, Sports, Science and Technology of Japan, 2018)	**<1500ppm**	**Air flow: 0.5m/s**	**18-28°C**	**30-80 %**			
United States (CDC, 2020; ASHRAE, 2022, 2023a, 2023b)	<800ppm (CDC) <outside+750ppm (ASHRAE)	5l/s per person	19-26°C (winter) 25-28°C (summer)	< 85% (winter); <65% (summer) 40-60%			

Australia (Standard Australia, 2024; Standards Australia, 2024)	**<850 ppm**	**12l/sec per person if mechanically ventilated**			**2m² per student**		
New Zealand (Education, 2022)	<800ppm target **<1250ppm daily average** **<2000ppm peak**	**8l/s per person**	**min: 19˚C (+/-1°C)** **Max: 25°C (no more than 80 occupied hours), 28°C (no more than 40 occupied hours)**	**30 to 60% ideally**			**50p/100m²**
WHO (WHO, 2022)	<1000ppm <800ppm in case of severe epidemic	6-7l/s per person			2m² per student		
ASHRAE (ASHRAE, 2023a)	Recommended limits: Outside air level +750 ppm for 90 minutes	5l/sec per person	Winter: 22 C Summer: 24 C	Winter: 40- 50% RH Summer: 50%-60% RH			
CIBSE (CIBSE, 2015a, 2021)	800-1000ppm	10l/sec per person	16 C				
REVHA (REHVA, 2023)	<1000ppm		Winter: 20-24 C Summer: 23-26 C	>20%			

4 – Discussion

There is a significant disparity in regulations and guidelines about ventilation and thermal comfort in classrooms around the World. 9 out of 20 countries have standards on one or more parameters, the other 11 countries have guidelines.

Some countries do not have a whole-country approach (USA, Canada) where regulations and guidelines may differ between areas of the same country. In the USA, both the CDC and ASHRAE have produced guidelines, which slightly differ. The ASHRAE standards are not regulations per se and therefore not necessarily enforceable. Some countries have strict enforceable rules (Australia, Belgium, Denmark, France, Netherlands, Portugal, UK) while others have recommendations (Germany, Ireland, Italy, Spain, Sweden).

In the UK, the regulations related to education are devolved to each region. Therefore, England and Wales, Scotland and Northern Ireland all have different regulatory texts.

Looking at the individual regulated parameters of interest, the maximum CO_2 levels acceptable in classrooms are lower when recent guidance or standards have been published. This can be assumed to be a consequence of the COVID-19 pandemic. The stricter maximum CO_2 value is 800ppm in the classrooms of France, then 900ppm in Belgium, 1000ppm in Denmark, 1200ppm in the Netherlands and in Sweden and in mechanically ventilated classrooms of England and Wales, and 1500ppm in naturally ventilated classrooms of England and Wales. New Zealand has three values: 800ppm as a recommendation target, 1200ppm as a maximum daily average and 2000ppm as the maximum peak value. In Scottish classrooms, the latest regulation imposes CO_2 levels to be less than 1500ppm in classrooms and 800ppm in music rooms and gym halls (Scottish Government, CERG, 2020).

The guidelines of the independent organisations are stricter than the standards in place in the countries (apart from the new Legislation in France 2023). The WHO gives two thresholds including one in case of severe epidemic. ASHRAE standards did not give a CO_2 threshold but rather a minimum ventilation rate. According to Persily, CO_2 levels are not a good indicator of ventilation or IAQ (Persily, 2021). However, since the pandemic, they recommend CO_2 levels to be 750ppm above the outside level. The Chartered Institute of Building Services Engineers (CIBSE) has published a new guide with CO_2 thresholds needing to be between 800 and 1000 ppm.

The minimum ventilation rates are ranging from 4l/s per person (France) to 12.5l/s per person (Spain), with an average of 8l/s per person.

Some countries have regulations for the minimum/maximum temperatures in classrooms. The values span from 17ºC to 27ºC. In Scotland, keeping the indoor temperature at an acceptable comfort level, especially in winter, is primordial. The indoor temperature in Scottish classrooms should be kept above 17ºC, according to the current regulations (Scottish Government, 2020), which is the lowest temperature threshold in classrooms found in the present literature.

Belgium, Japan and New Zealand are imposing strict limits to control RH in classrooms (between 20 and 80%). Other countries have guidance levels (Ireland, Italy, Spain, Sweden, Canada, USA), which are between 30 and 80%. In Scotland, there is currently no mandatory legal requirement to control RH and the relative risk posed by this parameter alone has not yet been fully ascertained in research. Nevertheless, numerous studies have identified an RH 'sweet spot' between 40% and 60% adding that air which was too dry would allow viruses to thrive and be more active (Azuma et al., 2020) and mould would develop when the air is too high in humidity.

The regulations or the guidance related to the surface areas, the volume of the classrooms or the maximum capacity are heterogeneous. When values are given, they are different from one country to

another. Belgium, Denmark and Australia have regulations in place either for the minimum surface area (2 to 4m^2 per student) or for the minimum volume (6m^3 per student). The Netherlands has set a minimum height of 2.6 meters for classrooms.

5 – Conclusion

This review aimed to explore the existing standards and guidelines related to thermal comfort and ventilation in educational buildings. The review revealed a significant disparity in regulations and guidelines about ventilation and thermal comfort in classrooms around the World. Most countries have standards or guidance related to the maximum level of CO_2 or the minimum ventilation rates or both. But the limits can vary from 800ppm to 2000ppm. Almost all countries have the minimum and maximum indoor temperature acceptable in a classroom, spanning from 17°C to 28°C. The Relative Humidity standards or guidance vary from 20 to 80%RH. The minimum surface area, the minimum volume per student needed in a classroom and the maximum occupancy guidance are heterogeneous and only three countries have regulated values. The international bodies have guidelines on most elements studied with a smaller range of values.

Future research should focus on exploring the impact of these different standards and guidance on the indoor environment of various educational settings around the World. This review was limited by the accessibility of related documents due to language barriers or experts found in the field.

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Session 4C: Workplace Preferences

SIM-OFFICE – A Gamified Research Tool for Workplace Exploration - Purposes, App Structure and Initial Data Analysis

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ABSTRACT

Purpose: Navigating the diverse individual and group needs within organizations to find the optimal office environment remains a complex challenge. This study introduces SIM-OFFICE, a web-based application designed to identify personalized preferences and categorize office preference types through advanced pattern recognition

Theory: The app's framework utilizes the 'Performance-Oriented Office Ecology Model' (Kämpf-Dern and Konkol 2017) as a holistic framework, the Five Factor Model (McCrae and John 1992) for the personality traits, and the Graves Value Model (Graves 1970) for corporate culture insights. The hypothesis is that individual preferences for office environment parameters can be grouped into a limited number of clusters based on demographics and aligned personality features, and job tasks.

Methodology: Utilizing an interactive, gamified survey that covers approximately 50 office environment parameters, 5 personality traits, cultural values and demographic data, the open-source app empowers and motivates users to articulate their preferences distinctly, especially as they receive instant feedback on their responses.

Findings: Initial analyses suggest correlations between demographics, personality traits, job tasks, and preferred workplace characteristics such as physical workspace design and leadership style. However, given the multitude of variables, a much larger dataset is necessary to confirm any cluster types statistically.

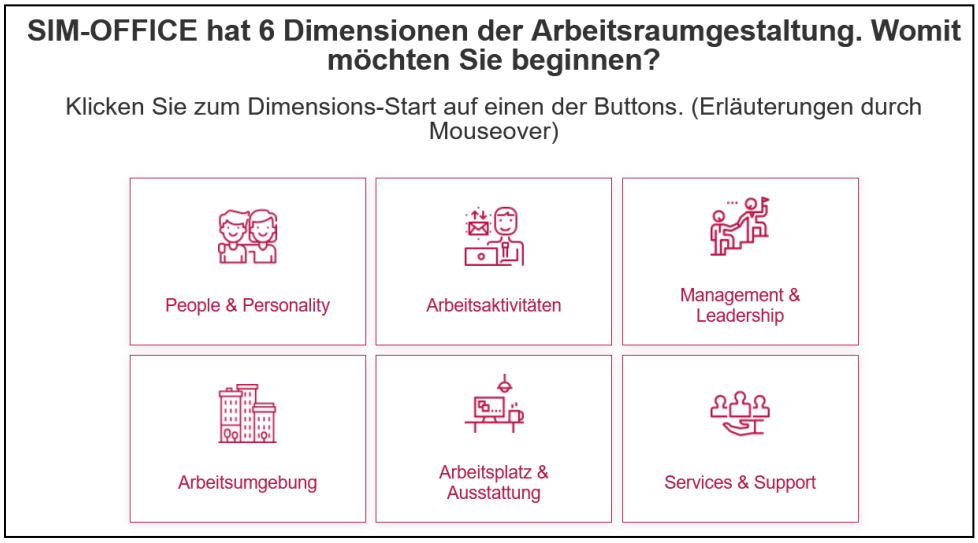
Originality: SIM-OFFICE introduces an engaging, gamified method for identifying individual office work types, fostering the creation of optimal workspaces and advancing the understanding of complex parameter configurations in workplace environments.
Limitations: The short paper can only give an overview of the tool's grounding theory, methodology and pilot data which will be further detailed in the journal paper.
Practical and Theoretical Implications: The tool's originality and the pilot findings underscore its potential to significantly enhance workplace design projects by providing evidence-based insights, especially for companies without consulting resources. As the empirical database grows, it continually allows for testing, refining, and advancing the applied models and theories.
Social Implications: The app motivates office workers to actively engage with their work environment and communicate their needs to companies. Moreover, it empowers users to enhance their workplace literacy, enabling them to more effectively understand and influence their work environment.

Keywords
workspace design; office environment; preferences; personality traits; job tasks; configurations; gamified workspace survey; pattern recognition; workspace education

1. Introduction

The transformation of work into predominantly knowledge-based activities demands an environment that nurtures health, well-being, and ultimately enhances performance. Recent studies emphasize the critical role of workspace design in influencing these outcomes, suggesting that workspaces tailored to the specific needs of employees can significantly improve their performance and satisfaction (Groen et al. 2019, Bergefurt et al. 2024). In this evolving landscape, SIM-OFFICE provides a robust tool that employs the Performance-oriented Office Ecology Model (OEM) to systematically assess and categorize workspace preferences, thereby enabling the development of workspace typologies that align with contemporary workforce needs (Kämpf-Dern and Konkol 2017). SIM-OFFICE is purpose-built to facilitate the empirical investigation of how various workspace elements impact individual and collective performance. By integrating data across six key dimensions—People & Personality, Work Activities, Management & Leadership, Physical Work Environment (Arbeitsumgebung), Workplace Technology (Arbeitsplatz & Ausstattung), and Workspace Services – SIM-OFFICE allows for a nuanced analysis of the interplay between personal preferences and workspace configurations (e.g. van den Berg et al. 2020; Weijs-Perrée et al. 2020).

Figure 1. Six Dimensions of SIM-OFFICE (Start Screen, Selection of dimension to begin with))



The first three dimensions of SIM-OFFICE cover the inner dimensions of the OEM which 'set the stage' for the latter three which are the 'design' dimensions of a fitting workspace.

The objective of this paper is to illustrate how SIM-OFFICE leverages detailed user-generated data to support the creation of work environments that are not only responsive to user needs but are also grounded in rigorous empirical research. The OEM underpins this process, providing a comprehensive framework that prioritizes employee well-being as a precursor to enhanced performance. This shift is critical as organizations increasingly recognize the importance of flexible, adaptive workspace designs that accommodate a range of activities and working styles, a need made more pressing by the rise of remote and hybrid work models (Haynes 2008;van den Berg et al. 2020).

This paper will delve into the theoretical foundation of SIM-OFFICE, focusing on its overall approach to data collection and analysis. It will discuss how the tool not only gathers extensive data across multiple workspace dimensions but also analyses this data to develop evidence-based, performance-enhancing workspace solutions tailored to the needs of knowledge workers. Section 2 and 3 will explore the theoretical underpinnings of SIM-OFFICE, Section 4 its practical application in gathering and analyzing workspace preference data, and Section 5 the potential implications of its findings for the future of workspace design.

2. Theoretical Background

The theoretical landscape of workspace design integrates models from environmental psychology, ergonomics, and organizational behavior, each providing validated scales for empirical work. The Office Ecology Model systematically employs these models to elucidate the impact of workspace design on employee engagement, well-being, and ultimately, performance.

Environmental psychology is represented by theories like the supportive design concept, which posits that workspaces tailored to specific tasks can enhance focus and reduce stress, thereby

improving well-being and performance (Vischer 2007; van den Berg et al. 2020). Ergonomics contributes through its focus on optimizing physical workspace aspects—like lighting and layout—which directly impact health and indirectly influence performance through increased comfort (Robertson et al. 2008; Artan et al. 2024).

Organizational behavior incorporates the Job Demand-Control-Support model, suggesting that environments providing better work method control and supportive interactions boost engagement and satisfaction (Karasek and Theorell 1990; Colenberg et al. 2021). Additionally, the Person-Environment Fit (P-E Fit) theory is crucial in assessing alignment between individual needs and environmental provisions, influencing engagement and performance (Edwards et al. 1998; van den Berg et al. 2020).

The Five Factor Model of personality (McCrae and John 1992) and Graves' Values System (Graves 1970; Beck and Cowan 2006) are operationalized within SIM-OFFICE to fine-tune workspace designs according to personality traits and organizational culture preferences, directly affecting user satisfaction and productivity.

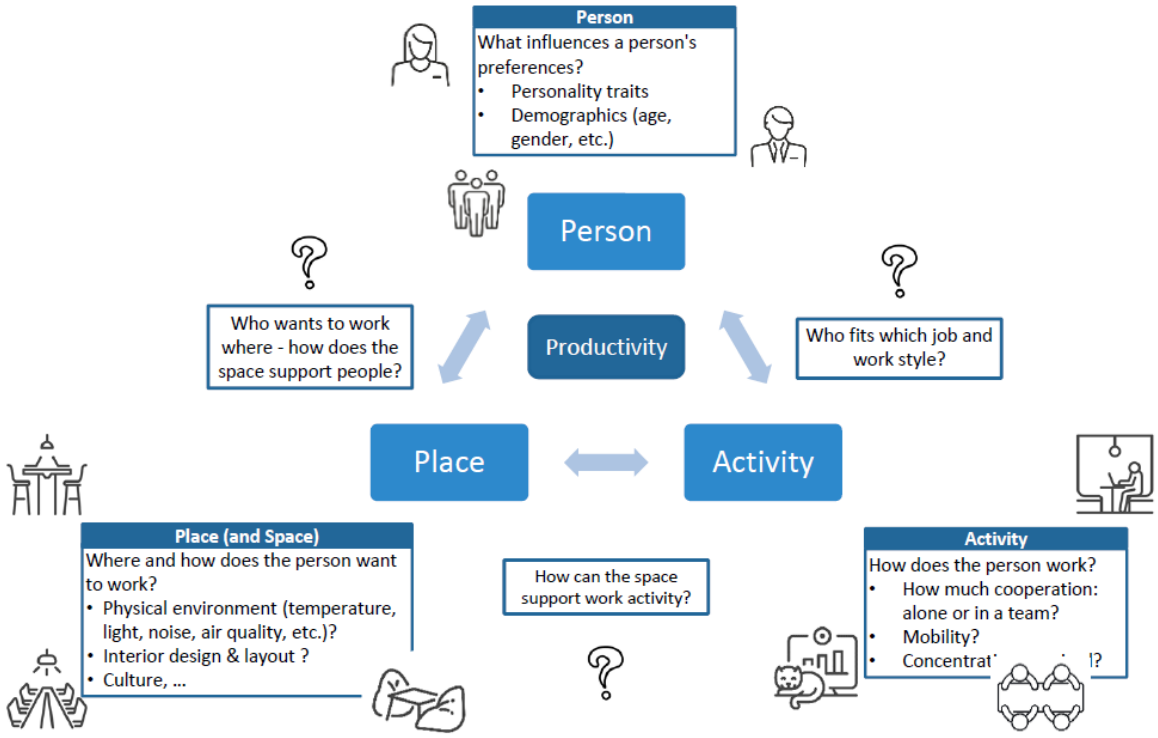
Furthermore, the integration of advanced technologies for data collection, as discussed in Artan et al. (2024), facilitates a more precise assessment of user interactions with workspace services, enhancing the accuracy and applicability of workspace solutions.

By grounding its methodologies in these well-established and contemporary theories, SIM-OFFICE ensures that its assessments and recommendations are both scientifically robust and aligned with modern workspace design principles, enabling the development of interventions that enhance both individual well-being and organizational performance.

3. Description of SIM-OFFICE

SIM-OFFICE employs a gamified approach to systematically collect data across six dimensions, focusing on identifying typologies in workspace preferences and contexts. The six dimensions are described in further detail in subsection 3.1-3.6.

Figure 2. Relationships between PERSON (Dim 1), ACTIVITIES (Dim2) and PLACE (Dim 3-6) (Kämpf-Dern, Strubelt 9/9/2022)



Utilizing theories from psychology and organizational behavior, SIM-OFFICE integrates established scales to ensure the reliability and validity of data, crucial for developing workspace typologies.
The gamified approach, described in subsection 3.7, engages users in dynamic interactions, encouraging the exploration of individual and collective workspace needs.

3.1 People & Personality

The People & Personality dimension leverages the Big Five personality model, which assesses traits influencing individual behaviors and preferences within workspace environments. These traits—openness, conscientiousness, extraversion, agreeableness, and neuroticism—serve as a psychological foundation for identifying user typologies that align with specific workspace configurations (McCrae and John 1992; Goldberg 1993).
Research has demonstrated how personality traits can influence workspace preferences. For example, extraverts generally prefer open, interactive office layouts that facilitate social interactions and collaborative work, whereas introverts may favor more private, quiet spaces that support independent work (Judge et al. 2002; Wilmot and Ones 2019). Nigel Oseland's research further supports this, highlighting how workspace design can impact productivity and well-being by accommodating individual personality differences (Oseland and Hodsman 2020; Oseland and Catchlove 2020).

Additionally, demographic variables such as age, gender, professional tenure, and job title are collected at the conclusion of the SIM-OFFICE assessment. These variables provide contextual depth, enhancing the understanding of how various factors may intersect with personality to influence workspace preferences. For instance, research suggests that younger employees often value flexibility and technology integration in their work environments, reflecting broader generational shifts towards mobility and digital fluency (Society for Human Resource Management 2021; Oseland and Catchlove 2020).

This comprehensive approach to data collection enables SIM-OFFICE to develop nuanced user typologies, which are crucial for crafting workspaces that genuinely meet diverse employee needs. While initial workspace recommendations based on this data are exploratory, they will be refined over time as empirical evidence accumulates, allowing for more targeted and effective workspace designs.

3.2 Work Activities

The Work Activities dimension in SIM-OFFICE meticulously captures detailed data about the types of tasks that users perform and their preferred work styles, such as whether they prefer working alone or in groups, and whether their tasks are more data-oriented or people-oriented. This dimension focuses solely on understanding the variety and nature of activities without suggesting specific workspace settings, which are addressed in later dimensions.

Activity-based working principles underpin this dimension, emphasizing the need for workspaces to support a variety of tasks effectively. By gathering data on how often employees engage in different types of activities—ranging from intensive, individual tasks to collaborative projects—SIM-OFFICE helps delineate the diverse functional needs within a workforce (van den Berg et al. 2020). For example, users might specify their frequency of collaborative versus solitary tasks, or their preference for interacting with people versus working with information systems.

Research has shown that aligning workspace design with the actual activities performed can significantly enhance both productivity and well-being (Danielsson and Bodin 2008; Croon et al. 2005). For instance, studies suggest that understanding whether employees perform better in team settings or when working alone can inform more effective workspace planning that caters to these preferences (Oseland and Catchlove 2020; Haynes 2008).

This dimension gathers insights into how employees prioritize their activities, which is crucial for identifying core tasks that drive their daily workflows. This data forms the basis for developing user typologies that reflect true operational needs without making immediate recommendations for workspace modifications.

3.3 Management & Leadership

The Management & Leadership dimension in SIM-OFFICE is designed to assess the organizational culture and leadership styles. It futhermore gathers insights into the managerial context and its impact on employees' work experiences.

Leadership styles significantly affect employees' perceptions and productivity. Transformational Leadership, which involves inspiring and motivating employees, is linked to higher engagement and performance levels (Avolio and Bass 1995; McCall 1986). Additionally, organizational culture, defined by shared values and norms, profoundly impacts employee satisfaction and alignment with the company (Schein 2010; Cameron and Quinn 2011).

SIM-OFFICE incorporates the Graves Value Model to assess the alignment between employees' values and the organizational culture. This model helps identify how well employees' personal values mesh with the perceived corporate values, which is key to understanding their satisfaction and fit within the organization (Graves 1970).

Furthermore, the dimension explores how management styles influence preferences for flexible working arrangements and technology use, affecting how physical and technological workspaces are configured (Judge and Piccolo 2004; Xiong Chen and Aryee 2007).

By collecting data on these aspects, SIM-OFFICE provides organizations with insights into how leadership, cultural and managerial aspects are perceived by different personalities and professions, impacting employee experiences and workspace requirements.

3.4 Physical Work Environment

The Physical Work Environment dimension of SIM-OFFICE covers but extends beyond the conventional office to include a broad array of physical locations where work is conducted, such as home offices, third places like cafes or libraries, outside and mobile settings like trains or cars. This dimension explores user preferences for different work environments and their specific attributes including temperature, lighting, noise levels, air quality, and spatial configuration, as well as materials, colors or room atmospheres.

Research highlights the profound impact of the physical environment on productivity, comfort, and overall job satisfaction. Elements such as natural light, adequate ventilation, and ergonomic furniture significantly enhance worker concentration and well-being (Heerwagen 2000; Veitch et al. 2008). In this dimension, SIM-OFFICE collects data on preferences for various environmental conditions, using interactive questions that allow users to specify their ideal settings for light, temperature, and acoustics.

Acknowledging the diversity of modern work dynamics, this dimension captures preferences for where work is best performed, accommodating the growing need for flexibility and personalization. The concept of third places, as discussed by Oldenburg (1999), emphasizes the importance of informal public places that are neither home nor work. These settings can foster community and creativity, providing a conducive environment for certain types of work activities or personalities.

Moreover, the survey asks about preferences for working onsite, remotely, or in a hybrid model, reflecting the increasing adoption of flexible working arrangements that have been shown to improve employee engagement and retention (Haynes 2008; Croon et al. 2005). Such insights are crucial for

understanding how physical location preferences intersect with individual job functions and lifestyle needs.

By gathering detailed information on the preferred physical work environments, SIM-OFFICE aims to develop workspace solutions that not only focus on the immediate physical attributes of spaces but also consider the broader contexts in which modern work occurs. This approach ensures that workspace design recommendations can accommodate a wide range of environmental preferences and adapt to the evolving needs of today's workforce.

3.3 Workplace Technology

The Workplace Technology dimension of SIM-OFFICE encompasses a broad range of tools and equipment that support daily work activities, extending beyond digital technologies to include furniture, lighting, basic hand tools, or decoration and plants. This dimension evaluates the adequacy and effectiveness of these resources in supporting employee comfort and productivity.

Questions in this dimension are designed to assess how well current workplace technologies meet the needs of employees, from the ergonomics of chairs and desks to the functionality of computer systems and connectivity solutions. For example, inquiries might focus on the sufficiency of screen quality for visually intensive tasks, the reliability of internet connections, or the adequacy of storage solutions for tools and materials (Wajcman 2015).

Recent studies underscore the importance of integrating efficient technology and ergonomic furniture to reduce physical strain and increase job satisfaction (Pejtersen et al. 2010; Hedge 2017). By collecting data on these aspects, SIM-OFFICE aims to identify gaps in technology provision that could hinder performance.

3.6 Service & Support

The Service & Support dimension of SIM-OFFICE is designed to capture preferences for a range of workplace services that support employee well-being and productivity. This dimension explores which services employees value most, including IT support, health and wellness programs, mental health services, childcare, fitness facilities, food services, and transportation options.

Understanding employee preferences for these services is crucial for developing typologies that can guide the enhancement of workplace environments. For example, preferences for onsite childcare versus remote work support services can indicate differing needs based on employee demographics or job roles (Kossek et al. 2015; Tammy D. Allen 2001). Additionally, interest in amenities like fitness facilities or relaxation areas might reflect a workforce's emphasis on health and wellness as integral to their ideal work environment (Edmondson 2018).

3.7 Gamification

According to Deterding et al. (2011), "gamification" is defined “as the use of game design elements in non-game contexts.” This concept applies to SIM-OFFICE, which aims to facilitate learning and contribute to research. Studies have shown that gamification can significantly improve user engagement and motivation and is effective for educational purposes. (Luo 2022)

Gamification is achieved through the inclusion of typical game design elements or gamification mechanisms. Some common game elements include points, badges, leaderboards, trophies,

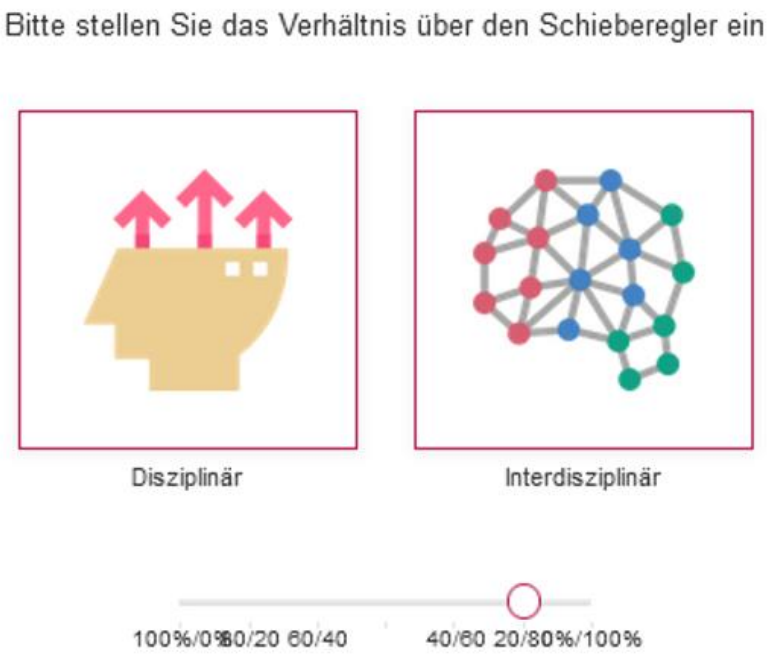
levels, tasks, and scoring systems. (Luo 2022) More critical for SIM-OFFICE are gamification mechanisms, which are “underlying guidelines that make gamification activities engaging, originating from human needs and desires.” Relevant examples include meaning, curiosity, self-expression, feedback, achievement, exploration, competition, collaboration, fantasy, fun, interaction, and user control. (Luo 2022) Unlike the development of serious games, gamification allows game elements to be applied in isolation. (Landers et al. 2017)

This paper briefly addresses which game elements and/or gamification mechanisms are included in SIM-OFFICE, or can be added in the future to maximize user engagement, learning, and research on optimal workspace configuration.

Firstly, allowing users to explore their preferences in a self-guided manner is a major driver. ‘Players’ can choose which dimension to start with or proceed to next. Completed dimensions are marked with a badge, indicating accomplishment.

Figure 3. Achievement and ‘Levels’(SIM-OFFICE)

Figure 4. Visualization & Sliders (SIM-OFFICE)



The integration of interactive elements such as sliders, sortable lists, and draggable buckets enhances user engagement and improves data quality by capturing nuanced preferences effectively. These gamification techniques make the survey process more intuitive, facilitating the collection of detailed data essential for constructing accurate workspace typologies (Deterding et al. 2011; Hamari et al. 2014; Landers et al. 2018). This approach ensures that the workspace recommendations developed are based on solid, empirically validated data.

Instant feedback, provided as documentation of stated preferences and scientifically validated insights, has been found to be a strong motivator. Competition can be introduced through contests between departments or companies to achieve the highest participation rates.

By gathering data on these preferences, SIM-OFFICE helps organizations identify which support services are most critical to their employees, facilitating targeted investments that can improve overall job satisfaction and productivity. This approach allows for a more nuanced understanding of how different types of support services can enhance workplace effectiveness and employee engagement.

This comprehensive approach to data collection allows SIM-OFFICE to develop nuanced user typologies and perform group- or company-specific analyses, supporting the development of workspaces that genuinely meet diverse employee needs. While initial recommendations are exploratory, the growing dataset will enable researchers to refine these insights over time, tailoring environments to enhance both individual well-being and collective productivity.

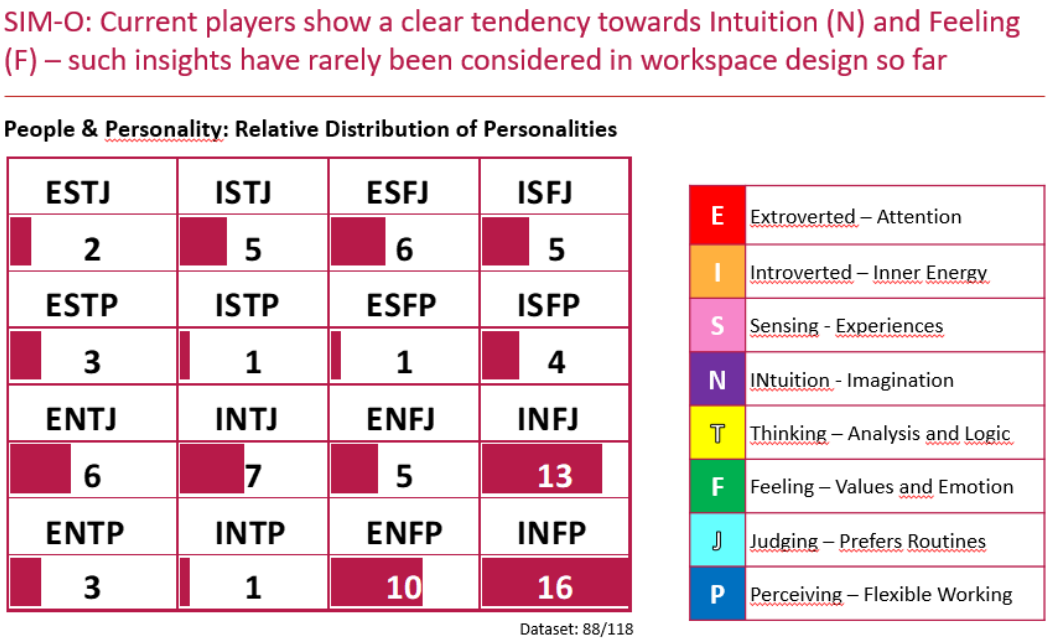
4. First Empirical Findings and Limitations

The pilot study of SIM-OFFICE, conducted in the fall of 2018, engaged 118 participants, who had the option to select how many of the six dimensions they wished to respond to, explaining the varying participant numbers across dimensions. This choice resulted in uneven data samples for each dimension.

First results show the direction of analysis with results that seem to fit to proven knowledge, while the data set had been far too small and too diverse to allow to identify typologies yet:

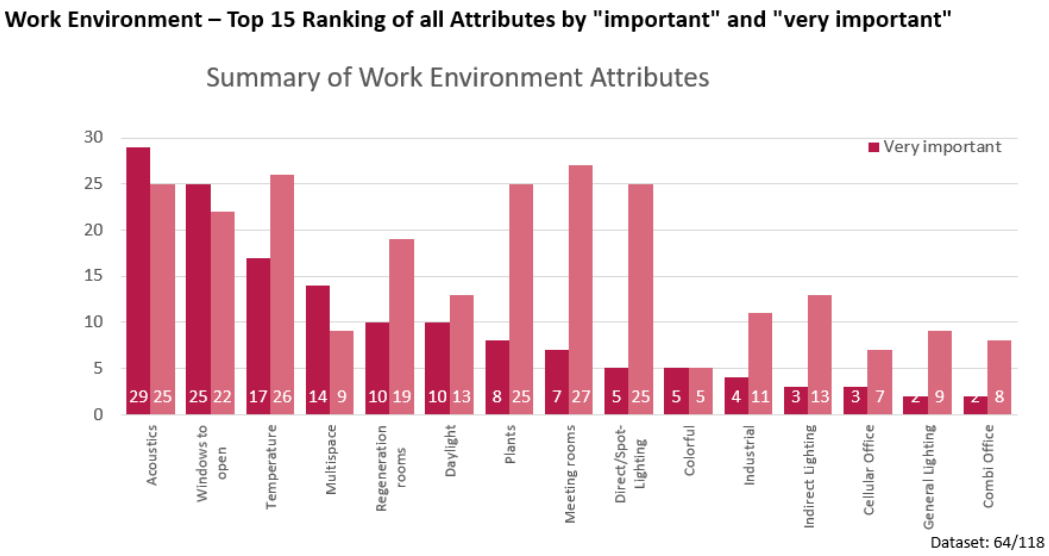
- People & Personality: Of the participants who chose this dimension, traits such as openness and conscientiousness showed distinct correlations with preferences for specific types of workspaces. For instance, extroverts demonstrated a clear preference for open and interactive office layouts, a trend that supports the hypothesis of personality impacting workspace design preferences.

Figure 5. Distribution of Personalities (SIM-OFFICE, Pilot Study 2018)



- Work Activities: This dimension revealed that 45% of participants prefer collaborative tasks, which aligns with their choice of open spaces. The data indicates that individuals' tasks—whether data or people-oriented—influence their workspace configuration preferences.

Figure 6. Work Environment Attributes (SIM-OFFICE Pilot Study, 2018)



- Physical Work Environment: Participants rated various environmental factors like lighting, temperature, and noise. The average scores indicated a preference for natural lighting and moderate noise levels, which varied slightly depending on the individual's role and seniority.
- Management & Leadership: Data from this dimension suggested a desire for more supportive and transformational leadership styles, with 60% of participants favoring leadership that actively fosters professional growth and innovation.

Limitations:
The findings are primarily based on descriptive statistics and trends and exploratory due to the pilot's scale—specifically, the relatively small sample size in relation to the number of dimensions and survey items. This limitation highlights the need for a much larger participant base and possibly reducing the number of highly correlating items within each dimension to streamline the survey process and reduce the average completion time, which currently stands at 40 minutes for all six dimensions.
More graphs and numerical data will be added in the journal article in the appendix to support the indicative results in this short paper.
These findings are merely exploratory (moreover collected before 2020 = Pre Covid), but indicate the potential of the SIM-OFFICE app as an innovative tool to survey a large group of people, a prerequisite to get into typology identification. As more comprehensive datasets will become available, SIM-OFFICE aims to develop more accurate and validated workspace typologies, ultimately leading to work environment configurations that optimally support diverse employee needs.

5. Future Research Directions and Outlook

As SIM-OFFICE continues to evolve, future research will focus on expanding participant engagement and refining the tool's data collection and analysis capabilities. The following directions are

anticipated to enhance the efficacy and applicability of SIM-OFFICE in developing workspace typologies that are scientifically robust and practically relevant.

1. Increasing Participant Diversity and Number:

To overcome the limitations noted in the pilot study, a crucial objective is to increase the diversity and number of participants. This expansion will ensure a broader representation of workspace preferences across different industries, roles, and cultural backgrounds, providing a richer dataset for analysis. Efforts will include targeted outreach and simplified survey processes to reduce participation barriers and fatigue.

2. Integration of Advanced Analytical Techniques:

Incorporating more sophisticated statistical methods, such as machine learning algorithms and predictive modeling, will allow for deeper insights and more accurate predictions of workspace needs. These techniques will enable SIM-OFFICE to identify subtle patterns and relationships within the data that may not be apparent through descriptive statistics alone.

3. Optimization of Survey Items:

Based on the feedback from initial data collection, the survey will undergo refinements to reduce the number of items, especially those that are highly correlated. This step will not only shorten the survey time but also focus on the most impactful questions, enhancing the quality and relevance of the data collected.

4. Enhanced Gamification and Simulation Features:

To improve engagement and data quality, future versions of SIM-OFFICE will feature enhanced gamification elements and simulation. These will include more interactive and immersive tasks that mimic real-life decision-making scenarios, making the data collection process more enjoyable and reflective of actual workspace preferences.

These first four items are critical for the success of SIM-OFFICE. The following three are further ideas for improvements:

5. Collaborations with Industry and Academic Institutions:

By partnering with various organizations and academic institutions, SIM-OFFICE can leverage external expertise and resources. These collaborations will aid in refining the tool's theoretical underpinnings, and ensure that the workspace designs it suggests are innovative and aligned with the latest research in environmental psychology, ergonomics, and organizational behavior.

6. Longitudinal Studies and Follow-up Surveys:

Implementing longitudinal studies and periodic follow-up surveys will help track how workspace preferences evolve over time and how changes in workspace design impact employee satisfaction and productivity. These studies will provide invaluable feedback on the long-term effectiveness of implemented workspace solutions.

7. Focus on Sustainability and Well-being:

Future updates will increasingly consider environmental sustainability and employee well-being. Research will explore how eco-friendly practices and designs contribute to workspace satisfaction and productivity, aligning with global trends towards sustainability.

6. Conclusion

SIM-OFFICE effectively harnesses user-generated data to inform the design of work environments that align with varied employee needs. By systematically developing user typologies, it provides a foundation for creating spaces that enhance both individual and organizational performance. Moving forward, enhancing data collection and expanding research methodologies will further refine the tool's capacity to deliver tailored workspace solutions.

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Appraising the Influence of Individual Workspace Preferences on the Perceived Productivity and Wellbeing of Employees: A Scoping Review

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ABSTRACT

Workspaces should provide a sense of comfort and positive wellbeing as workers spend a large amount of time there. Also, productivity can be affected by a number of varying working conditions and indoor environment quality (IEQ) levels. Such working conditions include abuse of power in assigned roles, gross mismanagement, increased overtime working and noise levels, while IEQ-related factors comprise of acoustic comfort, indoor air quality, interior designs, thermal comfort, and visual comfort. The persistence of these conditions has been largely attributed to nature of the physical workspace environment. Considering the plethora of workspace environments in existence it is believed that employees would prefer certain workspace environments. Impliedly, understanding employees' preferred workspace environments would contribute positively to their productivity and wellbeing. Therefore, it has become imperative to determine this nexus as it would facilitate the development of a mechanism for effective workspace allocation in corporate organizational settings. However, studies seeking to achieve this objective remain scant. This is the gap that this study seeks to address. The aim of this study is to determine if an individual's preference for certain workspace environments can influence his/her perceived levels productivity and wellbeing. This paper relied on the principle of the person-environment fit theory to explore the alignment between individual preferences and the surrounding environment. The study employs a

scoping review methodology for data collection. The selected papers were thoroughly analysed to provide an overview of findings and research gaps. The study found that by incorporating individual traits and demographic information allows for creating workspaces which are highly productive and contribute positively to wellbeing. The findings contribute towards developing a framework for understanding how employee workspace design preferences affect productivity and wellbeing from an individual prospect.

Keywords
Design, Employee, Workspace, Productivity, Wellbeing

INTRODUCTION

Corporate real estate (CRE) literature reports that workspaces are largely responsible for productivity of workers in organizations (Appel-Meulenbroek, et al., 2011). Accordingly, it is expected that organizations should create workspaces which enhances the productivity of workers (Appel-Meulenbroek, et al., 2011). Similarly, the attaining job satisfaction whilst maintaining positive wellbeing has been noted as increasing productivity at an individual and organizational level (Chan, et al., 2007). Therefore, employees are known to be more productive the more satisfied they are at work (Mufti, et al., 2019). In order to maintain an advantage within the business environment, it has been seen that employee's satisfaction, productivity and wellbeing need to be catered for (Rothe & Nenonen, 2012). It can then be concluded that there is a relationship between the type of work environment a worker is exposed to, and the degree of job satisfaction derived there from and the person's contribution to the overall performance of the organization (Raziq & Maulabakhsh, 2015). Such nexus has been explained severally from the person-environment (P-E) fit theoretical lens (Kristof-Brown & Guay, 2011).

Kristof-Brown & Guay (2011) defined person-environment (P-E) fit as connoting the compatibility between employees and the environments in which they find themselves. The theory highlights the complementarity which ought to exist between an individual's personality traits and aspirations and the characteristics of their working environment (Ahmad, et al., 2011). It is considered as a multidimensional construct as it encompasses various aspects of the working environment in which workers centred in (Kristof-Brown & Guay, 2011). Scholars posit that organisations which can cater to wellbeing their employees have higher chances of retaining them (Su, et al., 2015). The P-E fit indicates that the wellbeing of an employee is not only influenced by their environment but also their individual personality traits (Shipp & Jansen, 2011). Such traits comprise of capabilities, knowledge, needs skillsets, beliefs, and values while organisational values, role characteristic and structures make up the environmental characteristics (Shipp & Jansen, 2011).

The P-E fit comprises of four sub-constructs within the organisational context namely; person-organisation (P-O) fit , person-group (P-G) fit, person-job (P-J) fit (Su, et al., 2015) and person-culture (P-C) fit (Fulmer, et al., 2010). Each fit plays a role in the P-E fit theory and includes productivity and wellbeing as measures of assessing influence. For example, the person-culture (P-C) fit indicates that positive psychological wellbeing may be influenced by a person's individuality and their surrounding culture (Fulmer, et al., 2010; De Leersnyder, et al., 2015). The P-C fit includes compliance with healthy lifestyle, decreased problems, enhanced life outlook, improved mental

capacity, and improved wellbeing (De Leersnyder, et al., 2015; Levine , et al., 2016). Improved wellbeing can also be influenced by an employee's individual preferences for certain workspace features. Such features could include exposure to either artificial or natural lighting within the workspace which could in turn, affect sleep quality (Colenberg, et al., 2020) and potentially culminate in shorter attention span and fatigue (Jamrozik, et al., 2019) for some workers and not for others. Other features of the workspace which tend to affect employees differently include noise exposure (Lin, et al., 2018), and thermal comfort (Lamb & Kwok, 2016). Both features have been identified as affecting the mood and fatigue levels of employees (Lamb & Kwok, 2016; Lan, et al., 2020).

Based on the foregoing, it can be discerned that increased attention has to be paid to the development and sustenance of high-performance workspaces to enhance employee productivity and wellbeing. Whereas this notion has received attention in extant literature, scant studies have sought to explore the consideration of the individual preferences of employees concerning workspace features and the impact of such features on their productivity and wellbeing. This study contributes towards addressing this knowledge-practice gap. The rest of the paper is structured as follows: methodology, presentation and discussion of findings, and conclusion.

Methodology

A scoping review was adopted for this study. This research design allows for a review of existing literature with the aim of mapping the extent of existing research within a specific field (Khalil, et al., 2016). Scoping review stems from a systematic review of extant literature; however, it summarizes the data and allows for the identification of research gaps within it (Arksey & O'Malley, 2005). It allows for a broader and increased range of research and conceptual issues to be considered unlike a systematic review which has a more defined scope (Cooper, et al., 2021). The study sets out to determine if an individual's preference for certain workspace environments can influence his/her perceived levels of productivity and wellbeing. The literature which was utilized was based on highlighting a detailed perspective on the findings of how IEQ and layout affects certain individuals however the final findings considered the holistic viewpoint. The articles also had more than ten citations. This study utilized the Scopus database and the following key words; "workplace" OR "workspace" OR "work environment" AND "employee" OR "worker" AND "productivity and wellbeing and health and individual preferences" or "individual attributes and physical characteristics and design" to source for relevant literature. The search was limited to English language and to engineering, management science and business. Furthermore, the search was limited to journal and review articles, book chapters, and books. Conference papers were excluded. In all twelve (12) peer- reviewed publications comprising of 2 book chapters and 10 journal articles published between 2013 and 2023 were identified and utilized for the study.

Presentation AND DISCUSSION of findings

In this section, the findings from the scoping review are presented thematically.

Workspace features impacting on employee health, wellbeing and productivity

The workspace does not generate any revenue but when designed accurately, its potential to promote organizational productivity becomes more pronounced (Wineman & Barnes, 2018). The main goal for any workspace is to foster high levels of productivity, health and wellbeing among employees whilst enabling increased engagement with other employees (Kleine, et al., 2019). Productivity refers to the amount of monetary value produced given the hours worked within the office (Stratford, 2020; Dávila-Fernández & Sordi, 2020). The wellbeing of workers includes physical and mental health conditions (Hafner, et al., 2015). Health conditions includes asthma (Chen, et al., 2008), absenteeism (Bradley, et al., 2006), fatigue and reduced sleep (Beesley, et al., 2011), also depression, anxiety and obsessive-compulsive disorder (Kendrick & Pilling, 2012). Isham, et al. (2021) found that increased display of improved wellbeing results in increased productivity, which is also seen in the type of health conditions. One of the positive effects of decreasing rate of productivity would be improved wellbeing of the individual (Isham, et al., 2021).

The design of a workspace engender decreasing levels of stress and burnouts among these employees (Kleine, et al., 2019). Therefore, improving workspace conditions is said to enhance organizational productivity by a minimum of 2% thereby posting a positive impact on the organization's financial bottom-line (Clements-Croome & Baizhan, 2000). Organizational productivity is not only linked to work performance of employees but also their positive attitudes and pleasant relationships amongst themselves (Sheel, et al., 2012; Ramawickrama, et al., 2018). The design of a work environment impacts on overall organizational productivity (Van de Voorde, et al., 2012). Such impact also extends to the health and wellbeing of those working within the workspace (Hanc, et al., 2019). The creation of a productive workspace should consider the following: personality of the employee, privacy, temperature, degree of thermal comfort, air quality, lighting, noise, degree of biophilia, office layout and design, indoor environmental quality and technological devices used (Appel-Meulenbroek, et al., 2021; Haynes, et al., 2017). These can be grouped into two namely personal aspects and environmental aspects within the workspace (Appel-Meulenbroek, et al., 2021).

Budie, et al. (2019) indicated that research conducted on workspace designs are usually more focused on the measure of the characteristics of the workspace without regarding employee needs. Furthermore, Appel-Meulenbroek, et al., (2019) considered the effects of certain workspaces to millennials and observed that their (millennials) preferred workspace setting was rather different from that of generation X. Impliedly, there is need to consider the personality traits of employees when designing workspaces to ensure congruence between such traits and an understanding of employee preferences for workspace features. The physical work environment comprises of form, finishings, and spatial arrangement of design features (Ching & Binggeli, 2018). These design features include furnishings, lighting fixtures and sources, spatial partitions and transitions, acoustics accessories and technologies relating to space (Ching & Binggeli, 2018), which indicates the inclusion of both aesthetic and architectural elements therein (Colenberg & Jylhä, 2022).

To create a workspace which positively affects employee health, wellbeing and productivity, the design should incorporate elements which facilitate such outcomes (Cirrincione, et al., 2020; Colenberg & Jylhä, 2022). For instance, the use of smaller, more intimate office spaces allowed for increased interactions and forming of friendships thereby contrasting with the provisions associated with open-plan offices (Morrison & Macky, 2017). Torbeyns, et al. (2016) indicated that the use of

open-plan offices negatively affects forming relations at work due to limited privacy during interactions. The smaller spaces could also allow personalization of space which leads to increased job satisfaction on the part of employees (Colenberg & Jylhä, 2022). The amount of lighting provided within the workspace has been observed to improve physical wellbeing as it affects the visual comfort which could be associated with health issues such as headaches and eye discomfort (Lamb & Kwok, 2016). Noise is a well-known factor for discomfort which could lead to stress hence the suggestion of using of sound absorption elements to limit disruptions (Lamb & Kwok, 2016; Shafiee-Motlagh, et al., 2018). The ability to control indoor climate such as the temperature has been viewed as another measure of increasing wellbeing as this allows the individual to set their preferred climate within their workspace (Boerstra, et al., 2015) **(see Table 1)**. It has been noted that employees have experienced positive effects when in contact with nature either directly, indirectly or in a symbolic manner (Lerner & Stopka, 2016). This has occasioned the introduction of natural or artificial plants within the workspace in recent times. Such additions have been reported to positively affect employee wellbeing and productivity (Bjørnstad, et al., 2016; Xue, et al., 2016; Lerner & Stopka, 2016). This is regarded as making use of biophilic designs. The use of biophilic design which creates a connection with nature (Colenberg & Jylhä, 2022).

Aspects of wellbeing influenced by workspace features

Worker retainment is essential for organizations to be able to meet the set standards and goals of the organization (Ng'ethe, et al., 2012). It is thus vital to establish the type of workspace which caters for the wellbeing of workers which in turn allows for them to accomplish set tasks (Janse van Rensburg, et al., 2017). Flourishing has been used in psychology to describe wellbeing (Janse van Rensburg, et al., 2017). The 'flourishing concept' incorporates aspects such as psychological wellbeing, social wellbeing, and emotional wellbeing (Janse van Rensburg, et al., 2017; Keyes & Anna, 2009). These aspects can be further broken down to include happiness, life satisfaction and work-life balance (Janse van Rensburg, et al., 2017). Emotional wellbeing can be described as feeling well while psychological and social wellbeing is described as functioning well (Rothmann, 2013).

Table 1 Influence of workspace features on employee productivity, health and wellbeing

Aspect Influenced	**Workspace Features**					
	Indoor Environmental Quality					**Interior Design**
	Acoustic Comfort	**Visual comfort**	**Thermal Comfort**	**Noise Levels**	**Indoor Air Quality**	
Productivity	(Appel-Meulenbroek, et al., 2011) (Patel & Alfaro, 2020) (Appel-Meulenbroek, et al., 2022) (Kropman, et al., 2023) (Hills & Levy, 2014):	(Appel-Meulenbroek, et al., 2011) (Patel & Alfaro, 2020) (Appel-Meulenbroek, et al., 2022) (Kropman, et al., 2023) (van der Berg, et al., 2020) (Hills & Levy, 2014) (Bergefurt, et al., 2023)	(Patel & Alfaro, 2020) (Kropman, et al., 2023) (van der Berg, et al., 2020) (Hills & Levy, 2014) (Bergefurt, et al., 2023)	(Appel-Meulenbroek, et al., 2011) (Kropman, et al., 2023) (van der Berg, et al., 2020)	(Kropman, et al., 2023)	(Brennan, et al., 2002) (Appel-Meulenbroek, et al., 2011) (Patel & Alfaro, 2020) (Kropman, et al., 2023) (Weijs-Perrée, et al., 2019) (Hills & Levy, 2014):
Wellbeing	(Bergefurt, et al., 2023)	(Kropman, et al., 2023) (Hills & Levy, 2014):	(Bergefurt, et al., 2023)	(Kropman, et al., 2023) (Bergefurt, et al., 2023)	(Kropman, et al., 2023)	(Appel-Meulenbroek, et al., 2011) (Lai, et al., 2021) (Appel-Meulenbroek, et al., 2022) (Kropman, et al., 2023) (Hills & Levy, 2014):
Health	(Bergefurt, et al., 2023)	(Kropman, et al., 2023) (Hills & Levy, 2014):	(Bergefurt, et al., 2023)	(Kropman, et al., 2023) (Bergefurt, et al., 2023)	(Kropman, et al., 2023)	(Appel-Meulenbroek, et al., 2011) (Lai, et al., 2021) (Appel-Meulenbroek, et al., 2022) (Kropman, et al., 2023) (Hills & Levy, 2014):

5.2.1 Impact of layout design on productivity, health, and wellbeing

The use of open plan office increased the occurrence of disturbances (Brennan, et al., 2002; Appel-Meulenbroek, et al., 2011) and reduced privacy (Brennan, et al., 2002; Appel-Meulenbroek, et al., 2011; Patel & Alfaro, 2020). Distractions could be telephone, copy machines, movement of employees and even doors opening and closing, and increased disturbances impact the ability of concentration (Kropman, et al., 2023; Appel-Meulenbroek, et al., 2011; Patel & Alfaro, 2020; Hills & Levy, 2014). These disturbances are associated with acoustic comfort and visual comfort as they impact employee productivity (Appel-Meulenbroek, et al., 2011; Appel-Meulenbroek, et al., 2021). The lack of privacy is associated with other employees being able to see their computer screens (Appel-Meulenbroek, et al., 2011). The type of office is also said to interfere and limit confidential conversations from taking place (Brennan, et al., 2002), thereby negating effective communication amongst employees. However, in the case of using activity-based workstations (ABW) employees expressed a sense of comfort in having confidential conversations within ABW (Appel-Meulenbroek, et al., 2011), as they are seen to motivate social interactions amongst employees (Lai, et al., 2021). This has given rise to preference of partially enclosed offices which limit unwanted conversations (Appel-Meulenbroek, et al., 2022). Privacy will thus allow the incorporation of personal settings within the workspace, which positively impacts productivity (Appel-Meulenbroek, et al., 2011), this includes the ability to display work and achievements (Patel & Alfaro, 2020; Kropman, et al., 2023). van der Berg, et al. (2020) did previously indicate that personal settings do not have an impact of productivity, but this was found to be not the case. The inclusion of homelike artefacts does positively impact health and wellbeing (Weijs-Perrée, et al., 2019). The layout of the office impacts productivity as the need of flexibility is regarded which would allow for movement within the workspace (Kropman, et al., 2023) in which allowance for adequate space should be accounted for (Hills & Levy, 2014). Appel-Meulenbroek, et al. (2011) indicated that colour of the workspace does not influence productivity but the colours especially white and blue have been positively linked to improve productivity (Kropman, et al., 2023). Placement near windows in the workspace positively impacts health and wellbeing but the amount of expose, glare should be monitored (Kropman, et al., 2023; Hills & Levy, 2014). Inclusion of plants positively impact concentration, health, wellbeing, and productivity (Kropman, et al., 2023).

5.2.2 Impact of IEQ on productivity, health, and wellbeing

Previously Brennan, et al (2002) had indicated that noise does not affect productivity and wellbeing, but the level of noise within the workspace does affect wellbeing and productivity (Kropman, et al., 2023; van der Berg, et al., 2020; Bergefurt, et al., 2023; Boegheim , et al., 2022) hence there tends to be preference in working in a quiet setting (Appel-Meulenbroek, et al., 2022). The limit to noise exposure should not exceed 35 decibels as this does affect productivity (Kropman, et al., 2023). Brennan, et al (2002) indicated that lighting comfort does not impact productivity; however improved visual comfort allows for a sense of improved productivity (Patel & Alfaro, 2020; Kropman, et al., 2023; van der Berg, et al., 2020; Hills & Levy, 2014). The foregoing is indicative that employees tend to prefer artificial lighting over natural lighting due to the glare associated with the latter (Kropman, et al., 2023). Also allowing personal control of the lighting settings and indoor air quality does impact productivity, health and wellbeing (Kropman, et al., 2023). Scholars like Appel-Meulenbroek, et al. (2011) and Kropman, et al., (2023) observed that the control of indoor climate does not significantly affect

productivity but improved indoor air quality positively affects productivity, health and wellbeing. Furthermore, Brennan, et al (2002) indicated that thermal comfort did not affect employee productivity directly. A contrary view was held by Patel & Alfaro (2020) who maintained that thermal comfort did impact employee productivity, health and wellbeing in the workspace due to the resultant potential to lead to an increase in stress levels. It was also indicated that optimal temperature in workspaces should be set between 20 – 24 degrees Celsius (Kropman, et al., 2023). However, van der Berg, et al. (2020) indicated that a colder temperature setting is more likely to be preferred by employees.

The findings presented thus far are indicative of the salient impact of IEQ and workspace layouts on employee productivity, health, and wellbeing. The influence of these factors is linked to the prevailing ambient and environmental conditions (Muñoz, et al., 2021; Kim, et al., 2016).

Eliciting individual preferences for certain workspace attributes

The need to ascertain any correlations between individual traits of employees and how these traits influence employee perceptions of the contribution of certain workspace attributes to their productivity, health and wellbeing remains paramount in enabling effective workspace design. Some instances of this nexus is highlighted in studies like Patel & Alfaro (2020), where it was observed that female employees between the ages of 25 and 35 years and in key positions preferred the workspace layout design which allowed for improved interactions amongst employees. According to that study, members of that given demographic opined that such layout design improved their wellbeing and productivity. However, despite the craving for layouts that supported improved interaction between employees, the study reported that the desire of the same demographics for workspaces which provided for high levels of visual and acoustic privacy (Patel & Alfaro, 2020). Bergefurt, et al., (2023) in a more recent study, observed that male employees aged over 45 years without children opined that their wellbeing was negatively affected by increased noise levels whilst their productivity was negatively affected by thermal discomfort in the workspace.
Furthermore, Hills & Levy (2014) discovered that male employees in both junior and senior positions preferred workspaces which offered more natural light, hinting the significant contribution of this feature to their productivity. Also, male employees in senior positions indicated that sitting next to a window or near natural lighting improved their wellbeing whilst the degree of thermal comfort impacted their productivity levels directly (Hills & Levy, 2014), . The lack of privacy negatively impacts productivity which was indicated by males in senior positions (Hills & Levy, 2014).
It is indeed pertinent that such perceptions rising from the prevalence of certain individual traits should be delineated and deployed during workspace design and allocation.

Conclusion

Findings from this study highlight the significance of workspace attributes in impacting employee productivity, health, and wellbeing within the organization. Reportage from the extant studies reviewed mentioned attributes such as IEQ-related factors and office layout design as having considerable impact on employee productivity, health, and wellbeing. However, the study also established the varied perceptions of different employee demographics on the degree of contribution of these attributes to their productivity, health, and wellbeing. Whereas a plethora of studies have

focused on the establishment of workspace attributes which have either impacted or possess the potential to impact on employee productivity, health and wellbeing, limited studies have attempted to ascertain the correlation between the personality traits or demographic category of employees and their perception of the contribution of different workspace attributes to their levels of productivity, health and wellbeing. This study provides a foundation for developing requisite knowledge to bridge this gap. It is considered that addressing this gap would result in the prioritization of individual personality traits and demographic category in the allocation of workspaces in contemporary organizations rather than taking a one-size fits all approach as is currently the case which future studies could explore.

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Identification of employee workplace choice determinants– A Best-Worst scaling study

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ABSTRACT

Knowledge work can be performed at various workplaces. Especially in hybrid working environments, employees engage in mental accounting when choosing their workplace, which changes the role of the office. The decision-making factors of employees in their workplace choice are of particular interest for future viability of office properties but have been under-researched so far. Recently, some corporates introduced rules that force employees to return to the office, while others wonder what features the future office must have to encourage employees to come back. Initial studies have therefore investigated the question of why management calls employees back to the office. Even though corporates are increasingly incorporating the needs of their employees into their workplace management strategy to create higher added value for the company, there is still a lack of knowledge about why employees choose specific places to work at. This study aims to measure the importance of various determinants of workplace choice by examining different disciplines, such as corporate real estate management, human resource management and psychology. A Best-Worst Scaling experiment is performed with a German sample of knowledge workers (*N* = 350). The results reveal that the three most important factors for choosing a workplace are the flexible organization of the working day in terms of time and location, the compatibility of challenges in employees' private and professional life and the possibility to work in a concentrated manner. This study contributes to understanding employees' workplace choice by holistically investigating the influence of environment-related, job-related, and person-related determinants. The results help corporates improve their workplace strategy by aligning it with their employees' needs.

Keywords

Hybrid work, employee workplace choice, Best-Worst scaling experiment

1 INTRODUCTION

Since the Covid-19 pandemic, the office is no longer the sole place of work for knowledge workers. The nationwide switch to working from home has been followed by a hybrid way of working, with employees working partly in and outside the corporate office (Wessels et al., 2019; Vermani/Sharma, 2021). The freedom to choose where to work has become part of everyday life for many employees, and companies are faced with the challenge of offering a range of different workplaces. Additionally, the possibility to work from home as well as the freedom to work in third places (e.g., coworking spaces) is expected by employees (Oldenburg, 1999; Gauger, 2021). The variety of different work locations can be understood as a hybrid multilocal work environment (Boucken/Gantert, 2021). This existence of several workplaces side by side is changing the role of the office, as everyone no longer perceives it as the central place where work is carried out (Olckers/Koekemoer, 2022; Piechatzek, 2023). The shortage of skilled workers on the labor market intensifies the situation: as companies are struggling to find skilled workers, employees are increasing their demands on spatial flexibility (Suravi, 2024).

As a result, many offices are being used less than they were before the pandemic (Hensher et al., 2023). Increased public attention on working from home and employees' growing demands for flexibility have sparked the debate in corporate real estate management about surplus space and the need to adapt

corporate real estate (CRE) strategy to the new requirements (Marzban et al., 2021; Naor, 2022; Marx et al., 2023). In practice, companies currently follow different strategies. Some recognize that giving employees the freedom to choose where to work from increases their success and holds potential for the company and society (Pfnür, 2023). Others however, are urging their employees to work entirely in the office, due to a supposed decline in business performance (Appel-Meulenbroek et al., 2022; Hensher et al., 2023; Ding/Ma, 2024). The best approach for having successful employees and adding value to the company remains uncertain, given the contrasting strategies.

Despite the interest in hybrid working, it remains unclear why employees choose a specific workplace. Previous studies dealing with the reasons why or why not to work in a certain location relate solely to one kind of workplace: the home workplace, office, or coworking space. However, Spivack/Milosevic (2018) discovered that autonomy in the choice of where to work affects the well-being and satisfaction of knowledge workers. Their results show that people with higher perceived location autonomy tend to select work environments that increase their productivity and well-being through intrinsic motivation. Höcker et al. (2022) come to a similar conclusion. In this study, the authors examine employees' desired workplace distribution across the home workplace, third places and the office and whether this promises work success. The results show that "knowledge workers have developed a good sense of the workplace where they can work successfully" (Höcker et al., 2022, p. 101) and make the right decision regarding where to work best. Companies aiming to promote the performance of their employees in the workplace might therefore allow flexibility in the choice of workplace for their employees and consider their employees' knowledge of what they do and how they do it (Dewulf/Van Meel, 2003; Weber/Gatersleben, 2022). Especially since a full return to the office is expected to increase employee stress (Fan/Moen, 2023). However, employee workplace choice and the factors that influence it have not yet been sufficiently researched (Appel-Meulenbroek et al., 2022). Yet, it is precisely the knowledge about the reasons for choosing one workplace over another that could help CRE management to develop sensible workplace strategies (Vischer, 2011). The feasibility of a mandatory or voluntary return to the office can also be better answered by identifying the key environmental, organizational and personal aspects that influence workplace choice.

Therefore, this study aims to address the research gap, and measure how employee workplace choice is affected by person-related, environment-related, and job-related factors. An experimentally manipulated Best-Worst (BW) scaling study (Case 1) (Louvriere et al., 2013) with N = 350 German knowledge workers is performed. This study offers researchers an initial starting point for understanding employee workplace choice. The insights gained are also highly relevant in practice in order to develop successful workplace strategies in harmony with the employees on the one hand, and to find starting points for encouraging employees to work in the office again and to find a suitable hybrid working mode on the other.

2 Application of factors influencing work outcomes to workplace choice

As one of the first, the study by Appel-Meulenbroek et al. (2022) focuses on hybrid working preferences of respondents within one organisation. The office and the home workplace are compared in order to determine the characteristics that are decisive for the workplace choice of communicative or concentrated work. Personal, work-related, and home workspace characteristics are included due to their influence on workplace preferences and decision making behaviour.

Based on the detected correlation that employees choose the workplace that increases their success (Spivack/Milosevic, 2018; Höcker et al., 2022), factors identified as relevant to employee outcomes are also considered in this study. The narrative of studies from different disciplines (CRE management, human resource management, and psychology) of the last ten years shows a multitude of person-related, environment-related, and job-related factors that influence employees' work outcomes, e.g., satisfaction, well-being, and productivity (see Table 1).

Table 1. Extant literature on factors influencing work outcomes

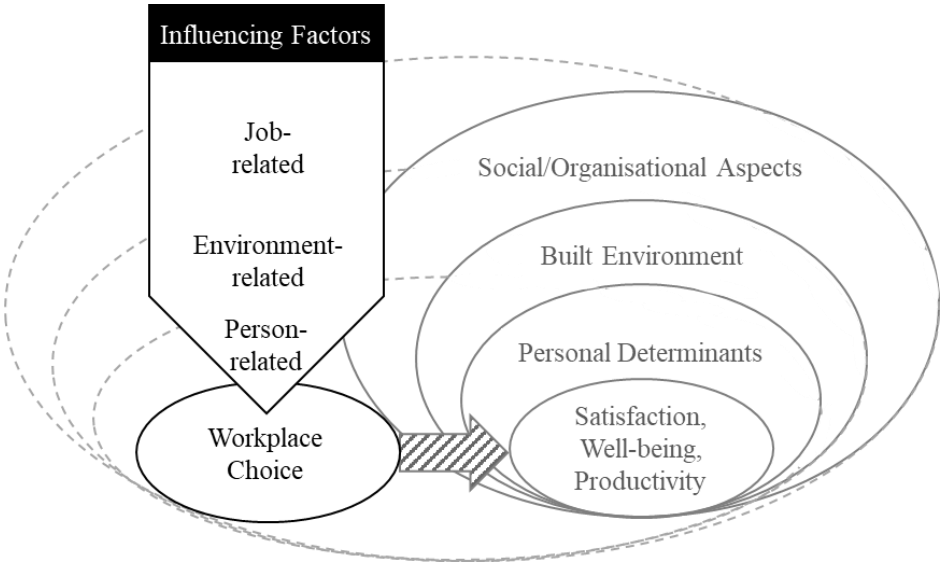
Authors	**Type of Study, Sample Size**	**Independent Variables**	**Dependent Variables**
Raykov (2014)	Survey, *N*=1,042	Employer support for creative work	Job satisfaction
Seddigh et al. (2014)	Survey, *N*=1,241	Concentration	Cognitive stress
Bowling et al. (2015)	Meta analysis	Workload	Psychological and physiological well-being and affective organizational commitment
Lee et al. (2015)	Survey, *N*=367	Task interdependence, team cooperation, team conflict	Job performance
Sivatte et al. (2015)	Survey, *N*=198	Work-life culture	Organizational productivity
Barakat et al. (2016)	Survey, *N*=85,167	Corporate social responsibility	Employee satisfaction
Hongisto et al. (2016)	Experiment, *N*=32	Sound insulation; sound masking	Work performance
Leder et al. (2016)	Field studies	Office environment parameters	Satisfaction
Spiegelaere et al. (2016)	Survey, *N*=927	Job autonomy	Employee engagement; innovative work behavior
Nye et al. (2017)	Meta analysis	Interest congruence	Job performance
Wheatley (2017)	Survey, *panel data*	Flexible working arrangements	Job satisfaction
Burmeister et al. (2018)	Experiment, *N*=99	Environments	Work-related cognitive performance
Ćulibrk et al. (2018)	Survey, *N*=566	Job satisfaction, job involvement	Organizational commitment
Krishnan et al. (2018)	Survey, *N*=120	Work-life balance; Job satisfaction	Employee task performance
Sharmilee et al. (2018)	Survey, *N*=310	Job stress	Employee performance

Budie et al. (2019)	Survey, *N*=327	Personal and workspace characteristics	Work environment satisfaction
Ma/Ye (2019)	Survey, *N*=1,121	Commuting behavior	Employee productivity
Wilmot/Ones (2019)	Quantitative review of meta-analyses	Conscientiousness	Performance
Baqir et al. (2020)	Survey, *N*=108	Reward and recognition	Engagement
Bayona et al. (2020)	Survey, *N*=531	Knowledge characteristics' fit, work engagement	Job satisfaction, job performance
Fernández-Salinero et al. (2020)	Survey, *N*=420	Job involvement, skills use and group identification	Job Satisfaction
Mora et al. (2020)	Survey, *N*=45	Work safety and work healthy	Employee productivity
Tamunomiebi/ Oyibo (2020)	Literature review	Work life balance, flexible work arrangements	Employee performance
Bui et al. (2021)	Survey, *N*=186	Workplace stress	Productivity
Colenberg et al. (2021)	Literature review	Interior office space	Employee well-being
Leitão et al. (2021)	Survey, *N*=514	Quality of work life (e.g., safe work environment and occupational healthcare), burnout	Productivity
Rostami et al. (2021)	Survey, *N*=480	Mental workload, job control	Job satisfaction
Wang et al. (2021)	mixed-method (interviews & survey, *N*=522)	Social support, job autonomy, monitoring and workload	Remote worker outcomes (e.g. performance and well-being)
Tingo/Mseti (2022)	Survey, *N*=135	Employee independence	Employee performance

Most of the presented studies are based on survey data, and investigate individual correlations. This results in a number of relevant determinants. For this study, these characteristics are grouped into three categories used to analyse employees' workplace choices: job-related, environment-related, and person-related. The classification follows the ideas of Weber et al. (2022) who developed a socio-ecological framework for teleworking to investigate behavioural intentions which includes various level of influences. Moreover, the categories of influencing factors are quite similar to previous research on work outcomes at other workplaces, such as the office environment (e.g., Krupper, 2015; Windlinger/Lange, 2021; Marzban et al., 2023), and equal to the characteristics in the study on hybrid

working preferences (Appel-Meulenbroek et al., 2022). The resulting research framework is presented in Figure 1.

Figure 1. Influences on workplace choice adopted from determinants of work outcomes (Own illustration following Weber et al., 2022; Appel-Meulenbroek et al., 2022)



3 Methodology

The experimental study used to analyse the influence of 34 job-related, environment-related, and person-related factors on employee workplace choice applies the BW scaling method, case 1 (Hinz et al., 2015; Louvriere et al., 2013; Louvriere et al., 2015). BW scaling belongs to the discrete choice experiments (Schlereth/Skiera, 2017; Hauser et al., 2019), and is used to measure an individual's preferences within a given choice set. As a result, it provides a ranking of the included items (Finn/Louviere, 1992; Beisecker et al., 2024). Drawing on the method of paired comparison to multiple choices (Finn/Louviere, 1992; Kaufmann et al., 2018) and random utility theory (Thurstone, 1927) the BW scaling method has a broad theoretical and mathematical foundation. The method is chosen for this study as it is considered to be more accurate, consistent, realistic, and objective than other survey methods (Bettman et al., 1990; Lee et al., 2008).

The data was collected using Clickworker, a platform known for producing fast and reliable responses (Lutz, 2016). The only requirement for participation is that the respondents have experience with hybrid working systems. 1,136 German knowledge workers completed the online survey in the beginning of 2023. As the experiment is part of a larger research context, the final sample after data cleaning consists of N = 350 respondents for this study. The sample includes 161 female respondents; the average age is 36.6 years and on average, the respondents have 11.6 years of work experience.

Table 2. Sample Descriptive Statistics

	N	%
Gender		
Male	189	54.00 %
Female	161	46.00 %
Age		
18 - 25 years	50	14,29 %
26 - 35 years	133	38,00 %
36 - 45 years	97	27,71 %
46 - 55 years	44	12,57 %
56 - 66 years	26	7,43 %
Work experience		
1 - 3 years	82	23,43 %
4 - 10 years	113	32,29 %
11 - 44 years	155	44,29 %
Position within the company		
Executive level	54	15,43 %
Higher management	4	1,10 %
Middle management	15	4,30 %
Lower management	27	7,70 %
Employee	219	62,57 %
Temporary staff, trainee and other	31	8,86 %
Management responsibility		
Yes	278	79,43 %
No	72	20,57 %

The BW scaling and evaluation process is as follows. The 34 factors gathered from the literature are formulated as precisely and exemplarily as possible to facilitate the selection process. In the survey, each participant weighs the attractiveness of nine different randomly assigned attributes. Participants are presented with twelve sets of three attributes, from which they must select the best and worst. The best and worst reflects the edges of the respondent's subjective continuum (Louviere et al., 2015). Figure 2 illustrates an exemplary experiment choice set. Overall, each item appears four times.

Figure 2. Experiment Setup Example

My workplace choice is least affected by the fact that ...		**My workplace choice is most affected by the fact that ...**
	... I work in a cooperative work environment.	
X	... my place of work offers me privacy.	
	... there are good transport connections to my place of work.	X

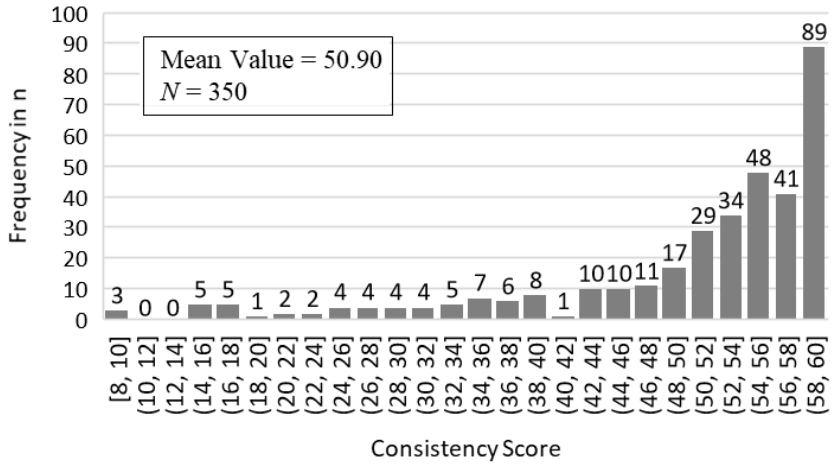
To observe the participants' decisions, the best and worst choices are counted. The so-called BW scores, i.e. individual or aggregated sample preference estimates, are calculated by the difference between the amount of time a respondent chooses an item as best and worst (Finn/Louviere, 1992). Each item thus can generate BW scores ranging between –4 and +4 (= 12 x 3 / 9) (Beisecker et al., 2024). The estimated BW scores are then standardized to normalized BW scores (0 = least affecting factor; 100 = most affecting determinant) (Louviere et al., 2015). To obtain the final ranking, mean values of the normalized BW scores are calculated for each item.

4 Results

4.1 Consistency

In order to observe the participants' correct understanding of the experiment and whether the participants are credible and aware of the factors most affecting their workplace choice, the consistency of the respondents' selections in the BW scaling experiment is examined (Beisecker et al., 2024). Figure 3 shows the histogram of the consistency score.

Figure 3. Histogram of Consistency



In the histogram, the x-axis represents the consistency score ranges and the y-axis represents the frequency i.e., number of respondents. Accordingly, the hight of the bars shows how many respondents have a consistency score in the respective value range. The consistency of each respondent is represented by the individual sum of all attributes squared BW values (Louvriere et al., 2015). The balance of levels and orthogonality are properties of the balanced incomplete block design (Beisecker et al., 2024). The consistency measure is close to zero for inconsistent answers. The highest consistency measure, i.e., a perfectly consistent respondent, equals 60 (= $2 * 4^2 + 2 * 3^2 + 2 * 2^2 + 2 * 1^2$) in this study. The mean value of the consistency measure is 50.90 showing that the respondents understood the experiment quite accurately.

4.2 Ranking of factors affecting workplace choice

The normalized BW scores identify the *flexible organization of the working day in terms of time and location* (100.00) as the most significant factor of workplace choice. The second most important item is the *compatibility of challenges in private and professional life* (98.25), followed by *concentrated work*

possible (90.18) and *independent planning of tasks to be completed* (87.10). Also within the top five influence factors of employee workplace choice is the *well manageable amount of work in terms of time and quantity* (86.36). Table 3 presents the normalized mean BW scores for all 34 items. The relevance decreases from top to bottom. Across all items, work-related factors have a particularly strong influence on the workplace choice. The top ten most influential aspects also include three person-related items (*compatibility of challenges in private and professional life, concentrated work possible, conscientious execution of work*) and one environment-related item (*healthy and safe working environment*). While the number of relevant environment-related factors increases in proportion of job-related items from rank 11, most of the other person-related items only appear in the last third, and represent less affecting aspects.

Table 3. Best-Worst Scaling Results

	Factors related to			**Items**	**Normalized mean BW Scores**
	Job	**Environ-ment**	**Person**		
1	X			Flexible organization of the working day in terms of time and location	100.00
2			X	Compatibility of challenges in private and professional life	98.25
3			X	Concentrated work possible	90.18
4	X			Independent planning of tasks to be completed	87.10
5	X			Well manageable amount of work in terms of time and quantity	86.36
6	X			Pleasant interaction in the team	81.27
7			X	Conscientious completion of work	80.73
8	X			Interest in the activities	78.18
9		X		Healthy and safe working environment	75.76
10	X			Independent decision-making in everyday working life	74.17
11	X			Stress-free work environment	73.37
12		X		Good transport connections to the place of work	68.31
13	X			Short way to the place of work	66.95
14		X		Equipment consisting of modern technical devices with fast internet connection	66.01
15	X			Tasks that challenge to use skills and abilities	62.82
16		X		Pleasant light, air, noise and temperature conditions	58.23
17	X			Successful cooperation with colleagues	56.12

18	X			Varied tasks	54.62
19			X	Cooperative working environment	46.98
20		X		Privacy at the workplace	46.32
21		X		Suitable space at the place of work for all activities	44.12
22			X	New experiences at work	43.15
23			X	Recognition of my work results by colleagues and superiors	40.88
24		X		Attractive design of the workplace	28.95
25			X	Innovative work possible	27.51
26	X			Identification with the values of the company	27.14
27			X	Creative work possible	25.59
28	X			Enabling training and further education	22.63
29		X		Attractive additional offers at the workplace	21.48
30			X	Social participation in a social group	16.26
31			X	Communicative work possible	12.47
32		X		Ergonomic chair and desk	5.46
33		X		Offers of daily needs in the immediate vicinity of the place of work	3.51
34		X		Plants and windows with a view of the greenery	0.00

5 Discussion and Conclusion

The study explores how employee workplace choice is affected by person-related, environment-related and job-related factors. The inclusion of determinants across CRE management, human resource management and psychology disciplines enables an initial overarching understanding without claiming to cover the whole spectrum of influencing factors. Despite the limited experience with hybrid working, employees accurately identified the factors affecting their workplace choice in this Best-Worst Scaling study. This illustrates the mental accounting of employees when choosing their workplace and reinforces the importance of the results for the future viability of office real estate and for workplace strategy development.

The insights gained from this study are valuable, not only for research, but also for practice. The study observes several highly affecting factors, headed by the *flexible organization of the working day in terms*

of time and location, the *compatibility of challenges in private and professional life* and the *possibility to work concentrated*. Not surprisingly, the five most important factors form the basis on which employees choose their workplace and are the prerequisite for employee mental accounting. This explains why there has been almost no research on workplace preferences to date. It is only since the prevalence of hybrid working that a greater number of employees have been given the flexibility to decide where they work. This calls for more research on the topic to find out, for example, whether the way hybrid working is organized in companies, the contractual agreements on usable locations (e.g., whether work can be done from anywhere in the world, including workation), or the family situation at home change the results. The results show a high relevance of the factor *compatibility of professional and private challenges*, which might reflect a general tendency in society. Due to the changing nature of work in hybrid working environments new demands in society are arising, e.g. work-life balance (Vyas, 2022). Striving for a good work-life balance is particularly important to younger generations (Purwatiningsih/Sawitri, 2021). If one place of work can contribute to this better than another, presumably the home workplace or a coworking space close to home, this is the preferred choice. The results are in line with previous studies, which show that one of the strengths of the hybrid working model is the work-life balance (Santillan et al., 2023). The third most important factor is the *possibility to work concentratedly*. This result underlines the good intuition of Appel-Meulenborek et al. (2022), who explicitly focused on concentration in their study on hybrid working preferences, and reinforces its relevance. Office planning and design should adequately cater to employees' needs for communication and focused work. This requirement is particularly necessary if companies' policy is to obligate employees to return to office.

The most important factors of workplace choice include aspects that are determined by the social and organizational environment (job-related) as well as those depending on the person. Items relating to the physical space (environment-related) appear to play a somewhat subordinate role for the choice of workplace. This underlines that there are some basic requirements that precede the decision-making process regarding the workplace choice. Only once these are fulfilled additional criteria are included in the choice and mental accounting. From the employees' point of view, the return to office debate is therefore not so much about the physical workplace in the office, but about supporting them in overcoming the challenges of their day-to-day work. If it is important to companies to encourage employees to work in the office voluntarily, then they should make an effort to adjust the scope of work, support a good work culture, and promote work autonomy. These aspects are more relevant to employees' workplace choice than, for example, the creation of additional offers at the workplace, which is often used as a lure in practice. Thus, it is assumed, based on the results, that a mandatory return to the office is not necessarily associated with a positive outcome for the company. This assumption is based on the finding that the most influential factors in the choice of work location are aimed at ensuring that the work to be done can be completed successfully. If the ideal workplace is not the office for some employees or depends on the tasks, then the withdrawal of spatial freedom of choice is unlikely to improve work results.

This study has a couple of limitations. First, the results are based on an experimental study. Thus, the ranking is limited to and relative among the aspects included in the BW scaling experiment. In addition, even if the study aims to include aspects from several disciplines, many more factors can affect workplace choice (e.g., national differences). Thus, future research could investigate whether other aspects influence the workplace choice and thus need to be included. Another limitation to the transferability of the results is the sample size. Even if the data is collected across industries and companies, a larger number of respondents could be advantageous in future studies. Finally, only individual employees were surveyed in this study. The results may therefore reflect the social tendency towards individualization and a focus on individual advantage. However, if the question of the best workplace strategy is considered at the level of the team and the entire company, rather than only on the individual employee, the implications could be different. These differences in how individual

success relates to team productivity, social interaction, and company performance when maximum flexibility is offered in the workplace choice need to be investigated in the future.

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The infrastructure of hybrid work environments - A comparison of different spatial offers

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Abstract

PURPOSE: This paper aims to present a targeted, comparable knowledge resource that provides an overview of spatial requirements, technical equipment and supporting furnishings that enable hybrid working. These include premises in office structures, the home office and other environments that initially serve a different purpose but are frequently used for and, therefore, suitable for hybrid work. THEORY: Information and communication technologies enable knowledge workers to work from locations outside the office, e.g., remotely from home or other locations. Many scientific publications focus on analysing working conditions in work environments and factors relating to management, such as organisation and coordination of employees. Therefore, the architectural and infrastructural aspects that make hybrid work possible should be particularly important. METHODOLOGY: As a basis, parts of an existing anonymised planning framework were used to identify premises particularly relevant for hybrid working. Extended by an inductive content analysis, the existing list was enlarged by observations in the context of field research, especially on hybrid work, which takes place on premises other than office structures. Additionally, these analyses were validated by literature research. FINDINGS: Hybrid work occurs in different environments: Primarily in office environments, secondarily in home offices, and thirdly in public spaces such as cafés, libraries, and lounges. These premises vary in spatial and technical requirements and equipment and offer various possible workplaces for hybrid workers. ORIGINALITY: The present work adds value for an interested community that wants to gain insight into the variety of hybrid work environments. By clearly describing spatial requirements, technical equipment, and supporting furnishings that enable hybrid working, readers should be able to compare different hybrid settings directly for further usage, e.g., by implementing them.

Keywords
hybrid work, activity-based work, work environment, work infrastructure, layout planning.

1 INTRODUCTION

Hybrid work has become an increasingly important part of modern working culture. Technology, digitalisation, and automation enable remote work from almost every global spot, allowing for more flexibility for desk workers. Other than working from a central office, teleworkers fulfil their work tasks alternating from the office and remotely from a location of their preference. In the course of worldwide lockdowns necessitated by the Covid-19 pandemic, remote work became even more prevalent, and more and more companies have enabled work from private households. In hybrid working, employees choose not only the premises but also the distribution of the working days on which they work in the office or from elsewhere Kaufman et al. 2020: 3. The experience of a better work-life balance (Griep et al. 2021) through reduced commuting time but also greater flexibility, autonomy (Stich 2020), and individual performance while remote working (Babapour Chafi et al. 2022) contributes to the popularity of remote working models, in addition to arguments for possible cost reduction by companies (Tedeev 2014).

The core philosophy of new ways of working is to optimise employee productivity and satisfaction by offering workspaces that allow employees to choose the best environment for their work (Haapakangas et al. 2018). Hybrid work environments (Summerfield 2022), just as activity-based work (ABW) environments (Divett 2020), support companies in recruiting and retaining new workforce. Both workplace strategies can complement and even reinforce each other's objectives. While ABW aims to provide workspaces that are more suitable for workers and their specific daily tasks within an office context, hybrid work enables the integration of new workspaces outside the office or home office. This gives employees a wider range of possible workstations, which they can use as required. Nenonen and Lindahl (2017: 309) even further say that the whole city is an office. This observation can be shared and extended to all other localities that initially served a different purpose but are frequently used for and therefore suitable for hybrid working, e.g. cafés, airport lounges, and hotel lobbies.

Hybrid work combines remote work and in-office work and is carried out in various locations. These locations are often diversely designed, and their specific features may suit different work types. Offices provide ideal settings for meetings and promote on-site collaboration and exchange among teams and colleagues (Redlein and Thrainer 2022). This face-to-face communication is crucial for sustaining social relationships at work (Nardi and Whittaker 2002). The home office, for its part, offers other advantages. Three of the four generations currently employed in the labor market favor working at home when undertaking work that requires concentration (Joy and Haynes 2011: 223). Participants in another study perceived working from home (WFH) as an improvement over regular office work, likewise in terms of their ability to concentrate and their personally perceived productivity (Chow et al. 2022). Bloom (2022) summarises hybrid working arrangements to combine the benefits of in-person collaboration at the office, the ability of quiet WFH, and a significant reduction of commuting times. Furthermore, Pan et al. (2023) emphasise the multi-use opportunity of different working layouts, which is a highly important feature for hybrid working.

The design of remote working environments has an impact on the employees, such as their physical health (Brand 2008; Larrea-Araujo et al. 2021), mental wellbeing (Brand 2008; Charalampous et al.

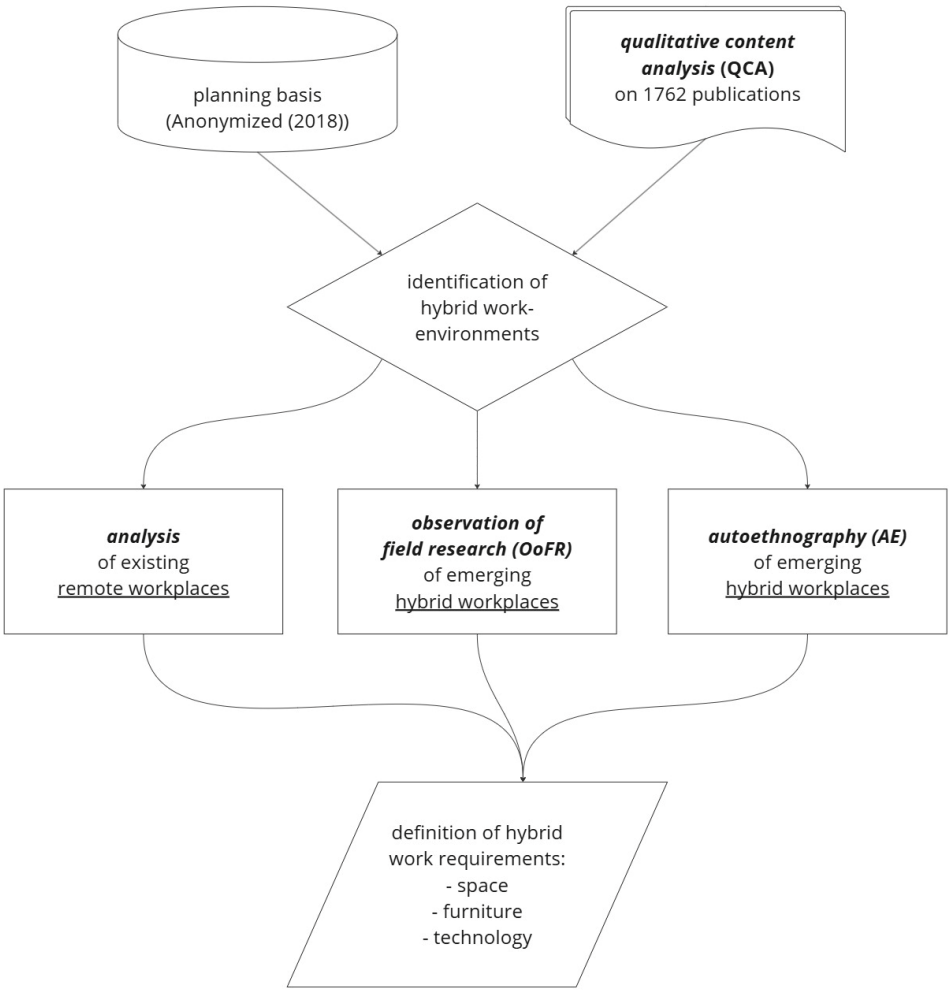
2019; Delanoeije and Verbruggen 2020), but also perceived productivity (Haynes 2008; Dul and Ceylan 2011). Only a few publications provide insight into the spatial prerequisites of remote work environments (Johnson 2003; Ng 2016). Considering the agility of the topic, current results lead to a better understanding of the diversity of work environments and help companies decide which hybrid spaces would enhance their space offering. Ensuing this need, the present article seeks to analyse a selection of spatial offerings of hybrid workplaces and aims to answer the following research questions:

- Which hybrid work environments are currently in use?
- For what kind of work are these hybrid premises most suited?
- What are the infrastructural and architectural requirements of these hybrid premises?

2 METHODOLOGY

The present research focuses on the variety of hybrid spaces. As a method, the application of a mixed-methods approach helps answer the previously introduced research questions. Figure 5 expresses the relevance of all methods applied.

Figure 5: Flowchart expressing the relevance of different methods applied.



Current developments require an almost up-to-date adapted list of possible hybrid workplaces. The starting point of this work shapes an anonymised planning basis (Anonymized), which helps architects

and planners of office layouts to understand the kind of premises desired by a project's client. There is no stated reason by the copyright owners for anonymising the document. Instead, it is assumed that the international insurance company, whose planning basis is involved, does not agree to further disseminate the document for data protection reasons.
Usually, these planning bases provide helpful information on the spatial characteristics and needed infrastructure, such as intended, e.g.:

- use of the space,
- occupancy rate,
- audio-visual and information technology,
- equipment and furnishings, etc.

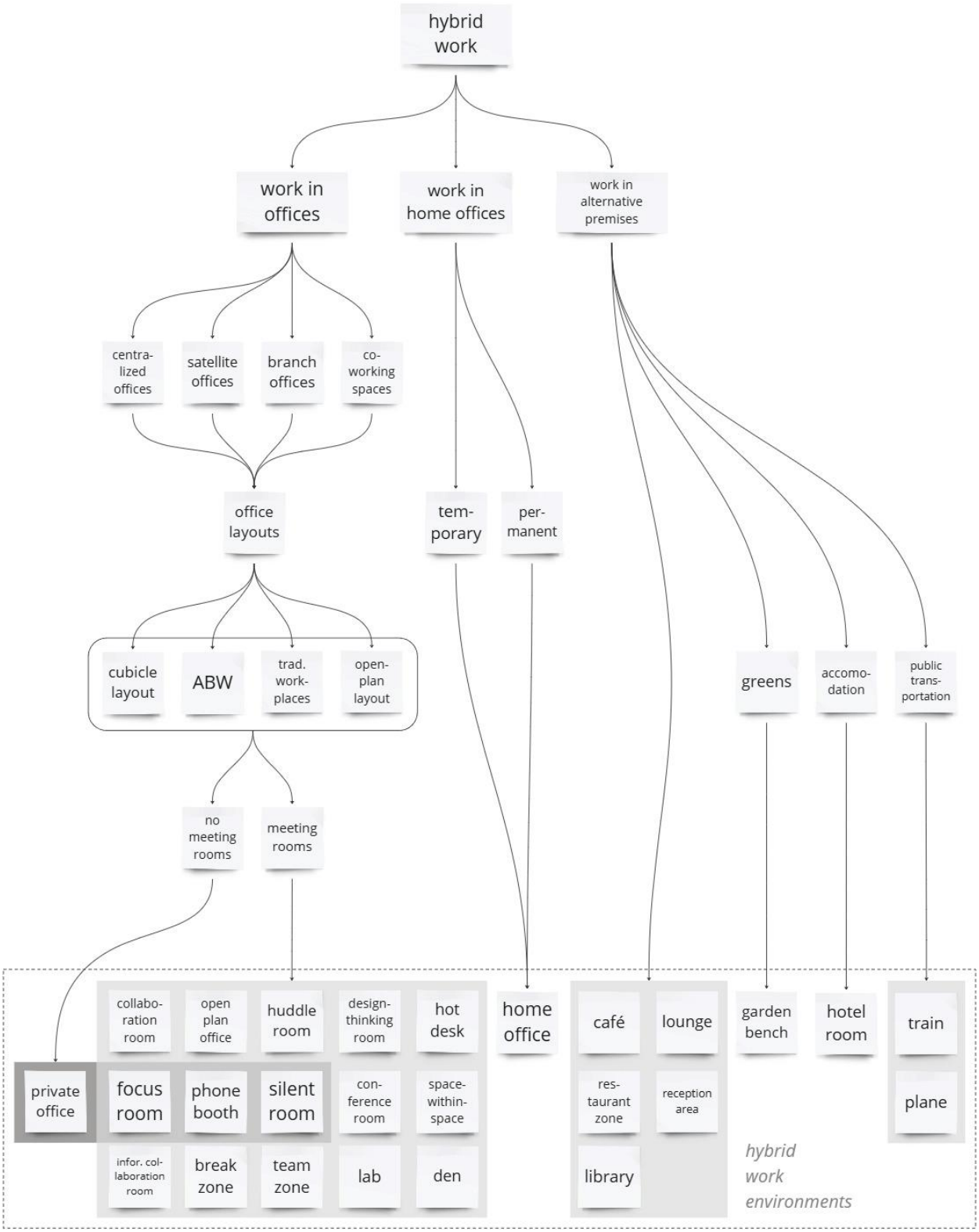
The present planning basis (Anonymized) focuses on several workspaces in an office context. This includes spaces designated for individuals and teamwork, partly considering connectable remote participants. Since the objective of this work is the analysis of hybrid work environments – be they in offices, in home offices or other environments that initially serve a different purpose but are frequently used for and therefore suitable for hybrid working – the application of additional methods seems immanent.
Conducting the inductive content analysis (ICA) serves to identify hybrid and remote premises that are mentioned as such in current publications. Due to the lack of existing principles, further methods help to analyse the infrastructural need of these emerging hybrid work environments: observations of field research (OoFR) and autoethnography (AE) supplement research and help understand particular technological and infrastructural requirements of hybrid work.
The ICA is a technique within the qualitative content analysis method (QCA). QCA has been developed since 1980, particularly by the German sociologist Philipp Mayring. As no previously developed theoretical publications exist in this area, this inductive approach of the QCA makes it possible to establish connections among various statements that characterise hybrid environments. Due to the rapidly advancing topic, care is taken to incorporate as many different types of publications as possible. This broad spectrum aims to give voice to different ways of research, expression and focus. This approach should cover a wide variety of topics due to the diversity of research fields concerned. The ICA has been constantly revised since July 2020 and consists of 1762 documents until this date. *Table 5* highlights the variety of the observed materials in the present research project.
Table 5: Types of publications as part of the ICA.

Total publications	**n = 1762**
Journal articles	47,7 %
Internet documents	13,6 %
Newspaper articles	11,0 %
Monographies and compilations	9,2 %
Conference proceeding articles	8,3 %
Reports	7,8 %
Theses	0,9 %
Acts, regulations and standards	0,9 %
Lectures and interviews	0,3 %

Other sources (e.g. special issues, press releases, sound recordings, film documents)	0,3 %

The definition of categories and subcategories during the ICA process revealed 26 hybrid work environments. Figure 6 illustrates the relations among the analysed terminology and highlights the detected 26 hybrid work environments.

Figure 6: Developed categories emerging the inductive content analysis (ICA) based on 1762 documents.


hybrid work
work in offices
work in home offices
work in alternative premises
centra-lized offices
satellite offices
branch offices
co-working spaces
office layouts
tem-porary
per-manent
cubicle layout
ABW
trad. work-places
open-plan layout
greens
accomo-dation
public trans-portation
no meeting rooms
meeting rooms
collabo-ration room
open plan office
huddle room
design-thinking room
hot desk
home office
café
lounge
garden bench
hotel room
train
private office
focus room
phone booth
silent room
con-ference room
space-within-space
res-taurant zone
reception area
plane
infor. col-laboration room
break zone
team zone
lab
den
library
hybrid work environments

All 26 hybrid work environments have in common that individuals make use of different working tools (e.g. laptops, smartphones) and access their employer's data (e.g. accessing company servers, email accounts, offline documents) by using LAN or WiFi connections. While the planning framework enables insight into the variety of hybrid workplaces in the context of offices, the ICA reveals supplemental premises.

Due to these work premises' differing spatial context and purpose, additional research steps OoFR and AE help differentiate between these environments. During the OoFR and AE, all premises were analysed in terms of their spatial characteristics and their effect on their users. Making use of an individually developed observation chart, supplemental information on previously non-analysed architectural requirements of hybrid work premises was added. The codes that were conducted contained structural specifics, which need to be included in the early planning phases of the construction of buildings. These codes comprised focus on:

- spatial requirements like construction materials (e.g. opaque or transparent materials) and room layouts (e.g. enclosed or open room structures),
- technical equipment like installations affecting wall and ceiling structures (e.g. ICT infrastructure) and devices (e.g. conference screens or projectors),
- and supportive furnishings (e.g. tables and seating options).

In addition to the structural codes, codes regarding the spatial offers included three differentiations. These have an impact on the configuration of the working environment itself and the work achieved in its context:

The first examination focused on the kind of work the premise is best suited for. Considering research by Turnbull et al. (2011: 63) and Miller (2013), a distinction was made between routine, creative, complex and recreational tasks. Secondly, the kind of meetings the premises are usable for help to further differentiate the detected hybrid work premises. Here, a distinction is made between scheduled and coincidental/spontaneous meetings. Apart from the various activities and appropriate meetings these spaces support, the third area of observation focuses on whether the premise can be used individually and/or as a team.

3 RESULTS

Approaching the spheres of the hybrid workplace, particular attention is paid to the design of flexible and diverse spatial structures in remote work locations, which improves company productivity while increasing employee satisfaction. By implementing different types of spaces, such as interactive workspaces adapted to working styles, employees could be better able to increase their efficiency and satisfaction.

The evaluation of the ascertained hybrid work environments should serve as a planning basis for those who want to offer hybrid work locations. By offering a comparable overview, the reader should be able to understand the diversity these locations offer. Table 6 lists all detected hybrid work environments with their individual spatial offers. Table 6 also indicates whether a work premise can be used for certain work tasks and if it is recommended to do so. This differentiation was initiated, because some tasks might not be very efficient regarding the ratio of user occupancy and size of the environment (see table 6). The following pages provide classifications of each environment including information on the spatial offers and suitability for different work tasks as individuals or in teams.

Table 6: Matrix expressing spatial offers for different types of work and personal exchange in hybrid work environments.

		creative	recreation	complex	routine	scheduled meetings	coincidental meetings
Break Zone	individual		•		○		
	team	•	•		○	•	•
Café	individual		•		•		
	team		•		•	•	•
Collaboration Room	individual						
	team	•		•	•	•	
Conference Room	individual				○		
	team	•		•	•	•	
Design-Thinking Room	individual				○		
	team	•		•		•	
Den	individual			•			
	team			•			•
Focus Room	individual			•			
	team			•		•	
Garden Bench	individual	•	•	•	•		
	team	•	•	•	•	•	•
Home Office	individual			•	•		
	team						
Hot Desk	individual				•		
	team						
Hotel Room	individual			•	•		
	team						
Huddle Room	individual						
	team			•	•		•
Informal Collaboration Zone	individual	•	•		•		
	team		•		•		•
Lab	individual	•		•			
	team	•				•	
Library	individual			•	•		
	team						
Lounge	individual		•	•	•		
	team	○	○				

Open Plan Office	individual				•		
	team				•		•
Private Office	individual		•	•	•		
	team			•		•	•
Public Transport (Train)	individual		•	•	•		
	team	○		•	•	•	
Public Transport (Plane)	individual		•	•	•		
	team						
Reception Area	individual				•		
	team		•		•	•	•
Restaurant Zone	individual		•		•		
	team		•		•	•	•
Silent Room	individual		○	•	•		
	team						
Space-within-Space	individual		•				
	team			•			•
Team Zone	individual		•				
	team	•					•
(Tele-)phone Booth	individual			•	•		
	team			•			•

• = work in this premise possible and recommended

○ = work in this premise possible

Finally, in addition to the enumerative classification of the detected hybrid work environments with their individual spatial offers, a selection of hybrid workplaces exemplifies architectural requirements (e.g. spatial requirements, technical equipment, supportive furniture), and sample photos serve for better illustration. All hybrid work environments have in common that wide WiFi coverage ensures access when many users access it simultaneously. Due to the wide scope of the topic, four of the 26 locations were selected to give the readership an understanding of the intention of the complete research. The selected locations are **highlighted** in table 6.

3.1 Break Zone

Break zones are usually offered in the context of office premises, which inherit a variety of activity-based working spaces. These zones invite employees to sit, relax, play and eat on the spot during break times (Bakker 2016).

Figure 7: Matrix expressing spatial offers for different work types and personal exchange in break zones.

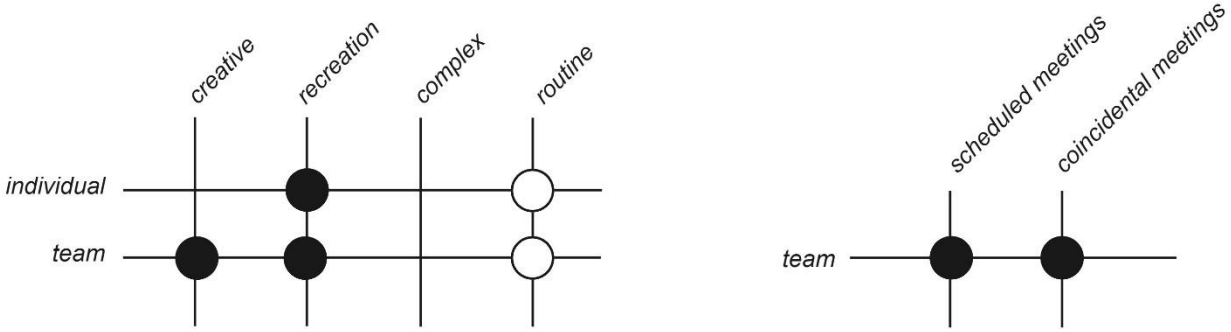


Figure 7 illustrates the possible uses of the room: By offering a playful setting, including game equipment such as soccer or pool tables, the break zone offers space for creativity and recreation. Even if these locations are not primarily suitable for this purpose due to the expected noise conditions, break zones can also be used for routine activities. Users choose this environment due to a change of location which outweighs a possible reduction in attention. The exchange among the users of this zone may be of verbal or non-verbal exchange and shall support employees to playfully gain distance to daily work contents. Break zones provide different types of personal exchange among colleagues. This might happen during random work breaks or scheduled events before going home for the evening, away from any work-context. The informal environment can help employees to come up with new ideas without pressure.

Table 7: Architectural requirements of break zones.

spatial requirements	**technical equipment**	**supportive furniture**
• closable area • noise-absorbing materials	• screen or projection surface for a projector • power sockets	• game equipment • comfortable seating

Due to the active use of break zones, it is recommended to situate premises in a closable area or secluded from workstations and equip them with noise-absorbing materials. Like so, remaining working employees do not have to fear distractions from their work tasks. Table 7 illustrates other spatial requirements, including additional technical equipment and suitable furniture. Supplemental to the game equipment, comfortable seating ensures relaxing breaks. Projection surfaces or screens allow any content to be displayed, while additional sockets can be used to charge, e.g. cell phones or other portable devices.

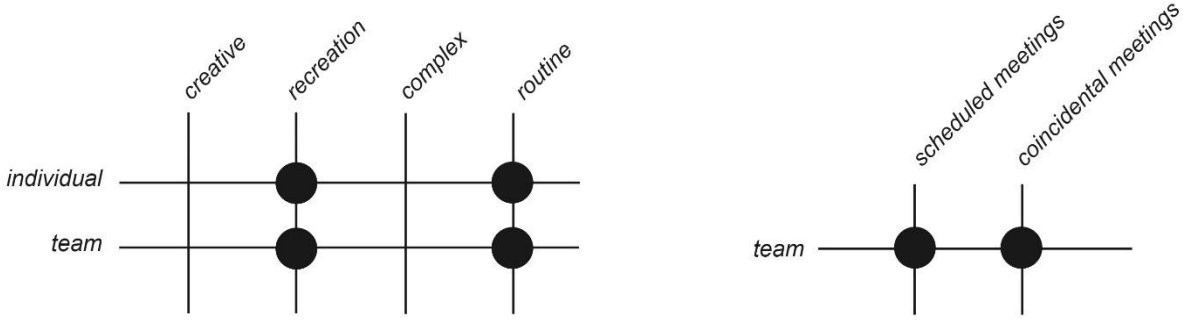
Figure 8 expresses different scenarios of break zones.

Figure 8: Examples of break zones (Photo courtesy by A. Redlein and L. Thrainer).

3.2 Café

Some companies provide café zones within their office premises, but also cafés at alternative premises are the focus of the present research. Oldenburg refers to cafés as 'third spaces' that *"are not home or work, but the places that help get people through the day"* (Oldenburg 1999: 56).

Figure 9: Spatial offers for different work types and personal exchange in cafés.



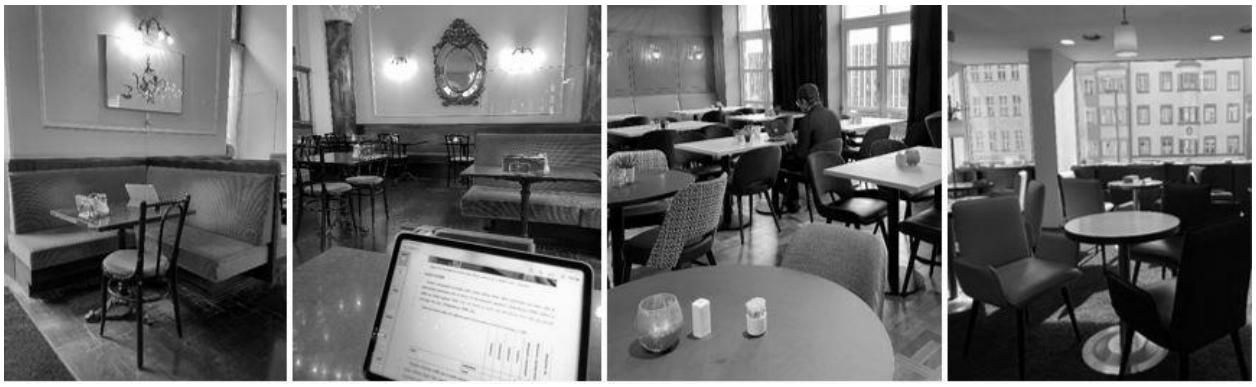
People choose cafés as a work environment in different circumstances. These can arise either from the need to work between two changes of location, because a business meeting is being held between two people from different companies, for example, or because the environment is particularly suitable for a work unit. Figure 9 illustrates several observed scenarios. Cafés are often used for routine work tasks, either by individuals, with no meetings set up, or in small groups, mostly in scheduled meetings.

Table 8: Architectural requirements of cafés.

spatial requirements	**technical equipment**	**supportive furniture**
• noise-absorbing materials	• power sockets at each table arrangement • if not implemented: • Wi-Fi-supply	• comfortable seating

The architectural requirement varies depending on the context where cafés are being set up (see table 8). Existing cafés may only retrofit power sockets at each table and ensure Wi-Fi-connectivity. Some companies provide cafés within their offices as additional spatial offer to their office premises. Comfortable seating ensures a pleasant stay and noise-absorbing materials reduce high noise levels. Figure 10 illustrates some examples of people working in cafés, and cafés usable as temporary workplaces.

Figure 10: Examples for cafés (Photo courtesy by L. Thrainer).



3.3 Collaboration Room

Collaboration rooms are functional professional and enclosed collaborative spaces in an office context. Remote teams use these multi-purpose spaces to meet and work together.

Figure 11: Matrix expressing spatial offers for different types of work and personal exchange in collaboration rooms.

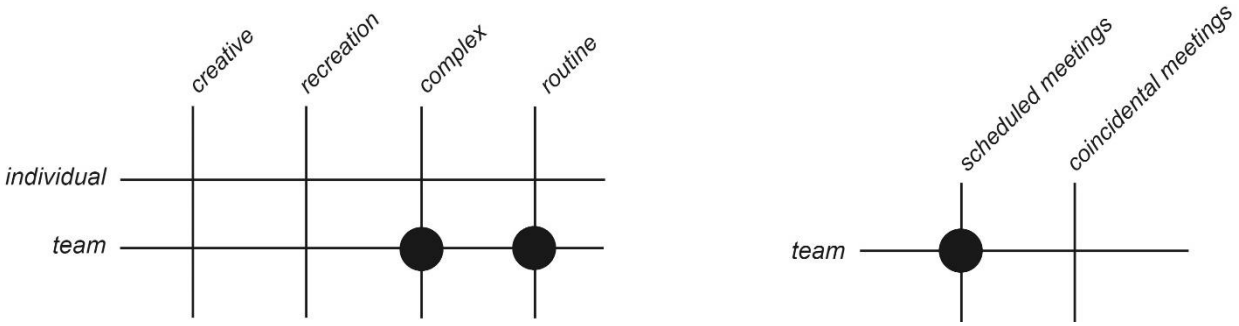


Figure 11 illustrates the usual work that is supported in these spaces: the provision of informal seating should support both daily routine and complex work tasks that employees need to accomplish. Normally, these meetings require face-to-face interaction, usually as part of scheduled team meetings.

Table 9: Architectural requirements of collaboration rooms.

spatial requirements	**technical equipment**	**supportive furniture**
• noise-absorbing materials	• video-conferencing hardware and software	• comfortable seating e.g. theatre- or u-shape seating arrangement

Table 9 summarises the typical architectural requirements for collaboration rooms. The application of noise-absorbing materials supports better in- and outward concentration. The provision of conferencing tools enables virtual participants to take part in conversations or presentations. In contrast to formal meeting rooms, in collaboration spaces work on individual laptops takes a back seat and meetings can take place in a more informal setting. Offering different kinds of seating supports users in different manners. For training sessions and presentations with a small number of local or virtual speakers, the use of theatre-style seating improves the focus of the presenter. Small adjustable tables help those involved to actively participate in taking notes. U-shaped seating supports group work as all participants can see each other and actively discuss.

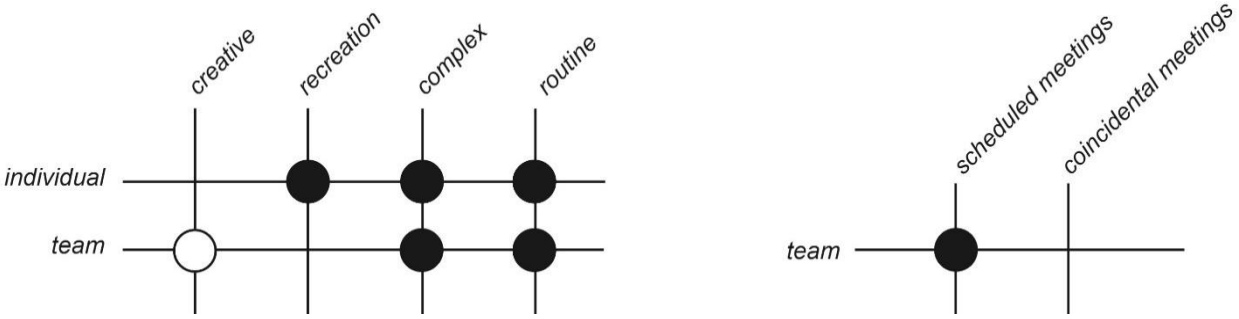
Figure 12 exemplifies varying scenarios for collaboration rooms.

Figure 12: Examples of collaboration rooms (Photo courtesy by A. Redlein and L. Thrainer).

3.5 Public transport - Trains

The development of ICT makes people more aware of public transport as a place of work. Especially during longer travels, both trains and planes are valuable hybrid work environments. Due to different spatial circumstances, both places offer varied advantages.

Figure 13: Matrix expressing spatial offers for different types of work and personal exchange on trains.



Depending on the layout (train companies usually offer seats in regular and comfort class carriages and sometimes restaurant zones), trains are suitable for individual and teamwork (see figure 13). Using portable devices like laptops, tablets or smartphones, train seats with foldable desks or fixed table sets serve as temporary workstations. Trains serve for concentration demanding and routine tasks and occasionally recreational and creative tasks. Depending on the choice of seating (single occupation with foldable table, double or quadruple table set), group work with up to four participants is possible. Even if the train companies often provide WiFi connectivity, care must be taken to ensure the connection is not always guaranteed during the trip. With this knowledge, people choose their tasks appropriately. Instead of working on online documents, they work offline on their tasks.

Figure 14 illustrates some examples of work environments on trains.

Figure 14: Examples of work environments on trains (Photo courtesy by L. Thrainer).

4 CONCLUSION

In hybrid work, people benefit from ICT and can, therefore, choose from a broader range of workplaces. Hybrid work environments offer a variety of work opportunities that are no longer limited to home offices and office premises. The present research process revealed 26 hybrid work environments that are usually offered in offices, home offices, and alternative premises, and workers can choose depending on their need for activity-based work. Each of the presented hybrid workspaces offers specific framework conditions for different types of work. This allows people to choose the most suitable workplace depending on their work (e.g. routine, creative, complex, and recreational tasks). The results of this study show that people use leisure areas for routine tasks, for example, which helps them to take a break from their daily tasks and shape new thoughts. The spatial offers for different types of work and personal exchange of some spaces might overlap, but the architectural requirements show the specifics of the spaces. Depending on the technical equipment and furniture, the context of meetings differs. The results also revealed premises that were initially intended for a different purpose can serve as work environments. Cafés are perfect environments for routine and recreational tasks both for individuals, but also for small meetings with colleagues or externals. ICT enables hybrid work while travelling. This is why public transport, like trains, offers supplemental options for hybrid work. Even though the data connectivity sometimes troubles, people adapt to this situation and work on offline documents and profit from higher concentration. Also, the type of meetings allows further evaluation of these work environments, depending on whether individual or teamwork happens.

5 DISCUSSION

The presented analysis of various hybrid workplaces enables an initial insight into the diversity of hybrid working environments. This differentiation allows both companies and remote workers to learn more about the potentials of already existing workspaces and possible new work locations companies aim to implement.

Subject of further research could shed light on seemingly overlapping features regarding spatial offers. Further observation of e.g. hybrid workers and incorporating their perceptions within the spatial context, might provide further input for later implementation strategies. The distribution of working hours at the various hybrid workplaces could also be subject of further research. This would enable hybrid workers to optimise work units in different work environments, in the office, home office and other places suited for hybrid work. Further research could also focus on validating identified hybrid

work environments by comparing them with current legislation focusing on the workers' health in their work environments.

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Session 5

Session 5A: The Evolving Workplace

A review of factors influencing employees' experience of occupancy in the office

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ABSTRACT

In workplace design and management, standards for square meters per person and average occupancy of workstations are often used to assess the fit between the number of employees and the availability of workspace and workstations. However, levels of occupancy may be experienced differently by individuals depending on the situation. The purpose of this paper is to provide an overview of factors that may influence employees' perception of occupancy at the office. This knowledge could support designers and managers in their decisions and provide a basis for further research in this relatively unexplored territory.

This study is embedded in environmental psychology and its theory about the perception of occupancy. The perception of occupancy is characterized by a perceived (mis)fit between personal demand and the availability of space. In high-density situations, individuals may experience crowding whereas in low-density situations individuals may experience isolation, depending on environmental factors, social factors, and personal factors. It is not entirely clear which and how factors influence perceived occupancy in workspaces.

Articles on the experience of occupancy in office environments were collected and analysed in a systematic literature review following PRISMA guidelines.

The preliminary results of the literature review show that environmental, social, and personal factors influence perceived occupancy in workspaces. Environmental factors include openness of workspaces, acoustics, plants, workspaces, personalization of workspace, and outside view. Social factors include territoriality, personal space, and culture. Personal factors are stimulus screening, inhibitory ability, task complexity, employee needs, and work pressure.

The experience of occupancy is a relatively unexplored topic in workspace research. By adopting a human-centered perspective on occupancy, this study contributes to a better understanding of discrepancies between organizations' measures of occupancy and the experience of occupancy by employees.

Keywords

Crowding, Isolation, Occupancy, Density, Office environments, Workspaces

1 Introduction

Why do office workers experience similar levels of occupancy differently in the workplace? The experience of occupancy is not exclusively caused by the number of people in a space and the availability of workstations, but also by factors from the physical work environment, the social work environment, and personal factors (Desor, 1972; Gifford, 2014; Stokols et al., 1973). These three types of factors, alongside the level of occupancy, yield a desired level of space that ultimately determines the experience of occupancy in workspaces (Altman, 1975).

Depending on environmental factors, social factors, and personal factors, levels of occupancy may lead to diverse effects. When a workplace has a high occupancy rate, employees may experience crowding (Bell et al., 2001). The term 'crowding' is used to describe a negative evaluation of high density

(Altman, 1975; Bell et al., 2001; Stokols, 1972). One may for example experience overstimulation and insufficient resources (Desor, 1972; Gifford, 2014; Stokols et al., 1973). Simply put, "*crowding refers to the way we feel when there are too many people and/or there is not enough space"* (Bell et al., 2001, p. 295).

Crowding encapsulates the sense of discomfort or unease experienced due to the perception of excessive occupancy within a given space (Altman, 1975; Bell et al., 2001; Stokols, 1972). This definition excludes a potential positive evaluation of high occupancy rates in the workplace. Studies have documented the positive effects of highly occupied workspaces (e.g. Fried et al., 2001; Szilagyi & Holland, 1980) besides the negative effects of highly occupied workspaces. (Aries et al., 2010; Oldham et al., 1995).

In addition to the effects of highly occupied workspaces, excessively quiet work environments may also negatively impact individuals. Altman (1975) argued that not having the desired level of space leads to discomfort and stress, with too little privacy causing feelings of crowding and too much privacy causing feelings of isolation. Individuals may feel isolated due to a perceived lack of interaction (Baumeister & Leary, 1995; Golden et al., 2008).

To address the above-mentioned experiences, we use the term 'perceived occupancy'. Perceived occupancy is the perception and estimation of the number of people present in the work environment, available space, and workplaces (Bechtel & Churchman, 2002). It encompasses a perceived (mis)fit between the personal demand and the availability of space (Altman, 1975). A 'fit' means that the perception of occupancy is within the optimal range of stimulation (Bell et al., 2001). A 'misfit' means that the perception of occupancy is outside the optimal range of stimulation. This may either be an experienced shortage of space ('crowding') (Bell et al., 2001) or an experienced abundance of space ('isolation') (Altman, 1975).

Even though the difference between occupancy and perceived occupancy has been known for decennia (Stokols, 1972), in both research and practice the distinction is often not made. Thereby the subjective evaluation of occupancy by individuals and a variety of environmental, social, and personal factors influencing the perceived occupancy are not always taken into account. As a result, it is not entirely clear which and how these factors influence the experience of occupancy in workspaces. Moreover, it caused mixed results when investigating the relationship between occupancy and psychological responses (Oldham et al., 1995).

The purpose of this paper is to provide an overview of factors that may influence employees' perception of occupancy in workspaces. In doing so, the results may also clarify some of the discrepancies in previous studies on perceived occupancy. The central question is: *how do environmental, social, and personal factors relate to the perceived occupancy of employees in office spaces?*

Research on the experience of occupancy, mainly on the relation between high-density environments and crowding, was foremost conducted in the field of environmental psychology (Bechtel & Churchman, 2002; Bell et al., 2001). This human-centered perspective on the experience of occupancy is barely used in the context of workspaces. It is valuable to conduct further scientific research into this matter, particularly concerning workplace environments, as it can provide invaluable insights into optimizing workspace design and inspire academics to further explore this topic.

2 Theoretical framework

Theories on the relation between occupancy and perceived occupancy are embedded in environmental psychology. Stokols (1972) was one of the first researchers to describe the differences between density and crowding in detail. Since then, multiple theoretical approaches have been applied to study the effects of density on humans (Bell et al., 2001; Stokols, 1976). Preceding the elucidation of the theoretical approach, the concepts are described below.

2.1 Occupancy

Occupancy refers to the factual amount of people in a work environment; it cannot be determined in advance whether the occupancy will be evaluated positively or negatively by employees (Bechtel & Churchman, 2002). In environmental psychology, the term density is used to express the availability of space. Occupancy can be seen as a form of density and is defined as the ratio of the number of occupied workstations in the work environment to the total number of available workstations (Brunia & Pullen, 2014).

2.2 Perceived occupancy

Evans (1979) concluded already in 1979 that occupancy is not objectively perceived by office workers, which means that office workers may perceive similar levels of occupancy differently (Zoghbi-Manrique-de-Lara & Sharifiatashgah, 2019). Perceived occupancy is differently defined by scholars, where Bechtel & Churchman (2002) define it as *the perception and estimation of the number of people present in the work environment, available space, and workplaces*. In this paper, the definition of Bell et al. (2001) and others will be used who argue that perceived occupancy encompasses a perceived (mis)fit between the personal demand and the availability of space.

2.3 Other influencing factors

Next to occupancy, environmental factors, social factors, and personal factors influence the perceived occupancy (Bell et al., 2001; Desor, 1972; Stokols et al., 1973). Research shows for example that perceived occupancy differs for spaces of similar size with different partitions, linear dimensions, and doors (Baum & Davis, 1980). Also, by increasing coordination, signage, and information about the supply of space feelings of crowding may decrease (Langer & Saegert, 1977; Wener & Kaminoff, 1983a). Other research shows that a mismatch between expectations of occupancy and the actual level of occupancy increases feelings of crowding (Gochman & Keating, 1980).

2.4 Psychological responses

In combination with the above-mentioned influencing factors, perceived occupancy may lead to a positive or negative psychological response. The main psychological reaction to an *overly crowded* space is stress (Evans, 1979; Stokols, 1976). A study conducted in Dutch offices shows that the higher the occupancy in an office, the more physical and psychological discomfort employees experience (Aries et al., 2010). In literature, high occupancies in workspaces are also associated with increased distraction, concentration, lower (task) performance, and less job satisfaction and commitment to the organization (Oldham et al., 1995).

When space is perceived as *pleasantly crowded* – or *pleasantly quiet*, referring to the same feeling – the supply and demand of space and places match. Bell et al. (2001). Studies associate high densities with less stress, employee satisfaction, and stronger social ties (Fried et al., 2001; Szilagyi & Holland, 1980).

A workspace may also be perceived as *too quiet*. Feelings of isolation in the workspace are usually associated with working from home intensively but can also arise within the office if the personal need for connection is not met (Baumeister & Leary, 1995; Golden et al., 2008).

2.5 Theoretical approach

For the most part, we follow the eclectic environment-behaviour model of Bell et al. (2001). This model suggests that high occupancies may cause inconveniences, such as too much social stimulation, loss of social control, unwanted social interaction, or a lack of privacy. Whether or not high occupancy causes inconveniences depends on the person and the situation. We argue that it depends on (1) environmental factors: physical features of the situation (e.g., layout, furniture, colours), (2) social factors: stimulation from social sources (e.g., coordination, cohesion), and (3) personal factors: individual differences between individuals (gender, age, expectations) (Altman, 1975; Desor, 1972; Stokols et al., 1973). Bell et al. (2001) use a slightly different categorisation of factors that influence perceived occupancy.

Subsequently, occupancy can be perceived as within an optimal range of stimulation, leading to no negative or even positive effects (Bell et al., 2001). Deviations from this range can result in either overstimulation (resembling crowding) (Bell et al., 2001) or understimulation (resembling isolation)(Altman, 1975).

A perceived misfit between the demand and availability of space triggers a behavioural response (Stokols, 1972). These coping mechanisms are aimed directly at reducing negative feelings (Bell et al., 2001). Examples of coping mechanisms include speaking up to colleagues, leaving the workspace, and adjusting expectations concerning the affordances of the workspace. When coping mechanisms are effective, they lead to a reduction in negative feelings, though there may be lingering aftereffects (e.g. fatigue) (Bell, 2001; Stokols, 1972).

3 Method

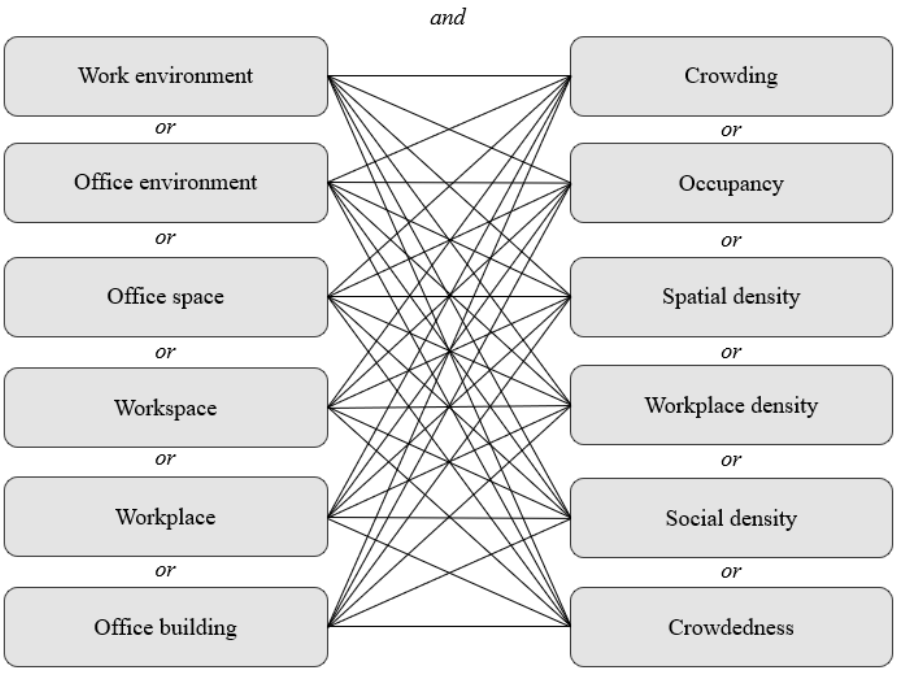
To gather the existing knowledge about the effects of occupancy in the workplace, we conducted a systematic literature review following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021). The main goal is to explore the environmental factors, social factors, and personal factors that influence perceived occupancy in workspaces.

3.1 Search strategy

De literature search focused on studies that investigated the psychological impact of occupancy in office environments on its users. Search terms referring to office environments were combined with terms that refer to occupancy and perceived occupancy (Fig 2). Unfortunately, isolation was not included as a search term, as we only recognized its relevance later in the research process. Since the research is not yet complete, we will incorporate articles pertaining to the term 'isolation' at a later stage.

The following databases were used to find relevant publications: Web of Science and Scopus. The databases were searched in the period December 2023 - January 2024. The search strategy included keywords related to (objective) occupancy and the office work environment. The same strategy was used in both databases.
Articles were included when they were published between 1971 and 2024 and the subject areas were sociology, psychology, & business. Articles were excluded when they used the following keywords: energy utilization, energy efficiency, energy conservation, energy use, intelligent building, sustainable development, computer simulation, or optimization.

Figure 2. Search strategy



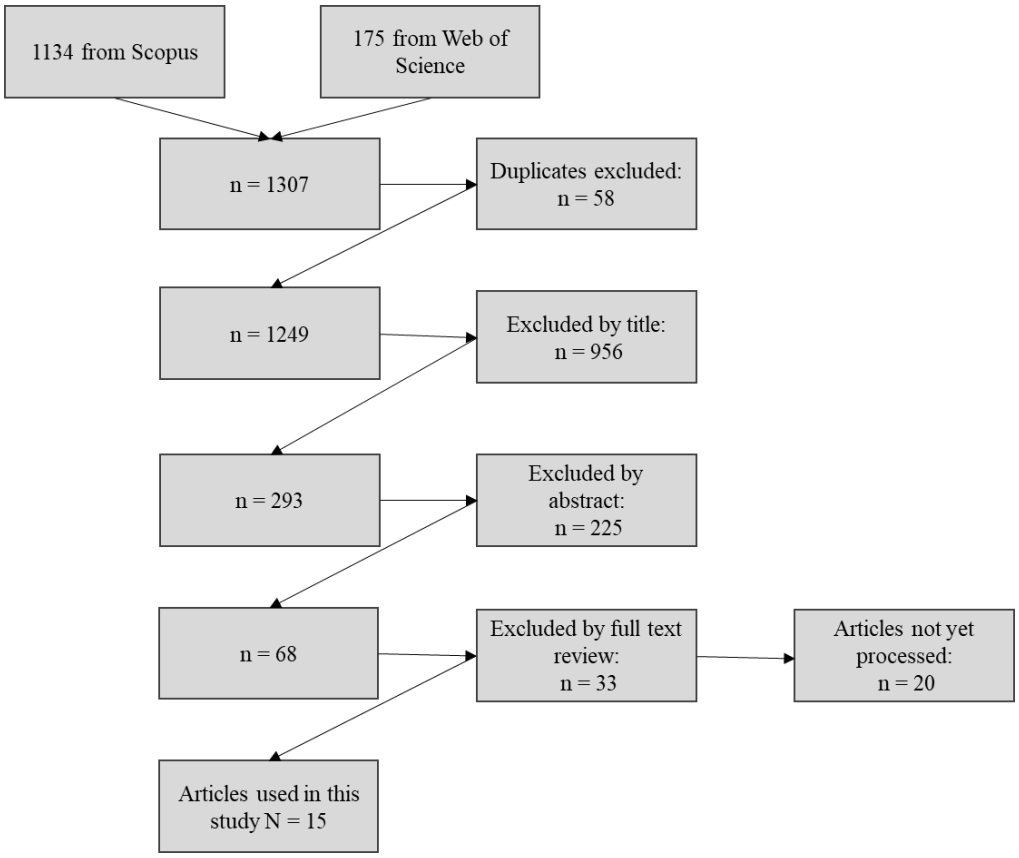
3.2 Selection criteria

Two reviewers independently selected and identified relevant and non-relevant articles retrieved with the search strategy. First, they screened titles and abstracts. Full-text articles were then reviewed for final inclusion. In this preliminary analysis, 48 of 68 articles were read. In each phase, the same selection criteria were used. In Figure 3 the screening process is displayed. Studies were eligible for inclusion if they met the criteria presented in Table 1.

Table 1. Inclusion and exclusion criteria

Inclusion criteria	***Exclusion criteria***
The studied environment is an office building or -floors.	Other environments, such as schools or dental practices.
The study is an empirical research or systematic review.	Theoretical papers, newspaper articles, etc.
The study population includes office employees or knowledge workers.	Other populations, such as prisoners, elderly people, and dentists.
The method and measures are clearly described.	When the method or analysis is not clearly described.
The dependent variables are a form of perceived occupancy or psychological responses of individuals.	Dependent variables that concern outcomes for teams or coping mechanisms.
The moderating variables are factors of the physical work environment, social work environment, or personal factors	Studies which focus on the method of measuring occupancy, without any relation to perceived occupancy or psychological responses.
The independent variables are forms of occupancy and/or perceived occupancy.	

Figure 3. Screening process.



3.3 Data extraction and analysis

Details were extracted from all articles by using a standardized form. Extracted data included study characteristics, outcome measures ((related concept to) perceived occupancy; psychological or physical reactions of individuals (feelings or emotions from perceived occupancy)), and key findings (factors of influence; link to additional articles and interesting findings). Related concepts to perceived occupancy variables such as the amount of privacy or personal space were also included in this study.

4 Results

Based on the preliminary analysis, 15 articles were identified that measured some form of perceived occupancy and psychological responses related to this. Firstly, these forms of perceived occupancy are discussed. The factors that were found to influence perceived occupancy at the office workplace are grouped into three categories: environmental factors, social factors, and personal factors. For each category, the factors and their effects are summarized.

4.1 Related concepts of perceived occupancy

Perceived occupancy was mostly not assessed directly in the articles. One exception is the study of Zoghbi-Manrique-de-Lara & Sharifiatashgah (2019) who measured the perception of crowding, which can be seen as a form of perceived occupancy. In other studies, constructs (e.g. privacy, distractions, and interruptions) are used that are related to perceived occupancy. Some studies use forms of (objective) occupancy, making no distinction between occupancy and perceived occupancy. In Table 1 the different constructs measured related to perceived occupancy are displayed.

Table 2. Related concepts of perceived occupancy

Reference	***Study type***	***Related concepts of perceived occupancy***
Bodin Danielsson & Bodin (2009)	Quantitative study	Acoustics (noise) and privacy
De Been & Beijer (2014)	Quantitative study	Privacy (satisfaction with privacy), ability to work concentrated, and acoustics.
Gonsalves (2023)	Case study	Territoriality and ability to work concentrated (unwanted interruptions)
Haapakangas et al. (2018)	Quasi-experimental analysis	Acoustics (noise sources) and privacy (visual and acoustic privacy)
Hodzic et al. (2021)	Quantitative longitudinal study	Distractions
Kazlauskaitė et al. (2023)	Systematic literature review	Occupancy (density) and privacy
Khoshbakht et al. (2021)	Quantitative study	Occupancy (number of occupants in the building)
Kim & de Dear (2013)	Quantitative study	Occupancy (workplace enclosure/proximity) and perceived occupancy (satisfaction with the amount of space)
Kropman et al. (2023)	Systematic literature review	Occupancy (number of occupants)

Laurence et al. (2013)	Quantitative study	Privacy (and architectural privacy) and workspace personalization.
Maher & von Hippel (2005)	Quantitative study	Privacy (objective privacy) and occupancy (social density)
Richardson et al. (2023)	Quantitative study	Occupancy (social density)
Vischer (2007)	Theoretical paper	Acoustics
Zoghbi-Manrique-De-Lara & Sharifiatashgah (2020)	Quantitative study	Perceived occupancy (perceived crowding) and privacy (invasion of privacy)

4.2 Environmental factors

11 articles studied the relationship between environmental factors and concepts to perceived occupancy. Six papers focused on the spatial openness of workspaces. The findings suggest that openness of the workspace may increase feelings of crowding. The other articles in this category assessed the impact of noise, plants, and the availability of quiet workspaces, personalization of workspace, and outside view. In Table 2 the results are shown for these different environmental factors and their impact on the related concepts to perceived occupancy.

Table 2: Environmental factors influencing perceived occupancy

Factor	***Impact on (related concepts to) perceived occupancy***	***Reference***
Acoustics	Noise is a consequence of high-density offices and a primary source of discomfort.	Vischer (2007)
Openness of workspaces	People are most dissatisfied with open-plan offices, in which noise and privacy are the main causes.	Bodin Danielsson & Bodin (2009)
Openness of workspaces	People in combi-or flex offices are less satisfied with productivity support, privacy, and concentration compared to people in shared room offices.	De Been & Beijer (2014)
Openness of workspaces	Working in an activity-based flexible office leads to an increase in distraction.	Hodzic et al. (2021)
Openness of workspaces	Open-plan offices were most disliked and productivity decreased as the number of occupants in the building increased.	Khoshbakht et al. (2021)
Openness of workspaces	Noise and privacy loss are identified as the main source of dissatisfaction in open-plan offices.	Kim & de Dear (2013)
Openness of workspaces	A larger number of occupants has adverse effects on productivity and well-being.	Kropman et al. (2023)
Personalization of workspace	Personalization reduces the negative impacts of low privacy at work.	Laurence et al. (2013)

Plants	Many plants may be seen as disorderly or hectic, reducing comfort in the workspace, though less than having no plants at all.	Kropman et al. (2023)
Type of workspaces	The provision of quiet workspaces was associated with fewer distractions, less stress, and higher satisfaction with the environment.	Haapakangas et al. (2018)
Type of workspaces	Undisturbed workspaces could mitigate negative effects on well-being by supporting employees' auditory and visual privacy needs.	Kazlauskaitė et al. (2023)

4.3 Social factors

Three articles studied the relationship between social factors and their impact on related concepts to perceived occupancy. These three studies assessed whether territoriality, personal space, and culture affected different related concepts to perceived occupancy. See Table 3 for an overview of social factors that impact (concepts to) perceived occupancy.

Table 3: Social factors influencing perceived occupancy.

Factor	***Impact on (related concept to) perceived occupancy***	***References***
Culture	British participants had higher personal space satisfaction with a lower social density than Korean participants.	Richardson et al. (2023)
Personal space	Invasions of privacy by supervisors and peers trigger deviant work behaviour in crowded environments.	Zoghbi-Manrique-de-Lara & Sharifiatashgah (2019)
Territoriality	A shift from territorial space to non-territorial space afforded workers greater control over social interaction.	Gonsalves (2023)

4.4 Personal factors

Three articles studied the relationship between social factors and their impact on related concepts to perceived occupancy. The studies addressed the influence of stimulus screening, inhibitory ability, task complexity, employee needs, and work pressure on perceived occupancy. See Table 4 for an overview of the social factors that impact the related concepts to perceived occupancy.

Table 4: Personal factors influencing perceived occupancy.

Factor	***Impact on (related concept to) perceived occupancy***	***References***
Employee needs	When the need for quiet workspaces is met, employees report greater satisfaction with their work environment, fewer distractions, less stress, and improved collaboration.	Haapakangas et al. (2018)
Employee needs	Support for the need for privacy appears to mitigate negative effects on well-being dimensions.	Kazlauskaitė et al. (2023)
Inhibitory ability	Employees who are better able to inhibit distractions within their environment also perceive their workplace as more private.	Maher & von Hippel (2005)
Stimulus screening	Employees with better screening ability have higher performance and job satisfaction.	Maher & von Hippel (2005)
Task complexity	When task complexity is high, poor stimulus screening and low inhibitory ability lead to lower job satisfaction	Maher & von Hippel (2005)
Work pressure	The negative relationships between distraction work engagement and fatigue were more pronounced in situations of increased time pressure and unpredictability.	Hodzic et al. (2021)

5 Discussion and Conclusion

In this study, we explored the factors that influence employees' perception of occupancy at the office. Our results demonstrate that occupancy or perceived occupancy was barely the central theme in the analysed studies. Except for Zoghbi-Manrique-de-Lara & Sharifiatashgah (2019), the articles used several concepts that relate to perceived occupancy (Bell et al, 2001; Stokols, 1976), for example, privacy, acoustics, the ability to work concentrated or (objective) occupancy. In our review, we found that these concepts are often measured, while the connection with occupancy is barely made.

Our results demonstrate that multiple environmental factors, social factors, and personal factors have an impact on these related concepts of perceived occupancy in workspaces. Environmental factors are the openness of workspaces, acoustics, plants, workspaces, personalization of workspace, and outside view. Especially openness of the workspace is the most studied factor in relation to perceived occupancy. Social factors are territoriality, personal space, and culture. Personal factors are work pressure, stimulus screening, inhibitory ability, task complexity, and employee needs.

Our preliminary results have limitations because they did not include various environmental, social, and personal factors known to influence crowding outside the context of workspaces. Examples of these include linear dimensions and doors (Baum & Davis, 1980), signage (Langer & Saegert, 1977; Wener & Kaminoff, 1983), in-group and out-group effects, coordination within spaces, expectations on the level of occupancy, and goals (Bechtel & Churchman, 2002; Bell et al., 2001). Future studies could shed light on the influence of these factors in workspaces.

Another limitation of our study is that our search strategy did not include isolation as a search term as we only recognized its relevance later in the research process. Since this study is still ongoing, articles containing the search term 'isolation' will be included in the remaining analysis. Despite these limitations, we hope to have shown the value of using the perspective of perceived occupancy in the workplace setting, providing insights for practitioners and inspiring academics to further explore this topic.

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The enticing workplace: Attracting people back to the office

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ABSTRACT

The pandemic forced most office-based employees to work from home and many now prefer to work remotely. Some organisations are encouraging their workforce return to the office, but the response from employees has been slower than expected. The purpose of our research was to explore what employees believe would attract them back to the office, and to understand their underlying concerns about returning to the office. Following initial qualitative interviews, an online questionnaire survey was designed and launched. The respondents rated 51 possible influences (including work activities, facilities and indoor environment, personal benefits, and sense of purpose) to indicate whether they were better supported working from home or in the office.

The home better supports focussed work whereas the office facilitates interactions. The home is clearly a better setting for concentration, confidentiality and personal productivity, so the office needs to better support these activities to entice people back. Regarding facilities and environmental conditions, a higher proportion of respondents report that their home is preferred, most likely because they have more control over indoor environmental conditions in their home. The area the office appears to compete most poorly with working from home is personal benefits. Most of the respondents deem their home to better support most personal benefits, especially those related to personal pressures, such as reduced travel costs and time. In contrast, the office better supports reducing loneliness and the delineation between work and home life. The office also fares better for supporting a sense of purpose with the majority of respondents believing the office offers more connection and reward.

The survey also found significant differences in responses depending on the length of time working at home, the type of organisation, the set-up at home, family circumstances, personality and the primary workplace (particularly those with unallocated desks versus private offices).

Keywords

Office design, psychology, hybrid working, attractive office, enticing workplace.

1 background and purpose

The COVID-19 pandemic forced most office-based employees to work from home and, since "gaining permission" to work from home, many staff now prefer to work remotely rather than commute to the office (McKinsey, 2023). Some organisations are encouraging, even dictating, that their workforce return to the office (Christian, 2024), but the response from employees has been slower than employers had hoped. The office staff are literally voting with their feet – it seems that the office cannot easily compete with the option and personal benefits of working from home. Consequently, many offices are under-utilised with a high proportion of desks sitting empty for most of the week despite the space being heated, cooled, lighted, serviced and maintained (Oseland et al, 2022). This is clearly not a long-term sustainable approach to office design and operation.

The purpose of this research was to explore what employees (workplace experts and others) believe would attract them back to the office, and to understand the underlying (real) concerns of workers about returning to the office. Furthermore, the study aimed to investigate the employee benefits and advantages of working from home compared to the office.

2 approach and sample

The study used a mix of qualitative and quantitative methods, primarily interviews followed by an on-line survey. Semi-structured interviews were conducted with five practitioners within the workplace industry. The interviews were used to explore the topics that the survey should address.

Following initial qualitative interviews, an online questionnaire survey was designed and launched using Survey Monkey. The respondents rated 51 possible influences to indicate whether they were better supported working from home or in the office. The 51 influences were presented in four groups, as questions relating to work activities, facilities and indoor environment, personal benefits, and sense of purpose (Figure 1). The respondents then identified the most important influences attracting or discouraging them from returning to the office and rated their overall preference for home versus office. Each of the 51 core questions was answered using a five-point scale: "Much better at home" (1), "Better at home" (2), "Little difference between home and office" (3), "Better in the office" (4) or "Much better in the office" (5). Respondents were also given the option of "Don't know or not applicable", which was treated as missing data. For ease of presentation, the responses were grouped and converted to the percentage of respondents answering: "Better at home", "Indifferent" or "Better in the office". Chi-square Tests were computed to check for statistically significant differences between sub-groups of respondents.

Sampling was broad and inclusive rather than representative. The focus was on the UK and rest of Europe, but other regions were also covered because of the sampling strategy. Respondents were invited by two main routes: i) direct electronic mail-out by Workplace Trends (an annual conference) to their database of approximately 3,200 practitioners, of which 2,900 are UK based, and ii) social media platforms, including the Workplace Trends LinkedIn group with 14,000 (worldwide) members.

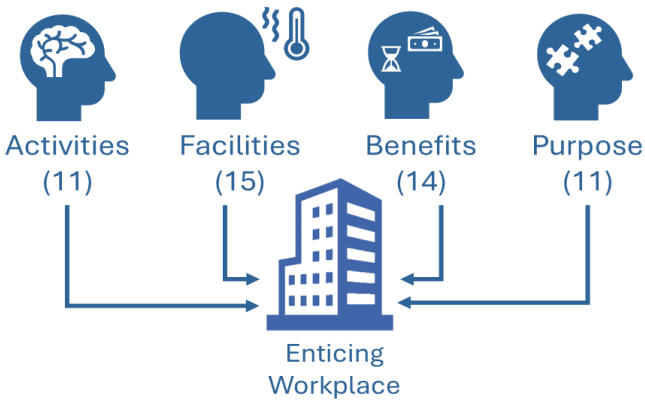

Figure 1. 51 influences

When a person accessed the questionnaire, initial filtering questions excluded anyone who either was i) a freelancer/sole-trader, ii) had never worked in their employer's offices or iii) had never worked from home. At the time of analysis, some 649 people had responded to the survey, mostly via social media invitations. However, as Figure 2 shows, only 490 respondents met the three sample criteria.

The respondents in the sample were a mix of workplace experts and employees in general who were not freelancers and had worked both at home and in their employer's offices. Almost two-thirds (61%) of the sample are located in Europe, with almost one-half (45%) in the UK. Over one-quarter (28%) are based in North America. The private sector made up most of the sample: 41% work for Small and Medium-sized Enterprises (SMEs), 37% large corporates, 12% public sector and not-for-profit, and the remaining 10% work in the education sector. Approximately one-half (54%) of the sample are workplace professionals and 18% consider themselves as leadership or senior management.

3 Preference Ratings for Whole Sample

Figure 3 shows the percentage of respondents who believe that 11 different work activities are better supported when working from home or in the office. A higher proportion of respondents consider their home better for conducting confidential calls or meetings, for work requiring concentration, and for feeling productive overall. In contrast, very few respondents consider the home to support teamwork and collaboration, managing or mentoring a team, improving knowledge through interactions or eavesdropping, or socialising with colleagues. The majority consider these activities to be better supported in the office along with holding meetings, making key business decisions and enhancing creativity and innovation.

In broad terms, the home better supports focussed work and the office those activities facilitating team development. While the home is clearly a better setting for concentration, confidentiality and personal productivity, the office needs to better support these activities in order to entice people back. Preferences regarding "creativity and innovation" are balanced, with some overall preference for the office; this reflects the need for both individual thinking and interactive development in creativity.

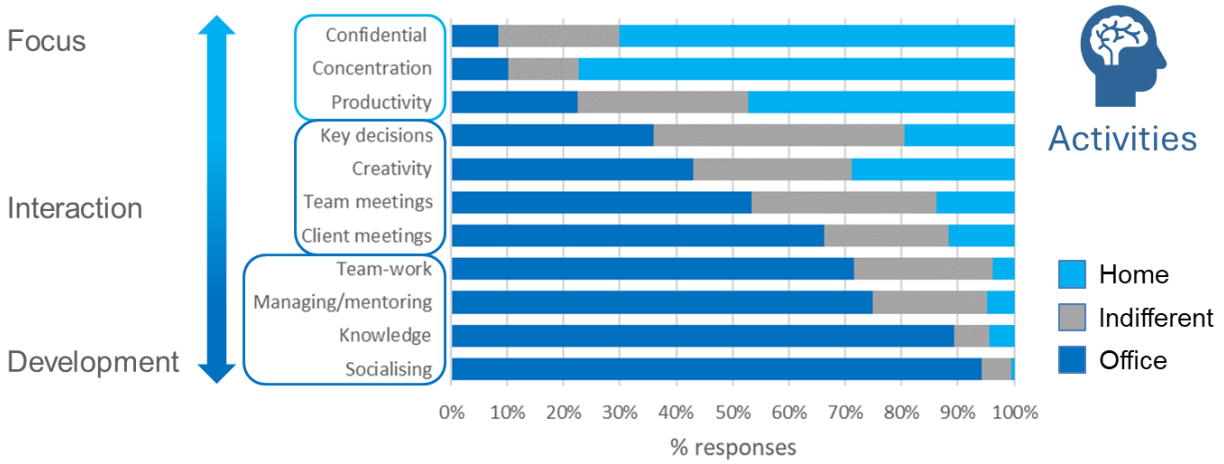

Figure 3. For each of the following work activities, do you personally find it is better supported in the office or at home?

Regarding facilities and environmental conditions, a higher proportion of respondents report that their home is preferred for the indoor environmental conditions (Figure 4). This is most likely because they have more control over the environmental condition in their home. Nevertheless, the office having a poorer perceived environment than the home is a disappointment, if not a surprise: a poor outcome for the workplace industry, which requires fixing. The top two influences that are considered better supported at home, and by an overwhelming majority of respondents, are privacy and control over noise. Densely planned large open-plan environments most probably decrease privacy and increase noise, and are not attractive to most office workers.

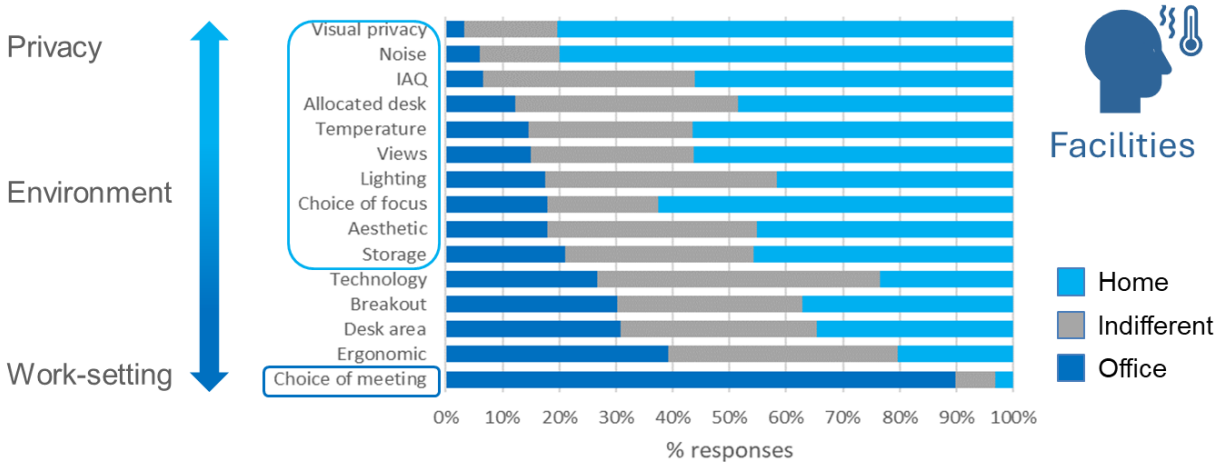

Figure 4. For each of the following facilities and environmental conditions, do you personally find it is better in the office or at home?

The office appears to compete most poorly with working from home in the area of personal benefits. Figure 5 clearly shows that most of the respondents deem their home to better support most personal

benefits, especially those related to personal pressures, such as reduced travel costs and time, improved work-life balance, access to childcare, managing a health condition or disability, and taking advantage of the weather conditions (avoiding poor and enjoying nice weather). While it is difficult to overcome such working from home benefits, organisations could consider assistance with travel costs (like subsidised rail tickets), access to nearby crèches, and flexibility over work hours and workload.

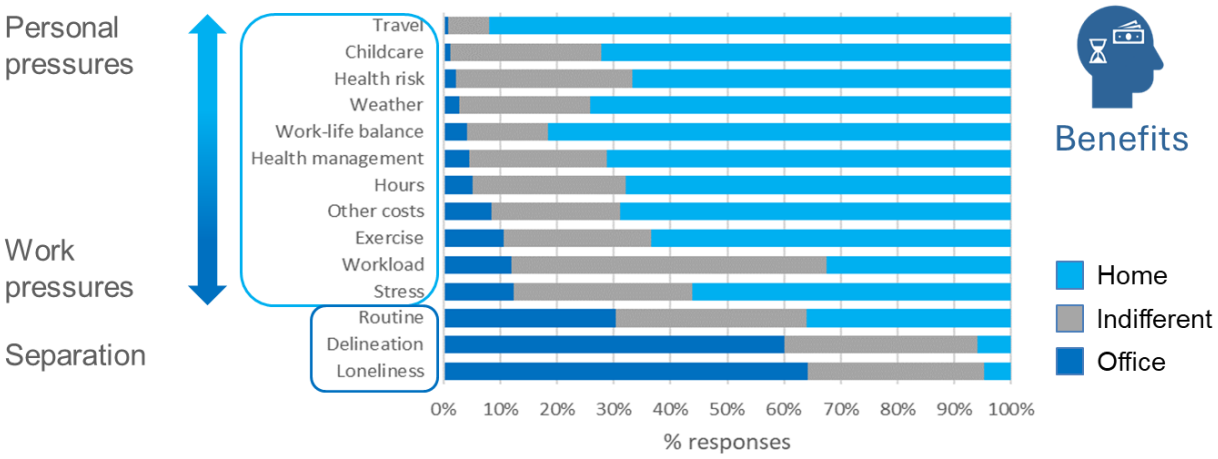

Figure 5. For each of the following benefits, do you personally find it is better in the office or at home?

In contrast, the office appears to better support reducing isolation and loneliness (an increasing health issue on the UK), delineation between work and home life. For some, the office also offers a more consistent daily routine. Office design and management can help enhance socialising and teamwork to help reduce loneliness.

The office fares better for supporting sense of purpose (with the exception of reducing the impact on the environment). Figure 6 shows that most respondents believe the office better supports connection and reward, particularly connecting with colleagues, aligning with the company culture, experiencing leadership and motivation, and reducing the “fear of missing out” (FOMO).

Increasing a sense of purpose and belonging, through strong leadership, motivation, connection and culture, should attract people back the office. Workplace design and the relevant facilities can help foster the organisational culture, but ultimately it comes from the leadership team. Regular events (like lunch and learn or socials), clubs and classes, or wellness facilities all help to make the office a more attractive destination.

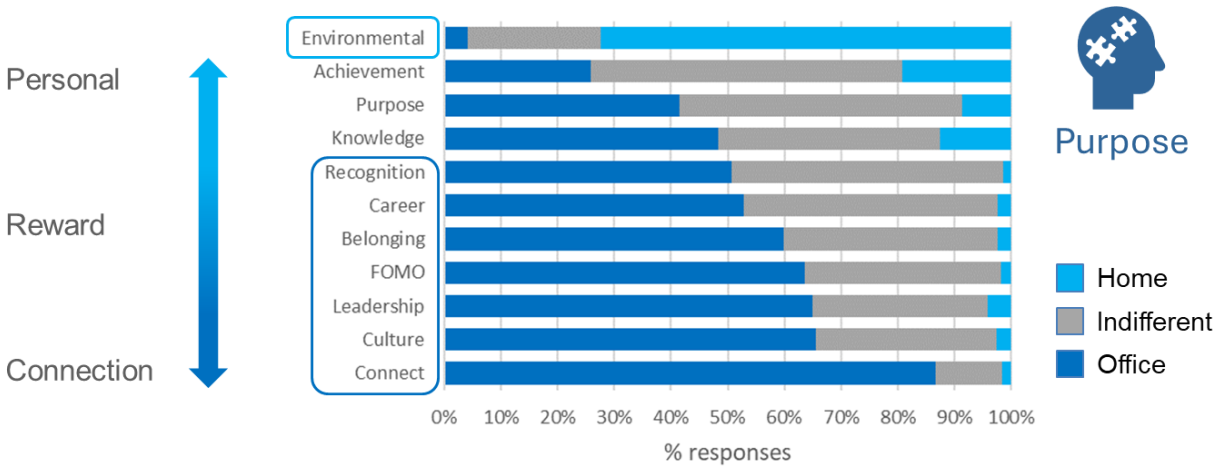

Figure 6. For each of the following factors, do you personally find it better in the office or at home?

4 Most Attracting and Discouraging Influences

At the end of each of the four sets of influences, respondents were asked to select two that most attract them to the office and two that most discourage them from returning to the office. From the resulting list of eight attractors and discouragers, they then chose their top three.

To attract people to the office, the most important influences involve interaction with colleagues (teamwork, socialising and connection), including having the spaces in which to interact. Then delineation between work and home, and avoiding loneliness, are considered key factors (Figure 7). The list of main attractors is completed by organisational influences (culture and belonging), having a routine, and workstation quality (ergonomics and technology).

The influences that most discourage people from working in the office are travel cost and time, work requiring concentration, control over noise and confidentiality (Figure 8). Visual privacy and space for focused work are also included, but further down the list. The challenge to architects and designers is

Figure 8. Based on the 8 factors you have already selected, overall which three most discourage you from working in the office?

to create workplaces that better support and encourage socialising and teamwork but simultaneously offer more privacy along with minimising noise and distraction.

Mid-table is work-life balance, productivity and environmental concerns. As mentioned, productivity is most likely related to producing deliverables without distractions and with greater flexibility over when work is done. Work-life balance is most likely due to managing time and possibly linked to the core discourager of travel time. The list is completed by temperature control, avoiding stress, and the opportunity for exercise. The latter two are also related to work-life balance and time management.

5 Workplace and Worker Characteristics

The survey also recorded background variables, describing the home and office, and the respondents themselves. The differences between the sub-groups of each background variable were computed and sorted for the most statistically significant and largest differences in preference (for the home or office) for each of the 51 influences. In the charts below, only the influences showing the top 20 statistically significant effects are outlined.

Figure 9 below shows that a proportion of respondents who had been working at home for less than one year prefer to work in the office. This may be linked to the time they joined their organisation, with new recruits wanting to spend more time with colleagues and their managers for mentoring, knowledge and career progression. Alternatively, those new to working from home may have poorer equipment, technology or ergonomic set-up than those established during or before the COVID-19 pandemic. Indeed, a higher proportion of those respondents working at their kitchen table are more likely to prefer working in the office. Conversely, those with a home office feel their home better supports them, especially in terms of ergonomics and storage, but also for a sense of purpose and reward.

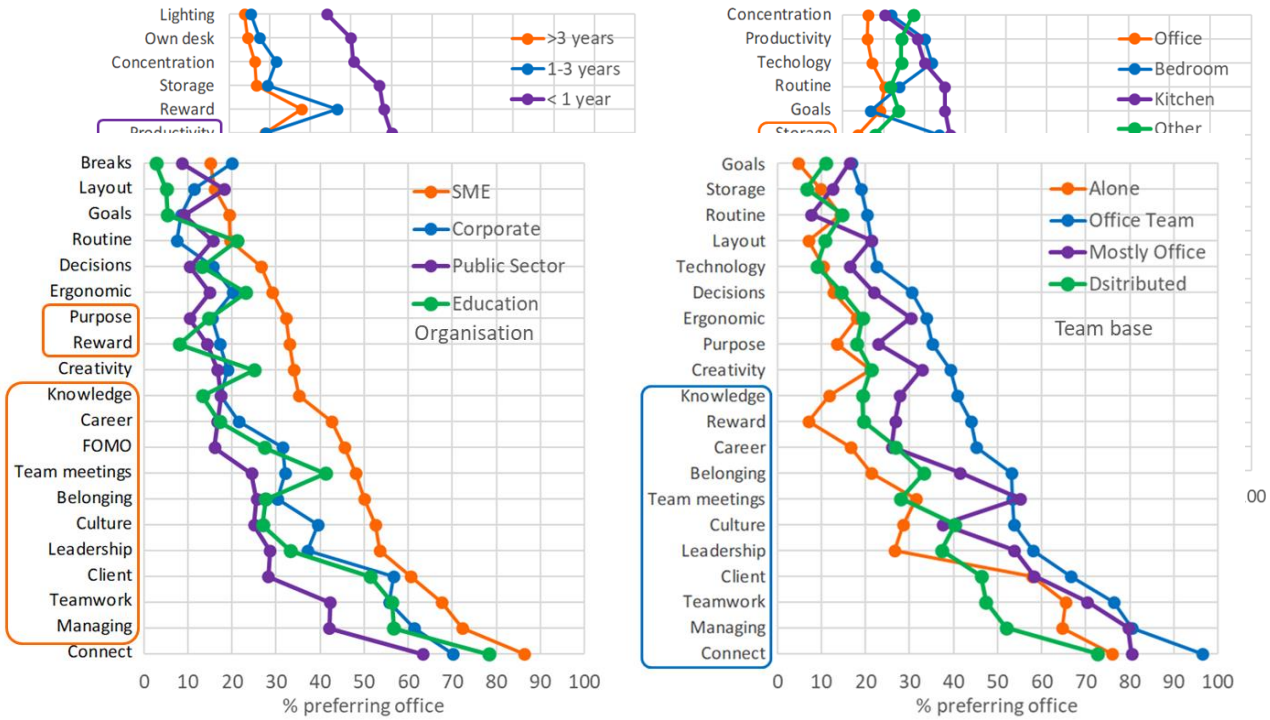

Figure 10. Type of organisation working for and primarily working alone or with a team

A higher proportion of the respondents working for a small and medium sized enterprise (SME) prefer working in the office, especially regarding a sense of purpose (Figure 10). Compared to respondents working in the public sector, those working in an SME consider the office to better support teamwork meetings, culture, belonging, leadership, FOMO and career development. It is possible that SMEs engender a more entrepreneurial, motivational, loyal and flourishing culture compared to some public sector workplaces.

The survey also revealed that a higher proportion of respondents working in office-based teams prefer the office, relative to those working alone or in distributed teams. Again, this was more evident for supporting teamwork, meetings, reward and career progression. The proportion of respondents in the public sector working in office-based teams was like that in SMEs, so it is unlikely to be the cause of the difference in preferences between SMEs and public sector.

A more controversial finding is that a higher proportion of respondents who have assigned/ allocated desks prefer working in the office compared to those with unassigned desks (Figure 11). If more employees are working from home, then an organisation might decide to implement unassigned desks (shared seating, hot-desking) to increase the desk utilisation and reduce any unused space. However, the survey indicates that unassigned desking may discourage occupants returning to the office, thus further reducing the utilisation. While it is not sustainable to have desks sitting empty most of the week, it is important that the transition to unassigned desking is managed well, and the implementation made for genuine reasons.

Consistent with the effect of having an allocated desk, those with a private office were the most likely to prefer working in the office. Those who did not use a desk as such but worked elsewhere (a focus pod/room, meeting room or breakout space) were least likely to prefer working in the office.

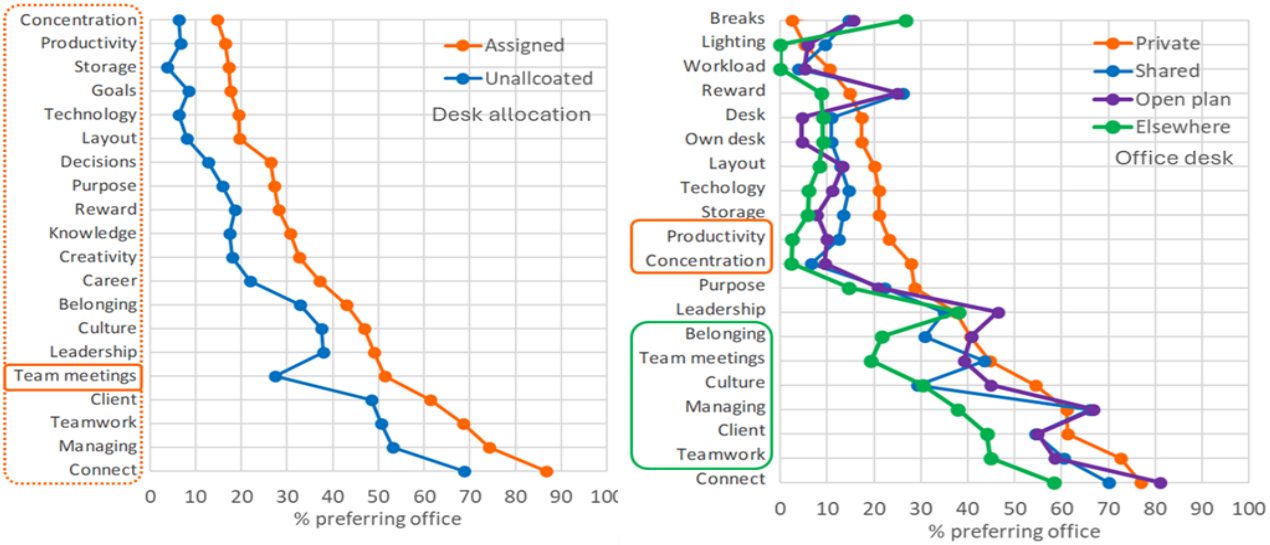

Figure 11. Assigned or unassigned seating and desk location in the office

Unlike many reports in the popular press, the survey did not reveal any statistically significant differences in preferences between age groups or generations (Figure 12). Generational differences may be confounded by other factors, such as tenure, career stage or home circumstances. For

example, unexpectedly the survey did show that a higher portion of single parents (or other lone adults living with dependants) are most likely to prefer the office.

Respondents were asked to rate how introvert or extrovert they considered themselves. Extroverts are more likely to prefer working in the office compared to introverts (Figure 13). This is in line with other research that shows extroverts are easily distracted at home and prefer the company of their work colleagues to working alone. In particular, extroverts believe the office better supports creativity, teamwork and meetings, and leadership/ management. It is important to recognise that employees with different personalities and backgrounds will have different preferences and different reasons for returning to the office, hence different contexts in which they are most productive, when determining what will attract them and what discourages them.

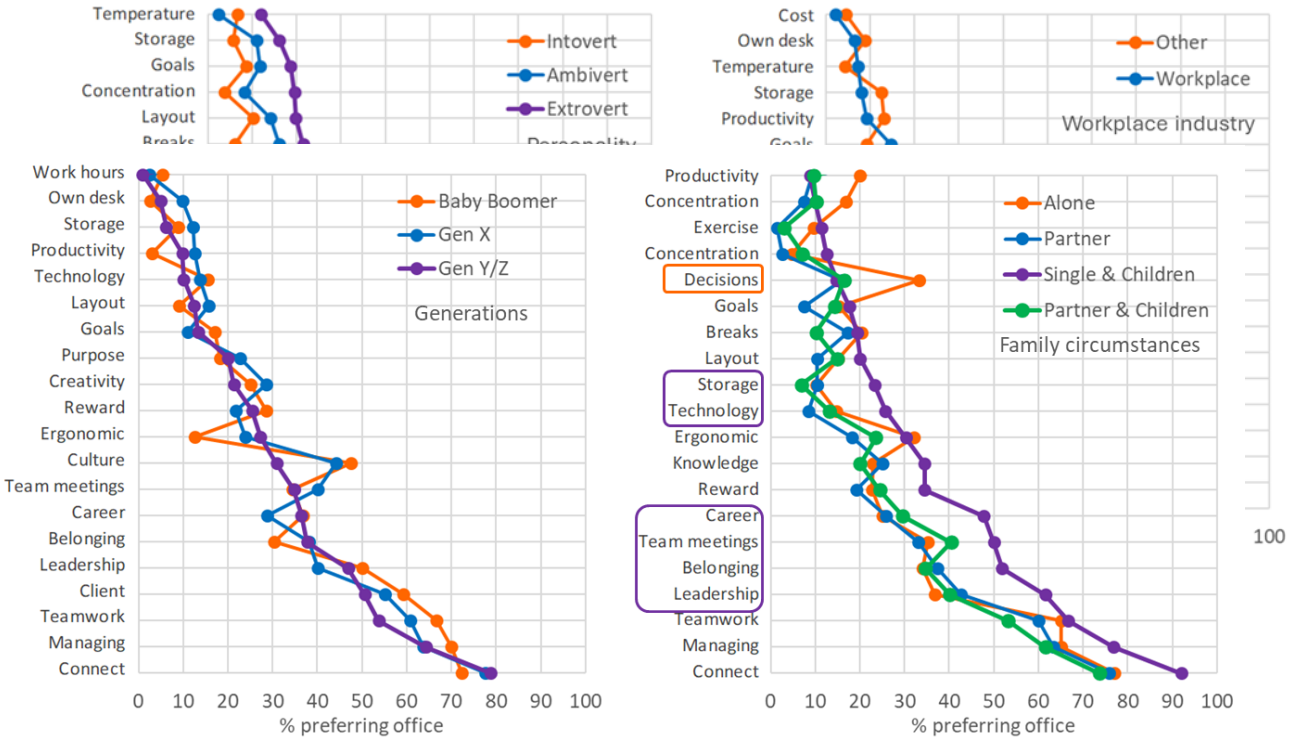

Figure 12. Year born (converted to generation) and home/family circumstances

As the overall preference and self-rating of introversion-extroversion were made on continuous (0-100) scales, their correlation could be calculated and plotted, as per Figure 14. The raw data was quite scattered but the average overall preference rating for clusters of every 10 points on the personality scale shows a clear non-linear (quadratic) relationship (r=0.88, r^2=78%). There is less difference between ambiverts and extroverts, but as found with the ANOVAs those more introverted have a higher overall preference for working from home. They can work without superfluous interactions (perceived distractions) from colleagues, and managers, and perhaps have more control over their work time and workflow.

One of the research objectives was to compare the views of those working in the workplace industry to the views of others to gauge whether professional advice reflects occupant views. Figure 13 shows that there are only minor differences in how workplace professionals consider the office to support various aspects of working. A higher portion believe the office better supports a sense of purpose and belonging, along with culture, leadership, reward and creativity. These are important influences but not necessarily strong enough alone to attract people back to the office and not the ones discouraging a return.

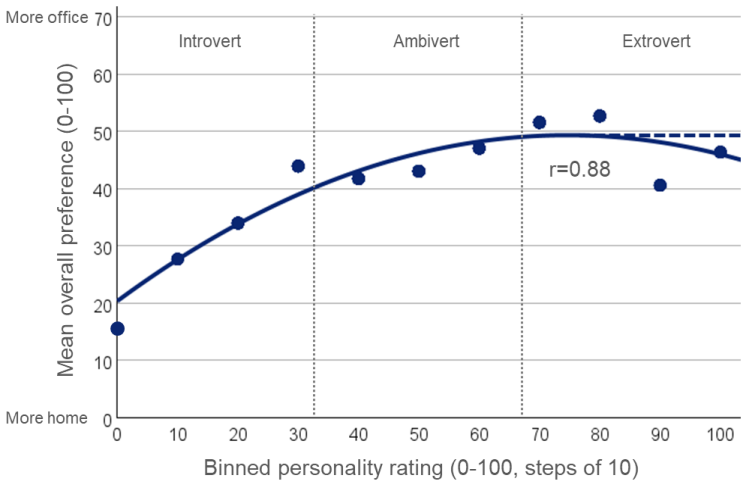

Figure 14. Extroversion and office preference

6 Overall preference

Respondents were asked (on a scale from 0 to 100%) whether, considering all 51 influences, they considered the better place to work was mostly their home or the office. Approximately one-half considered their home better and approximately one-third said the office. According to this survey sample, the office requires some improvement to entice people back

The meaning of overall preference will depend, to some degree, on how it arises from preference based on individual influences. The 51 influences were therefore entered into a multiple regression analysis to predict overall preference. Five influences added to the predictive power of the final regression equation, with a correlation (r) of 0.79 so altogether accounting for 63% (r^2) of the variance in overall preference, which is quite good. The five influences, in order, are:

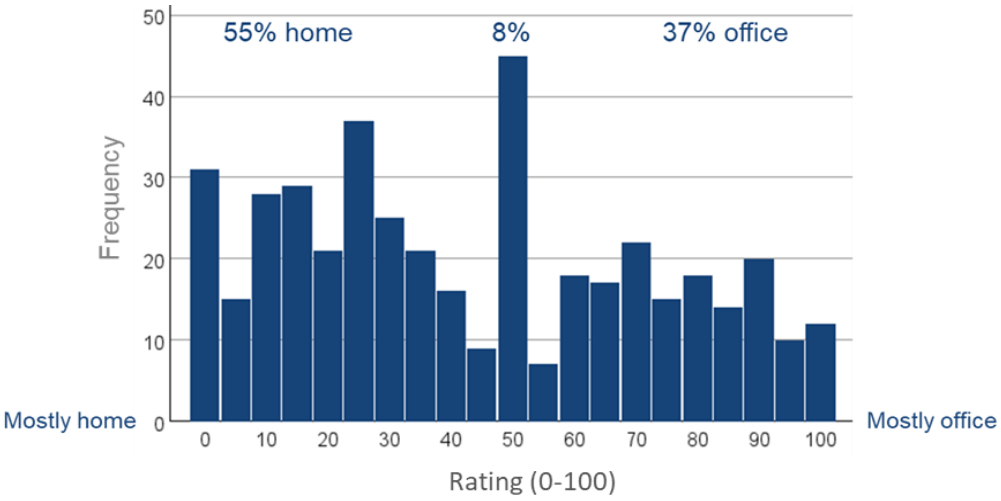

Figure 14. Considering all the previous factors, do you personally find your home or the office the better place to work?

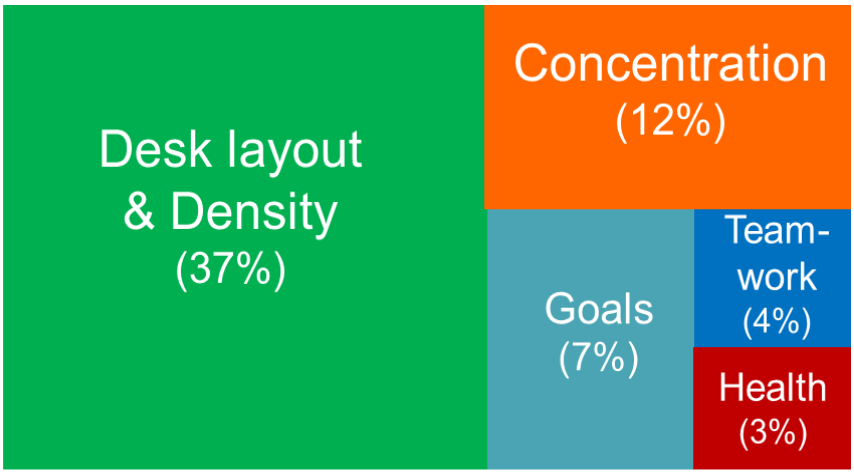

Figure 15. Multiple regression results

1. “The desk area, space, layout and density” (r=0.61, r^2=36.9%),
2. “Work requiring concentration, like analysis, coding or reading” (r=0.34, r^2=11.8%),
3. “Sense of achievement and reaching personal goals” (r=0.26, r^2=6.8%),
4. “Teamwork and collaborating closely with colleagues” (r=0.20, r^2=4.1%),
5. “Reduced risk to health and safety, e.g. infection, allergy, accidents” (r=0.18, r^2=3.1%).

As found in other recent research, over-densification of workspaces can lead to increased noise and distraction, reduced privacy and issues with other environmental conditions thus discouraging people from returning to the office (Oseland et al, 2022; Oseland, 2022). Work requiring concentration was also a key predictor.

7 Workplace implications

A recap of the recommendations for attracting people back the office, based on the survey results, is as follows, and illustrated in Figure 16.

- Create an attractive working environment by reducing the desk density, offering some control of environmental conditions with good natural light and views out. High desk density is symptomatic of many issues with the modern office that discourage working there.
- Most importantly, reduce distraction and noise, and provide both visual and acoustic privacy. For example, break up large open plan areas with screens, bookshelves, plants, pods, etc. See Oseland’s (2022) “landscaped office” for more ideas.
- Provide spaces for focus and concentration, for example nearby rooms, pods and booths. Not all employees have suitable space at home and those coming to the office to connect will also need quiet space occasionally.
- Also provide spaces for interaction, collaboration, teamwork, socialising and connecting. These are key reasons for coming to the office rather than staying at home. While on-line meetings (Teams/Zoom) are an improvement on teleconference calls, they tend to be planned and so do not offer impromptu interactions or socialising. They also miss much non-verbal communication.
- Offer more options for travel (costs/time), work hours, wellness/exercise and childcare. In addition to flexible travel times, consider help with subsidised travel or loans for rail tickets. Also consider on-site wellness facilities or subsidised membership of nearby gyms, spas or clubs, etc. Likewise, consider access to crèches and subsidised lunches. Such subsidies alone will not ensure a return to the office, but they are one contributing factor.
- Emphasise and enhance the reasons to visit the office (connection, culture, belonging) through events, key meetings, social gatherings and leadership. Organise regular team catch-ups, both work and social. For example, ask new members of staff to make a short presentation on their experience and introduce them to their new colleagues across the organisation. Activities and events (e.g. charity coffee mornings, bake-offs, hobbies clubs, on-site fitness classes) all provide one of maybe several reasons to come to the office, thus making the trip more worthwhile.
- Ensure a motivating culture through leadership, encouragement, loyalty and work ethic. While this is not primarily a workplace design issue, well-designed workplaces can embody the corporate culture.

- Consider the employee's differences and personal circumstances, especially those with family or healthcare issues, or just starting out on their career. Discover what will attract different groups of people, such as different personality types, back to the office and design for their requirements.
- Implement unassigned desking only with caution and provide allocated desks to those who genuinely need them – generally or on specific days. This should not be based merely on seniority. Monitor utilisation and manage desk numbers to ensure that staff have a desk when choosing to work in the office.

Figure 16. Recommendations for attracting people back to the office

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Social affordances of communal office spaces: a visual analysis

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ABSTRACT

Purpose: In the hybrid working model, offices largely serve as a place to meet co-workers and clients and fulfil the need for casual encounters and social bonding. Not much is known about what interior design characteristics office users perceive as supportive of these informal social interactions. This study explored the relationship between interior design attributes, affordances and perceived support of informal interactions in depicted office spaces.
Theory: Based on the theory of affordances, it was assumed that particular combinations of interior design attributes could be perceived as supporting or impeding social interactions.
Method: Photographs of communal office spaces designed to support informal social interaction were collected from workplace designers. A selection was coded by five interior designers regarding colour use, materialisation, and decoration. Subsequently, the 14 most high-consensus pictures were rated by 34 office workers for social affordances. Spaces were ranked, associations between affordances were calculated, and affordance-design connections were counted. The high-performing spaces were further explored through qualitative comparative analysis.
Findings: The depicted social office spaces predominantly featured light colours, angular shapes and artificial finishes rather than biophilic designs and were not very pronounced regarding colour use. Spaces with ample decoration, plants, rounded shapes, and at least some enclosure were deemed most supportive of informal social interactions. Although many lacked perceived privacy and comfort, they still seemed to afford some intimate conversations. But overall, the spaces' social affordances and support of informal social interactions were perceived as quite limited.
Value: This study's novelty lies in applying visual analysis to gather detailed insights into the relationship between interior design attributes and perceived social affordances of office space. The study serves as a basis for further data collection and systematic comparison of social office spaces to discover patterns that could guide workplace design projects.

Keywords
Offices, Interior design, Affordances, Social interaction, Visual analysis.

1 INTRODUCTION

The emergence of hybrid work models and the rapid improvement of remote connectivity have redefined the purpose of physical office spaces (Sailer et al., 2023). Currently, the office is evolving as a dynamic hub for collaboration and community and a social anchor, emphasising the importance of fostering informal social interaction among employees (Fayard et al., 2021). Informal interaction, characterised by spontaneous exchanges and socialising, plays a pivotal role in shaping organisational culture, fostering a sense of belonging, and enhancing performance (Pyöriä, 2007; Sailer et al., 2021). Even minimal interactions increase happiness (Sandstrom & Dunn, 2014) and daily small talk at work has an uplifting effect and serves as a social ritual (Methot et al., 2021). Winslow et al. (2019) argue that social interactions represent affective events which accumulate to form enduring workplace relationships. They define informal or non-instrumental interactions as casual, non-task/work-related interactions in the organisation, such as talking about shared interests, making jokes, sharing personal experiences, and discussing events of non-work time.

Informal interactions cannot be planned or forced but research in the field of environmental psychology shows that the likelihood of their occurrence can be increased by workplace design. Sailer and McCulloh (2012) showed that spatial integration and sightlines increase the likelihood of social interactions at work. Furthermore, environments shape behaviour patterns, guiding social interactions by signalling acceptable behaviour through design cues (Scott, 2005). Biophilic design, such as views of greenery, can create an environment conducive to positive social interactions by restoring sources of prosocial energy (Klotz & Bolino, 2021).

On the other hand, stressors like noise and crowding can inhibit social interactions, emphasising the importance of freedom of choice to reduce stress and enhance social bonding (Proshansky et al., 2004). Seat choice and personal space influence privacy control, impacting interpersonal dynamics and well-being (Evans & Wener, 2007; Staats & Groot, 2019). Symbolic barriers and personalisation contribute to a sense of ownership, reinforcing social norms and reducing conflicts (Brown & Robinson, 2011; Brunia & Hartjes-Gosselink, 2009).

In a recent study, interior designers explained their strategies for supporting informal interactions and connectedness among employees, for example by creating an informal or cosy atmosphere that invites people to visit and linger and providing facilities for social activities (Colenberg et al., 2023). Spreitzer et al. (2020) argue that the scents and sounds of coffee bars and food spaces can trigger emotions that stimulate informal interaction. However, empirical research on how employees perceive the support for informal social interaction at the office by its interior design is limited.

This paper addresses this gap by investigating the perception of these ‘social office spaces’ designed to support informal social interaction among employees, such as breakout rooms, lounge areas, and collaboration spaces. By classifying and quantifying the interior design features depicted in realistic visual representations of different social office spaces, the study aimed to elucidate how various interior design elements contribute to an atmosphere that office workers perceive as appropriate for informal social interactions. This knowledge could support designers and organisational leaders in informed decision-making to create work environments that foster vibrant social ecosystems.

2 Social affordances of the office environment

This study is rooted in the theoretical framework of affordances (Gibson, 1977) stating that users perceive an environment based on what it offers them in terms of action possibilities. In this viewpoint, the work environment may be perceived as supporting or inhibiting social behaviour based on its physical characteristics. Norman (1988) expanded the concept of affordances to include its application in design. Contemporary perspectives, such as those by Still and Dark (2013), highlight affordances as perceived and dynamic, influenced by both automatic perception and cultural processes. The essence of the affordances concept implies that an interior design can communicate possibilities for social behaviour through semiotic materials that convey a message to the users (Ledin & Machin, 2018).

Affordances can serve as nudges for social behaviour (Service et al., 2015), stimulating interactions through design elements like spatial configuration and object placement. For example, Khazanchi et al. (2018) argue that shorter distances increase the frequency of face-to-face interactions and personal (vs. task-oriented) conversations and architectural privacy contributes to longer conversations, building expressive ties. Fayard and Weeks (2007) showed how water-coolers and copiers served as people attractors in the office and Olsson et al. (2020) provide examples of how open spaces for shared activities and displays that disclose information about users could enhance collocated social interaction.

In this paper, social affordances refer to the workplace's physical characteristics that foster positive social interactions, support relationship-building, and cultivate a sense of community and belonging among employees while mitigating negative interactions and feelings of alienation. Fayard and Weeks (2007) used the term social affordances to refer to workplace characteristics that enable propinquity, privacy, and social designation necessary for informal interactions. Spreitzer et al. (2020) defined social affordances of the working environment as opportunities for social connection, promoting positive relationships through design elements like coffee bars, quiet zones, and team spaces. This study focused on these types of social office spaces and aimed to describe their interior design attributes, perceived social affordances, and opportunities for different types of informal interactions, including casual encounters, eating, drinking, or playing together, in-person collaboration, and intimate conversations for relationship-building. An appropriate atmosphere, privacy for personal talks, and comfort for lingering were included as affordances that may support one or more of these interactions.

3 Method

The association between interior design attributes and perceived social affordances was investigated through the assessment of 14 depicted office spaces by both interior architects and office workers (Fig. 1) in February-March 2024. Using pictures is cost-effective and makes it easy to gather feedback from a large and diverse group of office workers. Pictures can easily be distributed and accessed by participants remotely, allowing for a broader sample size. Furthermore, pictures provide a standardised stimulus ensuring that everyone evaluates the same visual information which offers consistency and reliability in the data collection.

3.1 Data Collection Procedures

Experienced Dutch workplace designers were asked to provide visual material of interior office spaces they had designed to support the users' informal social interactions and connectedness. From their submissions, 24 pictures were selected which were taken from the user's eye level and (after cropping) framed the space in question. Artist impressions and 3D sketches were excluded. Due to their extremely wide angles and less detail in textures and lighting conditions, these images less accurately represented reality, which could impede office workers from imagining themselves in the depicted spaces.

Among the collected pictures, six categories of social office spaces were distinguished: lounge areas, recreational spaces, informal meeting spaces, collaborative workspaces, and traffic zones with room for social interactions. Within each category, four examples were selected. Additionally, examples from a variety of designers and projects were included to establish a mix of styles and colour palettes which would cover the versatility of interior design and minimize differences in perception based on personal taste. Subsequently, the pictures were de-identified by blurring faces, logos, and other items that may reveal the identity of the occupants.

To quantify and classify the depicted interior design, the 24 anonymised pictures were coded by five interior design experts. Through a survey, they assessed the space's look and feel on 7-point semantic differentials, for example, *Warm colours* (1) vs. *Cool colours* (7), and the presence of interior design objects from *None* (1) to *Many* (4), complemented by the option *Not clear*. This assessment focused on the interior design's decorative aspects visible in single overview pictures, excluding layout and details such as texture.

Subsequently, 34 random office workers rated the space's social affordances on a 5-point scale ranging from (1) *Not at all* to (5) *Very much*. The affordances included an informal atmosphere, cosiness, conversation privacy, and comfort. To indicate the possible effect of these affordances, the spaces were also judged on their opportunities for different types of informal interactions.

Since pilot testing showed that participants' attention span and willingness to complete the survey was too low when presenting all 24 pictures, their number was reduced to the experts' 14 most unequivocally assessed ones. An anonymous link to the survey was distributed through direct mailing and social media and data collection was closed after two weeks.

Figure 1. Schematic overview of the data collection procedure and analysis

4.2 Perceived Support of Informal Interactions and Affordances

On average, the 34 office workers who completed the survey were not very enthusiastic about the potential of the depicted spaces to support informal social interactions. Overall, none of the depicted

spaces was considered to possess much of any affordance or interaction support (*Mode* ≤ 3, *Somewhat*).

Only four spaces were considered to have a convincing informal atmosphere (*Mode* = 4, *quite a lot*), which referred to a casual, playful and lively character. In 13 pictures, this affordance was significantly and strongly associated with cosiness (average r (29 to 32) = .672, p <.05), which referred to a warm, homely and intimate atmosphere. However, the scores on cosiness were lower than on informal atmosphere. For example, the recreation space in picture #17 was rated relatively high on informal atmosphere, maybe because it featured a bar and billiard, but scored lower on cosiness, maybe because it featured less homely decoration and doubled as a transit area. An informal atmosphere was positively associated with facilitating spontaneous encounters (average r (29 to 32) = .495, p <.05) and eating, drinking, or playing a game together (average r (29 to 32) = .591, p <.05).

Conversation privacy, i.e. not being seen and heard during social interaction, was rated very low in most spaces (*Mode* = 1, *not at all*, or 2, *a little*). As expected, in most pictures perceived privacy was positively associated with support of intimate conversations (average r (29 to 32) = .563, p <.05). Remarkably, perceived conversation privacy was not significantly threatened by opportunities for eye contact with passers-by and did not significantly reduce opportunities for spontaneous encounters. Comfort seemed more important for conversation privacy (average r (29 to 32) = .502, p <.05) than cosiness (average r (29 to 32) = .473, p <.05).

Overall, the spaces' support for informal social interactions was better rated than their social affordances. This could mean that other characteristics of the work environment may be more important in supporting this than the affordances measured in this study. Opportunities for eye contact with passers-by had the highest scores, maybe because many pictures showed open spaces or glass walls. All spaces were perceived to provide reasonable opportunities for eye contact, spontaneous encounters, in-person collaboration, and eating, drinking or playing a game together; the latter despite the absence of specific facilities such as games or coffee machines in the picture. An informal atmosphere seemed the most important in supporting informal interactions and a lack of comfort the least.

4.3 Connections with Design Attributes

A qualitative analysis of the high-performing spaces revealed that they could be divided into two groups: (1) spaces that best support *public interactions*, such as eye contact, casual encounters and recreational activities, and (2) those that best support more *private interactions* such as working together (or co-located working) and personal conversations. One of the spaces, which featured a workbench along a hallway, was considered to support public interactions and working together reasonably well but was rated inappropriate for personal conversations.

The spaces that were perceived as most stimulating for spontaneous encounters appeared to be accessible from several sides, situated in a transit area, and featuring a coffee machine. The spaces that were considered to offer at least a little conversation privacy appeared to be relatively enclosed physically or visually. None of the spaces was perceived to afford eye contact with passers-by and conversation privacy simultaneously, except for a glass-walled meeting room. However, this space was deemed not very cosy or informal. Partly enclosed spaces, such as seating arrangements in an alcove, hallway corner, or a project room with potted plants at the window were perceived as the next

best options for personal conversations. A well-decorated shared office was perceived as offering both privacy and cosiness. Spaces which were rated best for in-person collaboration all featured a table. The five spaces with the highest scores on informal atmosphere and cosiness featured relatively much decoration, such as a rug, cushions, pending or table lamps, a notice board, and bookcases. They also included quite some plants and four out of five featured predominantly rounded shapes. However, plants are no guarantee of success because two spaces which featured many plants were still rated as barely cosy. Table 1 lists the number of depicted social office spaces that feature both a specific interior design feature (according to the majority of the experts) and a social affordance or supported interaction type (office workers' perception, mode ≥ 2). It shows the little variety in design features across the different affordances and interaction types. For example, not many spaces featured predominantly dark colours, soft finishes, or rounded shapes, maybe because these were considered inappropriate for office environments. The observed uniformity of applied design features could mean that social office spaces require more or less the same design approach, the assessed spaces were coincidently designed in approximately the same way, or the data of this study were not sufficient due to small sample sizes.

Table 1. Number of depicted spaces (n=14) in which both the specific design feature and the social affordance or interaction support were rated as present

Design feature	**Social affordances**				**Supported interactions**				
	Informal atmosphere	Cosy atmosphere	Conversation privacy	Bodily comfort	Eye contact with passers-by	Spontaneous encounters	Eating, drinking, or playing together	In-person collaboration	Intimate conversations
More cool colours	●	●	●	●	●●	●	●●	●●	●●
More warm colours	●●	●●	●	●	●●	●●	●	●	●●
More muted colours	●●	●●	●	●●	●●	●●	●●	●●	●●
More saturated colours	●●	●●	●	●●	●●	●●	●●	●●	●●
More light colours	●	●	●	●	●	●	●	●●	●●
More dark colours	●	●		●	●	●	●	●	●
Few colours (uni)	●●●	●●●	●●	●●●	●●●	●●●	●●●	●●●	●●●
Many colours (colourful)	●●	●●	●	●	●●	●●	●	●●	●●
More hard finishes	●●●	●●●	●●	●●●	●●●	●●●	●●●	●●●	●●●
More soft finishes	-	-	-	-	-	-	-	-	-
More natural materials	●	●	●	●	●	●	●	●	●
More artificial materials	●●	●●	●●	●●	●●	●●	●●	●●	●●
More round shapes	●	●	-	●	●	●	●	●	●
More angular shapes	●●●	●●●	●●	●●●	●●●	●●●	●●●	●●●	●●●

Presence of plants	●●●	●●●	●●	●●●	●●●	●●●	●●●	●●●	●●●
Ambient lights	●●	●●	●	●●	●●	●●	●●	●●	●●
Decorative objects	●●	●●	●	●●	●●	●●	●●	●●	●●
Wall decoration	●	●	●	●	●	●	●	●	●
Seat variety	●●	●●	●	●●	●●	●●	●●	●●	●●
Amenities	●●	●●	●	●	●●	●●	●	●	●●

Both present in ● 1-3 pictures; ●● 4-7 pictures; ●●● ≥ 8 pictures

5 Discussion and Conclusion

This study aimed to shed light on the affordances of social office spaces perceived by office workers and the composition of these affordances from interior design features. The findings show that most of the studied spaces were not very pronounced in terms of colour but predominantly featured hard and artificial finishes and angular shapes rather than biophilic designs. An informal atmosphere was associated with the support of spontaneous encounters and social activities and conversation privacy and comfort were perceived to support intimate conversations. The highest-rated spaces featured relatively much decoration, plants, and enclosure. These insights may guide workplace designers in their decisions when designing social office spaces.

However, the social spaces' affordances and support of informal interactions were not rated very high. This could indicate that, according to the office workers, the depicted designs failed to strongly support informal interaction or the study did not capture the most important affordances. After all, the study was limited by the small sample sizes of the pictures, coders, and respondents. The number of pictures was reduced to prevent survey fatigue and drop-outs among the voluntary participants. Alternatively, the surveys could have presented a random selection of a larger number of pictures to each respondent. This would require a larger sample to collect sufficient data per picture. Other strategies could be paying the participants or reducing the number of questions about each picture. Larger samples of both the experts and the office workers would enable quantitative analyses and statistical tests which would provide more generalizable results. For example, the importance of the design features in predicting perceived affordances could be examined through ordinal regression analysis (Eiselen & Van Huyssteen, 2021), taking one of the affordances (ordinal) as the dependent variable and several relevant design features (continuous/ordinal) as independent variables.

By using pictures, the spaces were assessed based on visual information only, neglecting other senses such as touch, smell, and sound. For example, Spreitzer et al. (2020) argue that the scents and sounds of coffee bars and food spaces can trigger emotions that stimulate people to interact. Additionally, pictures may not fully capture the holistic experience of space since they do not convey the spatial context. Therefore, this type of data provides an incomplete understanding of how office workers perceive social office spaces. Future research should consider case studies to capture the spatial and cultural context of office workers' perceptions and include behavioural observations to relate these perceptions to actual behaviour. Case studies may also provide more insight into the design features' contribution to perceived affordances. Assessment of different social spaces within one office building which were decorated by one design agency reduces the variation in design styles.

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Creative Informatics: how data driven innovation has transformed the creative workplace

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ABSTRACT

The creative economy is powered by a workforce with a high proportion of freelancers and SMEs. This paper reflects on *new ways of working*, accelerated by the digital pivot of the creative workplace caused by the global pandemic. Whilst the impact of digital technology on the creative workflow has been well documented, in this paper case studies from Creative Informatics, a five-year R&D project (2019-2024) which supported data driven innovation in the creative economy in Edinburgh and the Southeast of Scotland, highlight how these changes have affected the creative workplace thus spotlighting how the future creative workplace may change, particularly for freelancers. Using a qualitative case studies approach, this paper reflects on the use of digital technology in the creative workplace by defining a new typology for (digital) creative workplaces: the *studio* as a place for synchronous and a-synchronous collaboration through the use of VR technology for craft makers (Applied Arts Scotland), the *water cooler* as a place to support diverse digital networking formats (Creative Edinburgh), and the *atelier* to support creative business to be introduced to emerging new technologies with low risk through peer learning (E11). The paper analyses how these innovation and developments have opened up opportunities, and raised challenges, for freelancers in particular and identifies directions for future developments in the creative workplace. We argue that the implications for creative freelancers can be applied to the freelancer workforce at large.

Keywords

Creative workplace, digital workplace, creative industries, freelancers, digital skills

1 INTRODUCTION

This paper reflects on how Data Driven Innovation (DDI) has enabled change in the digital workplace of creative businesses. DDI is the next evolution of innovation processes, supported by expanded digitisation, enabling increased access to (big) data and advances in digital technologies (e.g machine learning, AI and others) (Luo, 2023). It does this by analyzing case studies from Creative Informatics, which supported DDI in the creative industries in the Edinburgh region. The global pandemic of 2020 accelerated the development of DDI in the creative industries. In this paper we particularly focus on freelancers or micro businesses. Freelancers make up 32% of the Creative Industries workforce, which is approximately double the proportion of the workforce in other sectors (Easton, 2021; DCMS, 2023). This has further relevance to the workforce at large, as of the 4.6 million business in the UK, over 99% are small to medium sized (employing less than 250 people) with 96% of those classed as microbusinesses which employ up to nine people. It is notable that these 4.6 million businesses are responsible for 65% of employment and 57% of GDP (Madsin, 1997; Pratt and Virani, 2015). The creative industries remain dominated by sole traders and micro businesses, with 95% of creative businesses having fewer than 10 employees with a strong reliance on a freelance workforce. Understanding the sole trader or freelance workplace is thus of importance to workplace studies at large.

The networked nature of a nimble, predominantly freelance and micro business, creative workforce has a responsiveness which enables it to be flexible in a volatile and uncertain marketplace (Panneels *et al*, 2024). This amorphous, flexible nature of the creative industries relies on the social capital of creative ecologies as demonstrated by the *model of governance* (Jones *et al,* 1997). Access to a mobile, flexible 'workplace' where creatives can meet to collaborate, network and access training is thus critical.

Changes to the nature of the creative workplace were accelerated by the effects of the COVID pandemic and subsequent lockdowns. Although the effects were differential across sub-sectors (Salvador, Navarrete and Srakar, 2021), freelancers were particularly vulnerable to economic contractions (Patrick and Elsden, 2020). One key finding from a meta-review of studies looking at the effects of the pandemic is that "the digital capabilities of firms and their ability to adapt were crucial components of resilience strategies" (Khlystova, Kalyuzhnova and Belitski, 2022: 1201). In this paper we particularly focus on the creative workplace and how existing and emerging technologies particularly affected the resilience of creatives, when access to creative workplaces was often curtailed. We use a set of case studies from Creative Informatics to reflect on how DDI has impacted the creative industries' workplace and introduce a typology of digitally mediated workplaces within which different aspects of creative work take place: a place to create work (studio), meet colleagues and network with collaborators (water cooler) and acquire training and skills (atelier), in the context of a predominantly freelance workforce.

2 Creative Informatics

Creative Informatics (https://creativeinformatics.org) was an ambitious five-year AHRC funded research project (2019-2024) across the creative industries in Edinburgh and the Southeast of Scotland region to bring together its world class creative industries and tech sector, by providing funding and

developing opportunities to enable creative businesses to explore Data Driven Innovation. Creative Informatics took a 'whole sector' approach which viewed the creative industries as an industry comprised of nine subsectors as defined by the UK Government's Department for Culture, Media and Sport (DCMS): 1) Advertising and Marketing, 2) Architecture, 3) Crafts, 4) Design and Fashion, 5) Film, TV, Video, Radio and Photography, 6) IT, software and computer services, 7) Publishing, 8) Museums, Galleries, Archives and Libraries (GLAM) and 9) Music, Performing Arts and Visual Arts.

Data Driven Innovation is the term given to the next evolution of innovation processes in the context of the Fourth Industrial Revolution, which is blurring the lines between the physical, digital and biological worlds, driven by data and technology (Schwab, 2016).

Creative Informatics received £ 7.7 million funding to support data driven innovation in the creative industries (Pirie, 2023). It did this through a multi-faceted approach to R&D that supported 1) a start-up programme delivered with Scotland's largest startup enterprise, Codebase, 2) a programme of strategic investment in R&D funding streams (Connected Innovators, Resident Entrepreneurs and Challenge project, and Creative Horizon) delivered in partnership with local creative industries network Creative Edinburgh, and 5) a programme of outreach events (regular Studios and Labs and annual Innovation Showcase).

In this paper we discuss the creative workplace not as the workplace where creativity might be encouraged and fostered, as has been the preferred 'future of the office' (Coleman, 2016) by tech companies such as Google, but as the place of work where creatives create their work, conduct administrative tasks, network and collaborate. In other words, we take a descriptive, rather than a normative approach to understanding the places within which creative work takes place. There is a long history of place-making research in organizational and management research which looks at the effects of the workspace environment on working practices (cf Vischer, 2012). In addition, there is a broader growth in literature around digital placemaking (Basaraba, 2023). Although there has been significant exploration of how digital technology affects (creative) work (Li, 2020), there is less focus on how the adoption of digital technology affects the places within which creative workers operate.

The case studies drawn from this five-year project were selected from the Creative Informatics Catalogue of projects (Elsden et al, 2021) where the applications received were all coded for keywords to give insight and oversight of what sort of projects CI was funding. The cases were theoretically sampled (Yin, 1984) based on the type of technology implemented as part of the DDI and to ensure representation across the projects funded. This selection was additionally guided by the first author's in-depth knowledge as a staff member within Creative Informatics. Additionally, we draw on interim and final reports from projects, as well as several publications by the Creative Informatics team of researchers and delivery team (referenced in text). Finally, the paper includes reflections and observations made by the researchers on the impact of DDI on the creative workplace throughout the five-year project and archived (https://creativeinformatics.org). The global pandemic impacted the pivot to online working spaces for the creative industries, as it did for many other workers too.

In this paper we thus present the role of DDI in forming distinct *workplaces* for a) creation of creative content (studio), b) meeting and networking (water-cooler), and 3) developing skills and training (atelier).

3 Case studies

3.1 The Studio: Applied Arts Scotland

Creative Informatics 'Connected Innovators' was an R&D funding stream which had an open brief with a particular remit to support emerging leaders from within the creative sector in the region with some access to R&D funding. Carol Sinclair, Chair of Applied Arts Scotland, received funds to support the use of VR as a means of collaborating digitally, in immersive spaces, in both synchronous and a-synchronous ways.

The DISTANCE (Digital Immersive Technologies and Craft Engagement) project took place during the UK Covid19 lockdown period of 2020-2021. DISTANCE facilitated the introduction and use of Virtual Reality (VR) headsets to enable a selected group of craft practitioners to use VR to collaborate synchronously and a-synchronously in a virtual studio space in VR. Whilst past research has reflected on the extent to which the DISTANCE project enabled craft practices that heavily rely on haptic skills (Panneels et al, 2023), here we want to particularly reflect on its relevance to the creative workplace. The 'studio' as a place to 'create': to experiment, to prototype, to produce creative products and services is an essential part of the creative workplace.

The VR headset gave the craft makers access to a virtual studio space where they were invited to both create work individually and collaborate on joint creative projects. The VR studio enabled access to a 'limitless' space which was unbounded by physical restrictions or financial limitations: the work created could be of any size desired as scale was unlimited and any virtual material desired, as there were no budget constraints. This, together with the removal of other 'normal commitments' (participant DISTANCE I), granted a 'permission to play' (participant DISTANCE I) which was enabled by the technology itself (which emerged from gaming industry) and supported playful prototyping and experimentation, if the required skills were acquired. Furthermore, the VR studio enabled rapid idea iterations to take place as physical and financial restraints were not present. The VR space also enabled a collaborative working space where participants could work together on a creative project in both synchronous (both present in VR at the same time) or a-synchronous times, to suit their own timetable and availability.

VR as demonstrated in the DISTANCE project thus enabled a new type of 'studio' as a creative workplace to emerge: one for rapid, playful prototyping where creative businesses could collaborate in three dimensional creative virtual spaces, without physical or financial constraints.

3.2 The water cooler: Creative Edinburgh

Creative Edinburgh was the industry partner of Creative Informatics. It is a membership organisation of creatives working in an around Edinburgh and currently has more than 6,000 members. Its role in the Creative Informatics project was to provide access to this network. Creative Informatics also built up an additional network from its programme of events which circulated its regular newsletter to over 500 subscribers.

Creative Edinburgh serves a community of creative businesses which are predominantly made up of freelancers and sole traders. Providing spaces and opportunities for its members, the creative workforce if you will, to connect and network has always been considered one of its key purposes. The value of the networks and ecosystems for creative businesses, we have written about elsewhere

(Panneels, Jones, Parkinson and Komorowski, 2024). Freelancers do not have workplace colleagues as such, so creating workplace type opportunities to network, socialize and collaborate is a key part of its programming remit. Creative Edinburgh runs a regular programme of 'Creative Circles' which provides both training opportunities, usually through a guest talk about a particular topic (e.g Exploring AI) whilst also enabling networking opportunities. These gatherings are for many freelancers a critical part of their business and the meeting places become extensions of their creative workplace. The pandemic forced a pivot to the delivery of these critical meeting places to online spaces. Creative Edinburgh became adept at hosting these events online and engineer these workplaces to maximize networking. Creative Circles online pivot developed Creative Edinburgh's expertise in hosting online events smoothly, which, together with partner Creative Informatics, became beacons of good practice (Elsden *et al,* 2020; Chan *et al*, 2022). In particular, we want to draw attention to how the digital spaces were carefully curated to enable the networking of the creative workplace 'water cooler' as a place to informally meet, to be replicated. Whilst the format of a speaker event was easily transferred to online, the networking part was more difficult to recreate. Creative Edinburgh made smart use of the online platform (Zoom) to create breakout rooms which were carefully managed to rotate participants in a quick succession of approximately two minutes. This format, borrowed from speed dating events, worked particularly well online as participants were only ever in small intimate groups (3-4 people) selected by the organizer, so no choices had to be made. Its rapid turnaround encouraged participants to be quick and succinct in their introductions and exchanges. Feedback from participants demonstrated that this format actually worked better than in person networking events. This format was also used during larger events, which encouraged the digital equivalent of the 'watercooler' or 'coffee chat' to take place in what was ultimately a difficult space to negotiate.

Creative Edinburgh thus made effective use of the tools offered by digital meeting spaces to create the informality of 'water cooler' places for creatives to network and to exchange information, particularly pertinent during Covid, but with learning that carries forward to post Covid hybrid practices.

3.3 The atelier: E11

Creative Informatics together with its two industry partners, Creative Edinburgh (see 3.2) and Codebase, provided a programme of training events, specifically aimed at the creative workforce. As the creative workforce exists of predominantly freelancers and SMEs, they are responsible for their own training and CPD (Continued Professional Development): there is no workplace to provide training for you. Organisations such as Creative Edinburgh thus often facilitate programming of skills development opportunities. Creative Informatics as a project was aware that data knowledge and training for DDI was a particular gap in creative training needs (Parkinson et al, 2020: Osborne et al, 2024). Creative Informatics thus collated and delivered a programme of events to introduce creative businesses to the concept of 'data driven innovation'. We particularly want to discuss the programmed events held at E11, an informal physical studio space offering creative practitioners access to a range of state-of-the-art technology equipment (e.g., VR headsets, robotics kits, audio and video, motion capture, 3D scanning and holographic equipment), along with support for using this equipment. Its strapline, to 'explore, experience, experiment', reflected the ethos of the space to encourage a low-threshold, safe space where creatives would be encouraged to try out pieces of technology. They may not be familiar with emergent creative technology or want to explore the potential benefits of a specific technology for

their creative practice. E11 provided both time and opportunity for creatives to experience a range of technologies prior to deciding whether to integrate them into their creative practice or invest in them in the longer term. The equipment supported experimentation with various new emerging technologies including audio, such as directional sound, moving image technology, such as state-of-the-art 360 degree camera equipment, immersive technologies, such as Virtual (Oculus quest 2) and Augmented reality headsets (Magic Leap, Holo Lens and HTC Vive), holographic technology (Looking Glass and HyperVSN), motion capture, projection and mapping technology (Lidar for iPad Pro, Lightform) and robotics (Anki Vector, Petoi Bittle) as well as basic introductory starter kits to coding and robotics (Sphero Bolt, Arduino, Raspberry Pi) and associated screen, lighting and audio infrastructures to support the above technologies. E11 has an online presence where creatives can view the list of equipment and get in touch with staff to discuss equipment needs and use of space: https://e11.studio. to support the exploration, experiencing and experimentation of creative tech by creative businesses of emerging new creative technologies by creatives.

The effectiveness of E11 as a tangible venue for exploration of new creative technologies and an intangible asset that provided opportunities for informal learning through experimentation, was tested during the period that Creative Informatics was active, with two years of intermittent lockdown during the global pandemic. A programme of E11 outreach events (Studios and Friday Forums), hosted in-person and online during the global pandemic, reached 758 participants and supported R&D of twenty creative businesses. E11 operated as an *atelier* (Tate, nd): a creative workplace where creatives could explore createch together and support R&D.This would have been more if the global pandemic had not curtailed physical access to this dedicated space and its equipment shortly after launch. The rationale of low threshold access to a broad range of specialist equipment, often emerging technologies, to 'explore, experience and experiment' focused on informal peer learning, as one would in an atelier.

The digital 'atelier' offered by E11 during lockdown proved only partially successful when access to physical equipment and technology was a critical part of enabling and supporting access to training for creatives. However, digital access to these still provided training opportunities for creatives.

4 Discussion

The role of creativity to urban placemaking projects has been widely heralded in the academic literature (Schoneboom, 2018), but the ways in which creatives engage in placemaking when digital technologies mediate their own workplaces has been less explored. Creative workplaces are traditionally the physical spaces in which key work processes, such as creating, training and networking take place. In this paper, we seek to show how these same functions are delivered in digitally mediated workplaces, and the effect this has on work processes and outcomes.

Any creative work process is both enabled and constrained by the boundaries of the space in which it takes place (Patrick, Greig and Beech, 2012). In digital spaces, such boundaries are commonly referred to as *affordances*, where different features of the digital space give rise to different opportunities for action (Nambisan, Lyytinen and Yoo, 2020). It has been argued that freelancers operate in 'entrepreneurial ecosystems' which differ from traditional 'clusters' of work due to their exploitation of digital affordances (Autio, Nambisan, Thomas and Wright, 2018). As such, there is a good opportunity to combine these insights by looking at how the uptake of digital technologies by groups of creative freelancers affects their workplaces.

This paper advances the literature by offering an analysis of how the uptake of different digital technologies (VR, video conferencing) reshaped the effects of workplace boundaries and affordances on the work processes of creatives, particularly in the context of the global pandemic which accelerated digital pivots. We identify a typology of three digitally meditated creative workplaces that emerged through the Creative Informatics project: the studio, the watercooler, and the atelier. Each of these are typically associated with a particular genre of creative work: creation, networking and training/learning (respectively) (see Table 1). In the case of the studio, we find that the adoption of VR technology removed limitations, creating a sense of boundaryless innovation which enabled faster and more playful prototyping. In the case of the water cooler, we find that the adoption of videoconferencing technology enabled the adoption of networking practices from other areas of social life (speed dating) which facilitated faster and broader relationship creation that co-located events. In the case of the atelier, we find that physical access to DDI supports the development of new technology into the creative workplace.

These findings advance the literature by segmenting the types of digitally mediated workplaces that may structure the future work practices of freelancers. This analysis is not intended to be exhaustive or generalizable but instead to help provoke a broader consideration of how different workplaces are differently translated into the digital domain. Importantly, much of the data for the cases was collected during the Covid-19 lockdowns. The lack of access to physical co-working therefore likely shaped attitudes to digital uptake. It is likely that the enthusiastic uptake and positivity around these digital technologies may be less evident in broader settings, and this positive bias may be reflected in our findings.

Table 1. Table with overview of Studio, Water Cooler and Atelier technology adaption

Workplace	**Work process**	**Tech adopted**	**How it changed work process**	**How it changed work outcomes**
(AAS) Studio	Creativity	VR	Removed limitations Created boundaryless innovation Greater sense of play	Rapid prototyping
(CE) Water Cooler	Networking	Video conferencing	Forced workers into networking with a broader range of people during shorter interactions	Faster and broader relationship creation
(CI) Atelier	Training	Creative Technologies	Lowering access barriers	Peer Learning of creative tech skills

5 Conclusion

This paper asks how digital technologies affect creative workplaces. It finds that such technologies may overcome the traditional limitations of workplaces, making digital affordances the new boundaries around (against) which creative work may be structured.

We introduce and repurpose the concepts of the Studio, the Water Cooler and the Atelier to help reflect on the different purposes and functionalities of the creative workplace to make, network or train. Additionally, we reflect on how existing or emerging technologies are affecting the creative workplace through this lens. Our findings suggest that digital innovation in the creative workplace supported easier experimentation and prototyping, enabled easier networking and facilitated peer learning. We want to highlight that these might be particular outcome of the digital pivot of the global pandemic and that the longer-term impact of this innovation may warrant more research in the future.

We suggest that the implications of the DDI on the creative workplace in particular, with its high percentage of freelancers, can thus be relevant to the freelance workforce at large.

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Session 5B: Learning and Education

Exploring Out-of-Classroom Activities for Students with Disabilities: Implications for Employability Skills Development

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ABSTRACT

The inclusion of students with disabilities in tertiary education is rising globally, however research on their participation in out-of-classroom activities remains limited. This paper investigates the significance of out-of-classroom engagement for students with disabilities, particularly its impact on their development of employability skills. While existing literature predominantly addresses accommodations within academic settings, this study emphasises the broader university experience. Through a scoping review, it examines the benefits and challenges associated with out-of-classroom activities and their relevance to employability post-graduation.

The study reveals that while universities primarily focus on subject-specific skills, the demand for complementary competencies is increasing. Out-of-classroom activities, including curricular, co-curricular, and extra-curricular pursuits, are crucial for fostering practical skills and social integration. Such activities are instrumental in developing employability traits like leadership, teamwork, communication, and resilience. Moreover, participation in these activities facilitates networking opportunities essential for career advancement. University graduates with known disabilities are less likely to find themselves in employment in the first year after graduation, and for some disciplines even less likely to find a relevant role within the area related to their degree. In the United Kingdom alone, adults with disabilities are amongst the most socially and economically disadvantaged groups.

Despite the acknowledged benefits and the drivers for inclusion, students with disabilities encounter barriers hindering their participation in out-of-classroom activities. Institutional, attitudinal, and

disability-specific challenges hinder their access to these opportunities. Lack of appropriate accommodations, fear of stigmatization, and limited resources pose significant obstacles for their inclusion. Addressing these barriers is essential to ensure equal opportunities for skills development and employment prospects.

Keywords
Extra-curricular activities, Employability skills, Disabled students, Inclusion, Graduate employability

1 INTRODUCTION

The number of students with disabilities in tertiary education continues to rise globally, with approximately 15 percent of the undergraduate student population having at least one impairment or disability (Riddell & Weedon, 2014; Moriña, 2017; Chipchase et al., 2023). As the population of university students with disabilities continues to increase, there is a growing interest in researching their inclusion in campus life. Research to date primarily focuses on implementing appropriate accommodations in academic environments and managing curriculum to support their needs (Toutain, 2019; Zorec et al., 2022). While there are significantly fewer studies exploring inclusion for out-of-classroom activities compared to those addressing in-class provisions, research emphasising the overall university experience for students with disabilities acknowledges the significance and advantages of engaging in extracurricular activities. This recognition underscores the importance of such involvement, particularly in fostering employability skills (Tinklin & Hall, 1999; Moriña, 2016; Chipchase et al., 2023).

In the United Kingdom, students spend only a small proportion of their time in lectures and tutorials, whilst substantially more time is spent out of the classroom, which includes engagement in recreational and social activities (Johnson, 2000; Lau et al., 2014; Moriña & Biagiotti, 2022). The choices students make regarding their leisure time is greatly influenced by the range of activities accessible to them, as well as their individual and social backgrounds. These factors significantly shape not only their university experience but also their career prospects after graduation. Despite the Government's attempts to increase inclusion in higher education, to ensure that all people have the chance to acquire the professional skills essential for employment and to smoothly transition into a professional environment, individuals with disabilities remain amongst the most socially and economically disadvantaged (Gibson, 2015). The data from the most recently available Graduate Outcomes survey reveals that across all subject groupings, graduates with disabilities are less likely to be in full-time employment 15 months after graduation (54 per cent), compared to individuals with no known disabilities (63 per cent) (HESA, 2023).

Universities are primarily focused on the development and fostering of subject-specific skills, yet the demand for a wider range of complementary skills is also increasing. Participation in out-of-classroom activities is considered important for the development of practical skills that may not be fostered in classroom (Buckley & Lee, 2021; Jackson & Bridgstock, 2021; Ribeiro et al., 2023). There is a proven link between participation in out-of-classroom activities and the development of transferrable skills sought by employers, which is also acknowledged by the British Government (Department for Education, 2018; Buckley & Lee, 2021). Engagement in out-of-classroom activities impacts the development of

knowledge and cognition more than academic engagement and helps students to become industry-ready and employable (Riberio et al., 2023).
This paper aims to review literature exploring the benefits and challenges associated with participation in out-of-classroom activities for students with disabilities, and the subsequent development of employability skills for success post-graduation.

2 METHODOLOGY

This study presents a scoping review of literature exploring the importance and benefits of out-of-classroom activities for the development of employability skills, and the inclusion of students with disabilities in these activities in universities. The goal of a scoping review is to explore and synthesize a range of evidence, offering broad insights and relationships to illustrate the extent, depth, and novelty within the specified field of research (Aguilar & Pifarre Turmo, 2019). Specifically, this research aims to answer three questions:

- RQ1: What are the different types of out-of-classroom activities available to students at universities?
- RQ2: What are the benefits of partaking in the out-of-classroom activities?
- RQ3: What are the challenges for students with disabilities who wish to participate in out-of-classroom activities?

Given the scope of the topic and the research's aim to provide an overview of available academic literature, a scoping literature review was considered a suitable approach. The primary aim of the review was to explore the benefits and challenges associated with participation in non-curricular activities across higher education institutions in the United Kingdom for students with all types of disabilities.

2.1 Literature search and the criteria for paper inclusion

The databases identified for the research were selected through the university's electronic databases search, under the *education* and *social sciences* sections. This returned the total of 17 eligible databases for research. These were further narrowed down to include only those that publish full text journal articles and conference papers, excluding databases publishing abstracts, book chapters, and/or dissertations. Additionally, only databases that provided up-to-date access were included in the further selection criteria. This process narrowed down the final eligible databases to six, namely, Taylor and Francis, ERIC, Elsevier, SpringerLink, Sage and Wiley.
Then, the titles, abstracts and keywords of papers considered relevant were evaluated. In this stage of research, the keywords 'extra-curricular activities', 'out-of-classroom activities', 'disability' and 'inclusion' were of primary interest. Furthermore, keywords like 'challenges', and 'barriers' were added. Finally, the following search strings were created to identify suitable resources:

- "extra-curricul*" AND "disab*" OR "inclusi*"
- "out-of-classroom" AND "disab*" OR "inclusi*"
- "extra-curricul*" AND "disab*" OR "inclusi*" AND "barrier*" OR "challenge*"
- "out-of-classroom" AND "disab*" OR "inclusi*" AND "barrier*" OR "challenge*"

The primary focus was on academic publications in English language published between January 2011 and December 2023, taking into consideration the introduction of *The Equality Act 2010*, which has a

significant influence on the inclusion of individuals, and the time at which the research was conducted. However, two British studies published pre-2011 were included – Tinklin & Hall, 1999 and Johnson, 2000 – due to their significant importance for the study, focusing specifically on the experiences of students with disabilities and the provision of support in and out of the classroom. Studies that were not directly linked to university students or higher education were automatically excluded from the review. This approach revealed a lack of pertinent academic resources in the British context; only thirteen, eleven out of which were published within the specified timeframe. For that reason, relevant and recent studies from primarily European countries published in the last decade in the English language were included as well. This approach identified 21 suitable resources.

3 REVIEW FINDINGS

3.1 RQ1: Employability and out-of-classroom activities

Employability can be defined as a set of accomplishments, including the skills, opinions, and individual characteristics, that increase the likelihood of graduates securing employment and success in their chosen occupations (Griffiths et al., 2021).

There are three primary types of out-of-classroom activities available to students in the United Kingdom: *curricular, co-curricular* and *extra-curricular* (Swingler et al., 2022). Curricular activities are embedded into the programme of studies, and although they can happen outside of a normal classroom setting, they are normally regarded as credit-bearing tasks. They can include work-integrated learning, study tours, student exchanges, and degree-related competitions (Jackson & Tomlinson, 2022). Co-curricular activities are delivered by the higher education institution but are not regarded as credit-bearing, nor are they formally part of a degree programme. They encompass employability events and activities that help to develop professional and industry-related skills, such as networking events, career-related workshops, or volunteering (Swingler et al., 2022). Extra-curricular activities are the non-academic activities conducted within the context of higher education institutions, that happen outside of the class and are not part of a normal academic curriculum. These do not only include sports and recreational activities such as sports and arts, but also award programmes community work, clubs and societies, and paid work (Buckley & Lee, 2021; Griffiths et al., 2021; Jackson & Bridgstock, 2021).

3.2 RQ2: The role and importance of out-of-classroom activities

Out-of-classroom activities play an important role in the overall university life of all its students. They are one of the primary factors in student integration in the institution, fostering and developing social connections and a sense of belonging, thus directly influencing student retention (Pedler et al., 2022). Additionally, participation in recreational activities is proven to have a positive impact on students' wellbeing by decreasing perceptions of loneliness that leads to poor mental health in students with and without disabilities, and physical health which is primarily associated with participation in sports and physical activities (Johnson, 2000, Kotera et al., 2021). There are numerous studies claiming additional benefits of out-of-classroom activities, especially with the connection to employability post-graduation, for both, students with disabilities, and their counterparts, as students have an opportunity to develop transferrable skills necessary for securing employment in today's competitive environment (Jackson & Bridgstock, 2021; Moriña & Biagiotti, 2022; Ribeiro et al., 2023). Furthermore, social

networks built while participating in out-of-class activities are linked to aiding fresh graduates with job search, and in many cases are linked to their current career paths by establishing industry-specific social connections (Ribeiro et al., 2023).

3.3 The development of specific skills

A document by the European Commission (2017) regarding higher education states that there is an increase in the demand for individuals who not only possess high-level qualification, but also transferrable skills. While the benefits of participating in out-of-classroom activities encompass a broad array of competencies, multiple authors agree on several specific personal and professional benefits for students. The most common are *leadership*, *teamwork*, *communication*, *self-confidence,* and *self-management*. These are also amongst the most desired transferrable skills by employers. Other benefits include *networking*, *decision-making*, *problem-solving*, and *entrepreneurship*. Additional identified skills were *innovation*, *self-advocacy*, *self-perception*, *adaptation,* and *resilience* (Buckley & Lee, 2021; Griffiths et al., 2021; Jackson & Bridgstock, 2021; Moriña & Biagiotti, 2022; Ribeiro et al., 2023).

It is important to note that not all activities help to develop all the necessary skills equally. Literature differentiates between the types of activities an individual gets involved in and the types of skills they develop. For example, participation in recreational activities such as sports is linked with the development of social relationships, leadership, teamwork, and the improvement of physical and mental health. Activities directly linked to the institution, such as representation in student union, help with the development of communication, networking, decision-making, problem-solving and resilience, are more likely to guarantee a fast transition from academia to employment (Johnson, 2000; Buckley & Lee, 2021; Riberio et al., 2023).

3.4 RQ3: The challenges faced by students with disabilities

Even with all the benefits that involvement in extra-curricular activities entails, there is a prevalent lack of participation from the side of the disabled student population (Chipchase et al., 2023). Empirical research indicates many reasons for this. Some authors argue that students with disabilities face many challenges in their everyday lives and there is a reported consensus among them that they must exert greater effort than their non-disabled counterparts, as they must navigate their disabilities alongside their academic pursuits (Moriña, 2017). Others claim that the reasonable accommodations agreed with disability offices only extend to the curriculum and academic performance, not covering extra-curricular activities (Garcia-Gonzalez et al., 2021). Some students with invisible disabilities simply choose not to participate in activities outside of the curriculum, from the fear of stigmatisation, or because they feel uncomfortable requesting adjustments (Riddell & Weedon, 2012; Nolan et al., 2015; Chipchase et al., 2023).

Strnadova et al. (2015) identified 3 types of barriers that students with disabilities encounter at university: *institutional* – such as the process of disability disclosure and requesting accommodations or architectural setting, *attitudinal* – arguably the biggest barrier for individuals with disabilities and the most decisive factor for participation in sports and recreational activities, including the perceptions of students by their peers; and *disability-specific* – individual to each student and each disability. Although Strnadova's study explored the barriers to inclusion in education settings, their findings apply

to extra-curricular activities as well. Institutional barriers include disability disclosure, accommodations, and architectural setting (Garcia-Gonzalez et al., 2021). Attitudinal barriers include the perceptions of disabled students by their peers. Many individuals choose not to disclose their disability to their peer group for fear of being stigmatised, and participating in extra-curricular activities might require disclosure (Nolan et al., 2015). Disability-specific barriers are primarily the outcome of lacking resources to support appropriate individual accommodations (Strnadova et al., 2015).
Despite the different barriers students with disabilities encounter, it is imperative to recognise that providing equal opportunities for skills development is key to securing employment, and thus achieving independence and participate in community (Moriña & Biagiotti, 2022).

3.5 Discussion

The review identified three types of out-of-classroom opportunities available to students at universities in the United Kingdom. It is noteworthy that each of these types of activities help to develop specific types of skills, some of which are not fostered in a normal academic setting. Additionally, participation in the non-academic part of university life is associated with an improved wellbeing, in addition to the development of transferrable employability skills. However, despite attempts by the Government and institutional inclusion frameworks, students with disabilities still face significant barriers that exclude them from a full participation in every aspect of university experience. These findings suggest that it is imperative for students with disabilities to be included in all parts of campus life, including out-of-classroom activities, and the provision of reasonable accommodations should extend outside of the normal syllabus into curricular, co-curricular, and extra-curricular activities.

4 Conclusion

This paper presented a scoping review of literature exploring the advantages and challenges related to the involvement in out-of-classroom activities of students with disabilities, and the resulting development of employability skills. Out-of-classroom activities are proven to help develop a wide range of personal and professional competencies and transferable skills desired by potential employers, for students with disabilities and their able-bodied peers. There is also a notable difference between the types of activities students undertake and the skills these activities help to foster. Despite the increased focus on inclusion in the academic side of university life and the introduction of reasonable accommodations to ensure the development of industry-focused skills, there are still known limitations for students with disabilities to be able to participate in out-of-class activities in the United Kingdom. Students with disabilities face institutional, attitudinal, and disability-specific barriers that hinder them from participating in out-of-class activities, and thus directly impact their development of transferrable skills. In conclusion, this paper highlights the importance of out-of-classroom activities for students with disabilities in enhancing their employability skills. It calls for further research to explore strategies for overcoming existing barriers and promoting inclusive practices in higher education institutions. By fostering an environment conducive to participation, universities can empower students with disabilities to achieve independence and contribute meaningfully to their communities.

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Places for Learning – the Changing Needs of the Students on University Campus

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ABSTRACT

Purpose The increase of digital practices in student´s daily life contributes to the demand and supply of the alternative learning environments. The new options for learning, new demands for studying and different forms of socializing based on the new ways to use technology. The goal of this paper is to identify how the new needs of students' effect to the design of the study places in the university library and campus.

Theory The campus and learning environment research is summarized in theory reflecting especially to the changing needs of the students.

Methodology

The case study research is qualitative by its nature. The case is a transformation of Learning Centre in the University of Helsinki, Finland, in which study places are updated to respond to the changing needs of the students in renovation project. The data has been gathered by workshops, observations, and surveys. Additionally explorative pilots were conducted.

Findings

The categories of social and individual study places were formulated based on the analysis of the data. The variety of learning places is essential. The diversity of social interactions among students on campus and online has increased. The group consistency sets requirements to the size, technology and location of the group working facilities. Both user and remote user centric approach are important in design of study areas.

Originality

The case study is a unique opportunity to develop post-covid study places in the university.

The practical contribution

The research provides design principles for the university libraries and learning environments on campus for the design experts, education designers and campus developers.

The academic contribution

The research contributes to learning environment categories of university campuses. The future studies could focus on widening the investigation to the places for collaboration outside the library.

Keywords

Learning environments, Students, University campus, Library, Transformation

1 INTRODUCTION

The significant disruption to campus life has taken place since the world first went into Covid-19 lockdowns in March 2020. During the lockdown social relations were transferred to digital learning environments and the knowledge creation took place with the help of various digital tools and technology. The student experience was quite different for the students who had already been part of the academic community compared with the students who started to study during the lockdown (Nenonen and Mäenpää, 2023). The new options for learning and different forms of socialising based on the new ways to use technology are part of daily life of students on university campus.

Increased remote learning, with academic staff and students located in multiple locations, will make hybrid learning a common part of many students timetabled classes. Students are likely to shift between face-to-face learning and on-line learning during the learning day or week. Space on campus will need to be able to support synchronous on-line participation in seminars and classes with appropriate levels of visual and acoustic privacy between students (Harrison and Hutton, 2013). The increase of digital practices effects to the demand and supply of the alternative learning environments. Students tend to request the university library to respond to the changing needs while library as a heart of campus is safe and common place for students from each discipline.

The goal of this paper is to identify how the new needs of students' effect to the design of the study places in the university library and campus. The research question presented is what kind study places is needed in the future learning centres or libraries. The paper consists of five chapters. After introduction an overview of the university study place related research is presented. The research process, methods and results are captured in chapters 3 and 4. The conclusions discuss findings, the research, and future studies.

2 learning on campus – changing needs of the students

University students learn in formally organized courses, and in a self-directed and intentional way from fellow students, through trial and error, and by reflection (Decius et al., 2024). The relevance of universities as traditional sites of teaching and learning has been questioned and more emphasis both in research and practice has been pointed out to informal learning environments.

Harrop and Turpin (2013) conducted a longitudinal, quantitative, and qualitative study at Sheffield Hallam University and explored learners' behaviours, attitudes, and preferences toward informal learning spaces in higher education, within and outside of the context of the academic library. They have developed a portfolio of discrete, interrelated learning environments, offering spaces with a clear identity, and encouraging students to translate their learning preferences into space selection.

However, according to Berman (2020) the emergence of informal learning spaces raises important questions regarding student behaviours and learning. The popular imaginaries of these spaces as free, open, and democratising in terms of students' use, technological affordances need to pay attention also to the possibility of negative social practices such as exclusion and marginalisation. Overall, remote learning has turned out to be more democratic when the external symbols of power are not present – however there can be new kind of power structures in digital entity, e.g., the competences to use diverse technological tools or the possibilities to use them. (Nenonen and Mäenpää, 2023.)

Valtonen et al. (2021) state that different pedagogical approaches, the use of information and communications technology (ICT), the diversification of student populations, and new expectations related to working life are setting requirements to learning environments. In their study about university students' perceptions of preferred learning environments they identified five main themes: characteristics of the campus; available resources; flexibility of learning opportunities; pedagogy; and implementation of ICT in education. Further, two larger perspectives were highlighted. One was the need for informal learning environments (where students can study alone or with peers or just hang out). The second pertains to the flexibility of learning, demonstrating the need for learning environments that allow participation without the need to come to the campus for face-to-face meetings. Jenni Poutanen (2024) states that students view the campus environment in many ways, preferring all supply in different scales, from buildings to spaces in different campus locations. The supply of spaces influences the preferences to a certain extent, but rather than the availability of the spaces, their quality seems more important. She argues that the transformed campus is a sharing-based learning landscape that is community-driven, accessible, flexibly used, versatile, and distributed that and nested network of places. Wheel et al. (2023) discuss student social connectedness: it is indicated to be changing with the increasing digitalisation of universities. They propose that co-design is a way of creating tailored and connected learning experiences.

The transformation from physical books to digital information is reshaping the library and the ways to work in knowledge creation. Library buildings are evolving toward a learning resource centre providing facilities for people to work together, to socialise and to meet in formal or informal ways (Curvelo and den Heijer, 2011). Instead of reading from the book there are more ways to learn. Brundy (2015) has contended that university libraries should cater to both formal and informal learning needs, where the rapid progress of technology is also one of the main drivers of innovation. According to Kelly et al (2011) social learning spaces such as the library foster social interaction between students and promote the development of a sense of belonging and community, all of which increase student engagement. Next to increasing use of technology one needs to remember that high-tech and no-tech could be combined by introducing high-tech and no-tech zones. Libraries could have no-tech zones and employees could schedule no-tech time slots, to assure their focus and improve their mental health (den Heijer, 2020). Harrison and Hutton (2013) state that libraries are shifting from a passive role as book depositories to an active role in learning as part of the total student experience, and social learning spaces are integrating formal and informal learning and social activities on – and off – the campus.

The learning environment research focuses on informal environments as a source for collaboration which is driven by active teaching methods, remote and hybrid ways of studying and increasing digitalisation. It is essential to identify the new requirements for university campuses, learning centres and libraries.

3 methodology and research design

To explore the informal study places, the case study method and qualitative approach was chosen. The case study is a Learning Centre in University of Helsinki, Finland, especially the transformation of it. The process to update the study places to respond to the changing needs of the students in a renovation project is followed thoroughly. The data has been gathered by workshops, observations, and surveys. Additionally explorative pilots were conducted.

3.1 Case Learning Centre

Learning Centre in University of Helsinki was established in 2003. Even before the onset of the pandemic, it was evident that the building required renovations and functional modernisation based on the utilisation data and regular user surveys.

Pre-pandemic, autonomous learning was centred around reading, writing, and group study with their own laptops: education was followed in-person in traditional learning environments. The typical day on campus were filled by attending instructional sessions according to the time schedule and interacting with peers in classrooms, corridors, and cafeterias.

Before renovation, the Learning Centre, with roughly 200 computers, had spaces for students mainly to study independently. The facilities need to be updated to today's studies, which have arisen especially after pandemic era. The systemic change in society has affected to university, education and pedagogical solutions. Remote education has become more common and the typical day on campus includes a varying amount of local and remote participation. At the same time, guided but also independent study in groups is constantly increasing. One big reason to come to campus is to meet people, and to support this spatially enables the emergence and strengthening of community. The new needs require suitable and versatile spaces for studying.

The transformation process towards post-covid learning centre began with the co-creation of the principle of the Learning Centre. The following goals were set:

The Learning Centre

- aims to support students' well-being with good acoustics, lighting, enough retreat and meeting rooms, adequate soundproofing of the facilities, a good indoor climate (temperature, indoor air) and furnished spaces that are comfortable and ergonomic and support the goals of the activity.
- aims to strengthen students' sense of community, the planning of the learning environment need to conduct so that bumping into each other takes place: the coworking cafe area on the entrance floor.
- aims to support group study: group study areas in open areas and bookable group study rooms.
- enables calm and quiet independent working with enough good ergonomic workstations.
- has intuitive guidance and ease of access (elevators, toilets, functional zones, accessibility).

3.2 Research process

The research process and data gathering of the co-creation process had three main objectives:

1. to gather information for the development of the Learning Centre,
2. to pilot self-study facilities,
3. to increase understanding in the overall development of study facilities in the university community.

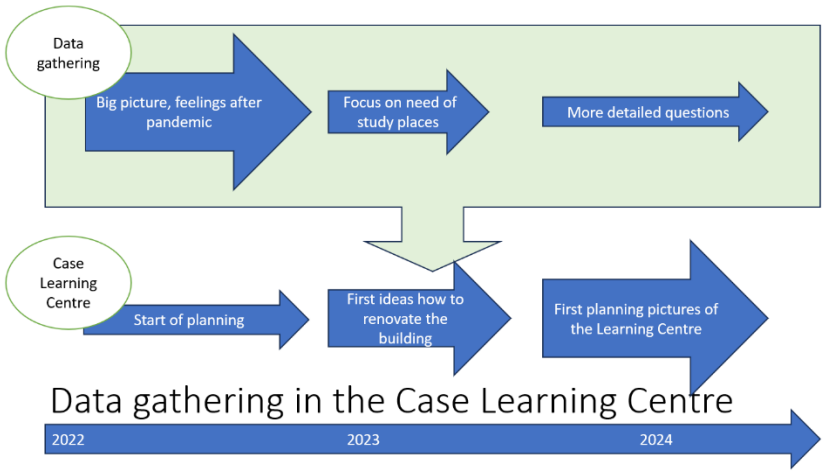
In the first phase of the data gathering students' opinions and new practices needed to be assessed. The initial assumption was that the Learning Centre would be renovated, but the designers lacked up-to-date information regarding the users. The research process started with broad and general questions in workshops, as the initial focus was on the students' feelings, preferences, and general wishes. The first general desires for study facilities were recorded as part of the Learning Centre project plan.

In the second phase the content of the workshops and questionnaires became more detailed when more information was needed for the design. a pilot environment was created in the main library of the University of Helsinki, where different workstations could be tested in practice.

In the third phase characteristics of pre- and post-covid learning environments were identified.

All together the Helsinki University Library and the Learning Centre have 43 bookable group study rooms. In addition, group studying is carried out in cafeterias, corridors, and other shared areas. Participants in group study are either present or remote. This research is still ongoing. The next study will explore what kind of space would be best suited for hybrid study, what kind of ground rules should be created to make the study run smoothly. Figure 1 indicates the data gathering process and how it is aligned with the development and pre-project phase of renovation of the Learning Centre.

Figure 1. Data gathering in the Case Learning Centre



3.3 Research methods, data gathering and analysis

The first step into our research began in the post-pandemic spring and autumn of 2022. We conducted a series of pop-up workshops and events on the campuses. We solicited input on what attracts students to campus, preferred remote study locations on campus, and the type of campus

environment conducive to study. Close to 1,000 students responded and engaged in our workshops by writing ideas, wishes and need to Post-it stickers.

The data from Post-it stickers was analysed by organising the data according to framework to physical, social, and digital learning environments (see e.g. Ninnemann et al., 2020). The physical environment refers to the physical elements of the place, the digital environment to information and communication technology enabled learning environments, and the social environment is about the ways in which the place is used for collaboration and individual activities, and co-commitment to their development based on experiences.

In the second phase we decided to pilot different spatial and equipment configurations in practice considering the substantial changes proposed for the Learning Centre. For the academic year 2023-2024, we outfitted a space with ergonomic workstations featuring variable components: some with just an electric desk and office chair, some with the addition of a monitor, keyboard, and mouse, and others with a university-provided desktop computer. Two questionnaires were open to students: one to find out general wishes and questions for the transformation of the Learning Centre, the other to ask about ergonomic workstations. The utilisation of the pilot spaces and workstations were evaluated through utilisation of e-forms, which were linked via QR codes placed at each station. Additionally, library staff observed the use of the space.

The analysis of data from the questionnaires, together with more qualitative data from the workshop, followed the analysis protocol of the framework use in the first phase. The data pertaining to observations and usage were organised and analysed according to frequency within the time scale of five weeks. We conducted a data analysis to identify and cluster the functional categories.

Finally, the data about pre- and post-covid use of the Learning Centre was compared. We have accumulated data regarding the use of the Learning Centre to understand in the overall development and use of study facilities in the university community. During the pandemic, building usage initially plummeted but gradually began to rise again. By spring 2024, the use of the Learning Centre will be extensively monitored on sampling days: computer utilization will be tracked through the network, space occupancy will be gauged by staff counts, and evening usage will be determined via access badges.

Table 1 presents a variety of data gathering methods. Descriptive data was employed for the Learning Centre project plan, while more detailed data provided more information for renovation designers. The gathering of data has led to a greater understanding of the overall development of study facilities within the university community.

Table 1. Data gathering focus and methods

Focus	**Nature and content of data**	**Method**	**Participants**
Attractive campus	**Descriptive data:** Preferences Sentiment gauges	Workshop	200 students
Preferred remote study locations on campus	**Descriptive data:** Preferences	Workshop	650 students

	Sentiment gauges		
The type of campus environment conducive to study	**Descriptive data:** Preferences Sentiment gauges	Workshop	400 students
Needs for a retrofitted the Learning Centre	**Detailed data:** Preferences Best place for studying and for well-being Furniture, equipment	Workshop	100 students
Use of ergonomic workplaces	**Detailed data:** Preferences Furniture, equipment	Feedback form Tracking of pilot area use	40 students 100 students/day
Use of computer	**Detailed data:** Preferences Equipment	Workshop Feedback form	700 students
Use of the Learning Centre	**Detailed data:** Preferences Opening hours Furniture, equipment Landscape of sound	Tracking of visitor amount	200 students/day
Use of group study rooms (in the Learning Centre)	**Detailed data:** Preferences Room sizes	Tracking and observation	5 group study rooms (The Learning Centre) 38 group study rooms (in libraries)

4 results

4.1 Student preferences

Initial surveys showed that students come to the campuses primarily for the people, the services, and the comfortable and ergonomic workspaces in the library. Because teaching is multi-sited and hybrid, students do not necessarily bump into their colleagues in lectures. We need new kinds of communal spaces where people can meet and work together.

In the post-pandemic period, it has also been noticed that existing study spaces do not work well for remote lectures. In old facilities, the need and lack of space can be addressed with new signage and house rules. In new and renovated facilities, the new learning style can be considered at the design stage. The surveys also showed that students prefer to use their own laptops or other devices, thus extending the digital learning environment.

In terms of physical spaces, the desires focused on the soundscape, ergonomics, and versatility. While modern learning increasingly requires collaborative spaces that allow even loud conversations, the importance of silence has not diminished. The multichannel nature of the world around us and the information and sound overload are prompting students to turn to libraries and learning centres in search of good working spaces to increase cognitive ergonomics. In the future, quiet and peaceful

solitary work will be merged with a sense of community and spaces for working together. The classified preferences are presented in the Table 2.

Table 2. Preferences of students

Physical environment	**Digital environment**	**Social environment**
Soundscape	Room and space for remote studies	Co-working areas
Ergonomics – physical and cognitive	Own laptops and devices	Cafes
Versality in furniture	Good internet	Services
Rest area and facilities	Enough sockets	Peer-to-peer support
Place to do exercise	Large screens	Sharing campus life

4.2 Solutions in the Case Learning Centre

Before the renovation, silence was the prevailing atmosphere, and Centre did not provide a place to gather for discussions or distance learning. In the future, the Centre will offer a variety of spaces for quiet and peaceful study as well as collaborative work areas. Based on the workshops and survey result, a functional plan for the Learning Centre was created, dividing the building into different spatial zones for different functional needs (Table 3):

1. Sense of community and recreation
2. Collaboration and teamworking
3. Desk working

The division of the Learning Centre into functional blocks gives clear guidelines to the designers, e.g., in the planning of electricity, in the size of the spaces. For more detailed planning and further discussions with the students, the places will be categorized in three separate groups. This makes it easier to discuss with designers and users to avoid misunderstandings.

Table 3. The concepts of the functional categories in the Learning Centre

1: Sense of community and recreation	**2: Collaboration and teamworking**	**3: Desk working**
Meeting points	Group study area	Ergonomic workstation
Refreshing area	Bookable group study rooms	Drop-in space/phone booth
Rest area	Hybrid group studying	Reading places
Break exercise point		
Multi-use self-study spaces		

4.3 Pre- and post-pandemic changes in learning environments

The variety of learning places is essential. The diversity of social interactions among students on campus and online has increased. The group consistency sets requirements to the size, technology and location of the group working facilities. Both user and remote user centric approach are important in design of study areas. The reservation systems need to transform accordingly. The data can be applied to concepts for post-pandemic campus self-study places.

Table 4: Pre- and post-pandemic changes in learning environments

Aspects of learning environment	**Pre-pandemic era** **Focus on...**	**Post-pandemic era** **Focus on..**
Physical environment	Silent and quiet studying areas	More areas to meet and talk next to silent areas
	Bookable group study rooms	Diversity of areas for studying together
	Physical accessibility	Physical and digital accessibility
	Single-use space	Multi-use space
	Limited ergonomics	Adjustable ergonomics
Digital environment	A university-provided desktop computer	A monitor, keyboard, and mouse – environment for a laptop (Possibility to borrow a laptop)
	Information technology and equipment - heavy solutions	Communication technology and equipment – light solutions, “bring for own device”
	One reservation system on-line	Mobile reservation system
Social environment	Physical presence in group study rooms	Physical and digital presence in group study rooms
	Individual studying	Also studying together, a sense of community
	Breaks and recovery in cafeterias and outside campus	Breaks during the studying in the learning centre
	Co-creation in the ideation phase of the Learning Centre	Continuous co-creation of retrofitted the Learning Centre
	Single service provision	Multi-professional support and service for students

The learning environment is in change. The changes can be visualised from social, digital, and physical aspects. This requires also multi-professional collaboration in developing them.

5 CONCLUSIONS

This paper discussed the students' wishes and needs for space changes in the Case Learning Centre. According to the literature in post-pandemic era, it has become crucial to re-engage students with campus life. Covid-19 disrupted longstanding patterns and habits, necessitating a collection of student preferences and thoughts from the ground up. Education shifted towards a hybrid model, and with it, the study habits of students inevitably changed.

The results indicate that the hybrid and remote ways of studying require new spatial arrangements. Additionally, the effort to support the community of the students and university are important for the students. The study lacks the preferences of the students from different disciplines. There are differences also between the faculties. However, this study focused on the Learning Centre, which is located close to the university library. Both places represent multidisciplinary space, where the background of the student or the field of expertise is not important. The significant factor is the demand and supply of community-based facilities for students to different ways to study together and alone.

The further studies can focus on understanding the common or diverse requirements for the students of the different disciplines. The quality of collaboration and studying in hybrid and face-to-face situations might be different and in the long run one can identify more precisely the appropriate ratio of different kind of zoning and diversity of study places. The amount and quality of self-study places will be affected also based on the ways students are living. The systemic change and its consequences are an interesting research stream for campus and learning environment topics. Additionally, the cultural differences in terms of remote and hybrid studying will shed light to the campus development and research.

Students come to study and prosper to campus more likely when the university can offer them three types of self-study places. Needs for study places differ from the time before Covid-19. Additionally, the need to meet other students is still important reason to come to campus.

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The relevance of learning space organisation. Insights from a real-world laboratory for hybrid and student-centred teaching and learning

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ABSTRACT

The rapid development of information and communication technologies increasingly erodes boundaries between digital and analogue or online and offline. It can be argued that higher education in particular needs to reassess their strategic approaches to placemaking and learning environments (Ninnemann, 2023, 2021). It is with this in mind that the interdisciplinary research project "Innovatives Lernraumdesign" (designing innovative learning spaces) at HTW Berlin, Germany, analyses spatial needs and requirements of users and stakeholders in the context of synchronous and asynchronous hybrid learning scenarios (Reinmann, 2021). The aims of the project, set up as real-world laboratory, are two-fold, first, to experiment with and evaluate innovative hybrid and student-centred teaching and learning environments and, second, to gain insights for the development of strategies for scaling up such environments in the context of institutions of higher education.

Using a multi-stage process with an explorative research approach, four learning environments for hybrid and student-centred teaching and learning scenarios were conceptualised and implemented to be used and evaluated as part of the regular learning and teaching at HTW Berlin. Working with the POST perspective, which links pedagogy, organisation, space and technology, processes were systemically analysed throughout all project phases. The first findings show that the new learning environments are well-received by their users but that challenges emerge in particular across the area of organisation. While aspects of pedagogy, space and technology can be analysed building on an already extensive knowledge in research and practice, organisational issues are not yet systematically observed and conceptualised. This paper outlines the project parameters and presents key insights. In

particular, it will argue that it is crucial to rethink organisational structures and processes at universities and to discuss the requirements for shifting from learning space design to learning space organisation if new learning environments are to become more than one-off experiments.

Keywords
Onlife Spaces, Learning Space Organisation, Formal Learning Spaces, Student-centred Learning Spaces, Real-world Laboratory

1 INTRODUCTION

Technological and cultural transformation processes in the information and knowledge society are increasingly eroding the boundaries between digital and analogue, online and offline. With the increasing integration of information and communication technologies (ICT), the digital world can no longer be viewed parallel to the analogue world, but instead requires a fundamentally new understanding of technology-enriched environments. To describe the resulting changes in perspective of action spaces Floridi (2014) has coined the term "onlife". Research on innovation processes for the design of hybrid learning environments at universities (Ninnemann et al., 2020) and the experiences of the COVID-19 pandemic clearly show that "an integrated understanding of onlife spaces on the one hand (a) leads to changes in existing physical places [...] and on the other (b) evokes the activation of new physical places" (Ninnemann, 2021, p. 284). These developments suggest that technological transformation processes will fundamentally change the university as a learning space and thus will impact on future campus development measures.

Currently, as one of the effects of the COVID-19 pandemic, the expansion of classrooms with media and conferencing systems is accelerating in order to support synchronous hybrid teaching[12]. A strong focus on technical equipment can be observed and investments are predominantly made to fund frontal teaching, teacher-centred seminar rooms and lecture halls. However, such spaces make it difficult to establish competence-oriented teaching and learning formats. Therefore, to ensure a long term paradigm shift from teaching and learning with spatial measures (Ninnemann, 2018, 2022a), it is necessary to develop and test innovative strategies for the design and organisation of hybrid and student-centred teaching and learning settings that support blended learning formats in a combination of face-to-face and online teaching.

2 Objectives of the Real-world laboratory

The project "Innovatives Lernraumdesign" (designing innovative learning spaces) at HTW Berlin provided a field of experimentation for the development, modelling, implementation and evaluation of four model spaces for hybrid and student-centred teaching and learning settings. By conducting the project across two faculties, Engineering and Design & Culture, it was possible to draw on an interdisciplinary expertise in learning space design as well as different perspectives on processes and structures of learning space organisation. Following an understanding of transformative research, which sees real experiments as a scientific method of complex transformation processes (Schneidewind, 2014), the project was conceptualised as a real-world laboratory. Here, through participatory processes of co-design, co-production and co-evaluation, proposals are jointly

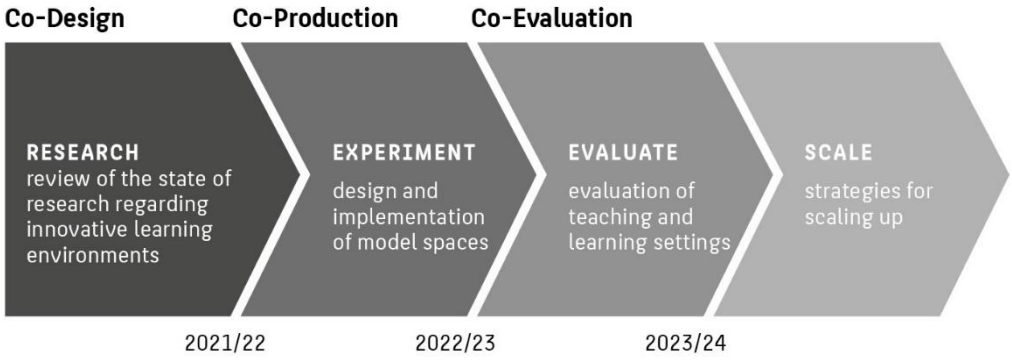
[12] see Reinmann (2021) for the differentiation of synchronous and asynchronous hybrid learning scenarios

developed, tested and researched with different stakeholders on the basis of real problems with the aim of initiating sustainable change processes and consolidate associated learning processes (Wanner et al., 2018; Beecroft & Parodi, 2016).
The project's aims as a real-world laboratory can be formulated on two levels: first, on the level of the learning space design, the aim was to develop and test different learning settings and their respective potential to support blended formats of hybrid learning and teaching in line with the current state of research and practice in higher education. Second, on the level of the project as one of four projects exploring different facets of innovative teaching and learning, the aim was to analyse and reflect on processes and challenges of implementing such innovative learning environments within the operational context of a university. The paper presents initial insights of the evaluation of the four model spaces as well as some contextual reflections on the process of development and implementation.

3 phases Of the Real-world laboratory

The real-world laboratory is divided into four phases: 1) Research, 2) Experiment, 3) Evaluation and 4) Scale, which comprise different tasks, milestones and processes (see Figure 1).

Figure 1. Milestones real-world laboratory



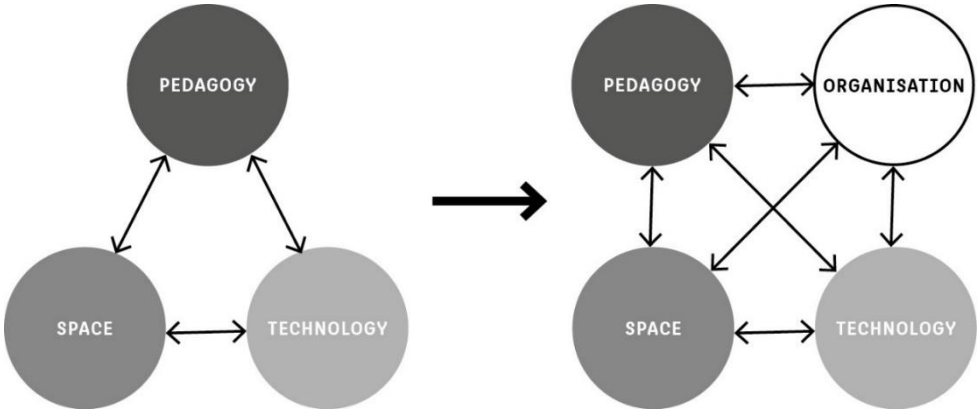
Phase 1) *Research*, laid the foundations for the conceptual design of the four model spaces for hybrid and student-centred teaching/learning settings over a period of ten months. This included a spatial inventory and analysis of formal learning environments on campus, a review of research into innovative learning environments and technical solutions for hybrid settings, data collection via qualitative interviews, focus groups and user experience methods, such as the development of personas and user journey mapping, to analyse user needs (students/teachers) and stakeholder requirements (administration/technical services) in order to gain insights into the interaction between space and learning, as well as the conceptualisation of central principles for modelling the four model spaces.
In phase 2) *Experiment*, the realisation of four model spaces was prepared and carried out over a period of ten months. Main tasks were the identification of appropriate seminar rooms to develop as model spaces, coordination with the academic and administrative management at HTW Berlin, negotiation of cross-faculty usage agreements, tender negotiations and the awarding of two lots for a staggered implementation of the model spaces as well as coordination of the construction measures.
In phase 3) *Evaluation*, the four model rooms were evaluated over a period of six months using quantitative and qualitative methods to gather responses from students, lecturers and other stakeholders.

Finally, in phase 4) *Scale*, strategies for scaling up the creation of hybrid and student-centred learning space settings are compiled on the basis of the phases 1-3. Additionally, the transfer of the model spaces to regular operations of the faculties is prepared and implemented.

4 POST perspective and project framework

As central starting point and conceptual programme of the real-world laboratory, the four central aspects of the POST perspective, pedagogy, organisation, space and technology, were brought together across all phases of the real-world laboratory (Ninnemann, 2023). At the beginning of the 21st century, the "Pedagogy-Space-Technology (PST) Framework" (Radcliff, 2009) was developed, defining pedagogy, space and technology as central design criteria for innovative learning environments. However, research in the context of onlife spaces shows that especially in learning space design measures with a high level of innovation the aspect of organisation must also be taken into account (Ninnemann, 2018). Owing the increasing integration of information and communication technologies (ICT), there are many opportunities to support teaching and learning processes innovatively on and beyond the university campus. This suggests the need of a fundamental change in organisational processes and structures for the development, implementation, use and management of formal and informal learning environments at universities (Ninnemann 2018, 2022b, 2023).

Figure 2. Extension of the PST framework to the POST perspective



Based on the four levels of the POST perspective, the conceptual framework for modelling, realising and operating the model spaces was developed collaboratively and iteratively throughout the real-world laboratory process:

Pedagogy

- Enabling student-centred teaching, learning and examination scenarios in hybrid settings
- Awareness of different needs of various disciplines and cultures at faculties
- Support of four central didactic modes: Input, Teamwork, Share, Discussion

Organisation

- Integration of the model spaces into regular course and room management
- Access to the model spaces as informal learning environments for students

- Integration of communication and support services to link pedagogy, space and technology

Space

- Spatial dissolution of frontally-organised teaching and learning settings
- Learning space design based on current research (Active Learning Environments / Flexible Learning Environments)
- Barrier-free use of the model spaces

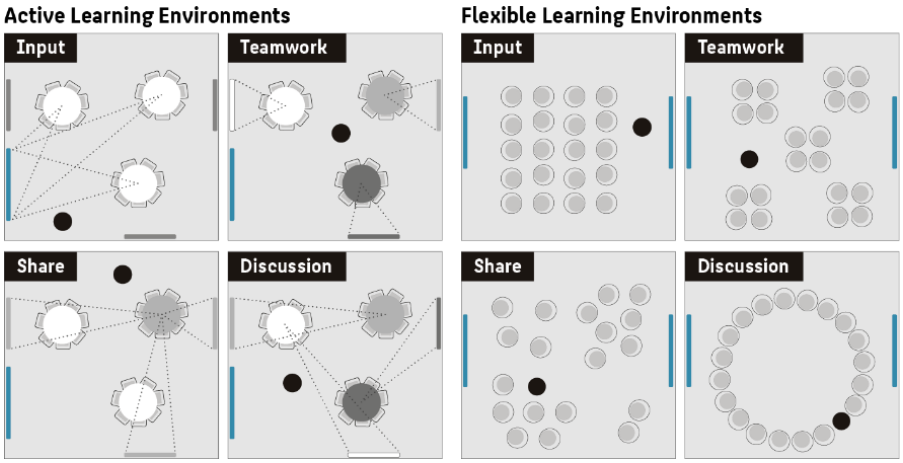
Technology

- Equipped for analogue and hybrid teaching and learning settings
- Plug & play (USB-C, BYOD)
- No personnel support or additional resources for the use of technology

5 Design of the Model Spaces

Based on the current state of research regarding the design of formal and technology-integrated learning environments, two basic models of Flexible Learning Environments (FLE) and Active Learning Environments (ALE) were implemented in the real-word laboratory. Figure 3 illustrates the two conceptual approaches using the four teaching and learning scenarios, Input, Teamwork, Share and Discussion, as central didactic modes.

Figure 3. Schematic representation of space settings ALE and FLE, based on Ninnemann (2022a)



Both spatial concepts have been positively evaluated to promote student-centred teaching and active learning processes among students (Ninnemann, 2018, p. 33 ff, 2022a). In FLEs this is realised via moveable and foldable furnishings (tables/chairs) that enable an easy (re)configuration of spaces. In contrast, ALEs, like SCALE-UP, TEAL, TILE classroom concepts, are furnished with permanently installed group-work islands. Each worktable is equipped with digital and analogue presentation media (monitors / whiteboards), available for use by both teachers and students. In the project, two spaces were developed and implemented as FLEs and two as ALEs, each with different spatial and technical equipment. Table 1 summarises the overall principles in reference to the POST perspective and the four spaces are presented in detail in tables 2 and 3 at the end of this contribution.

6 Evaluating the model spaces

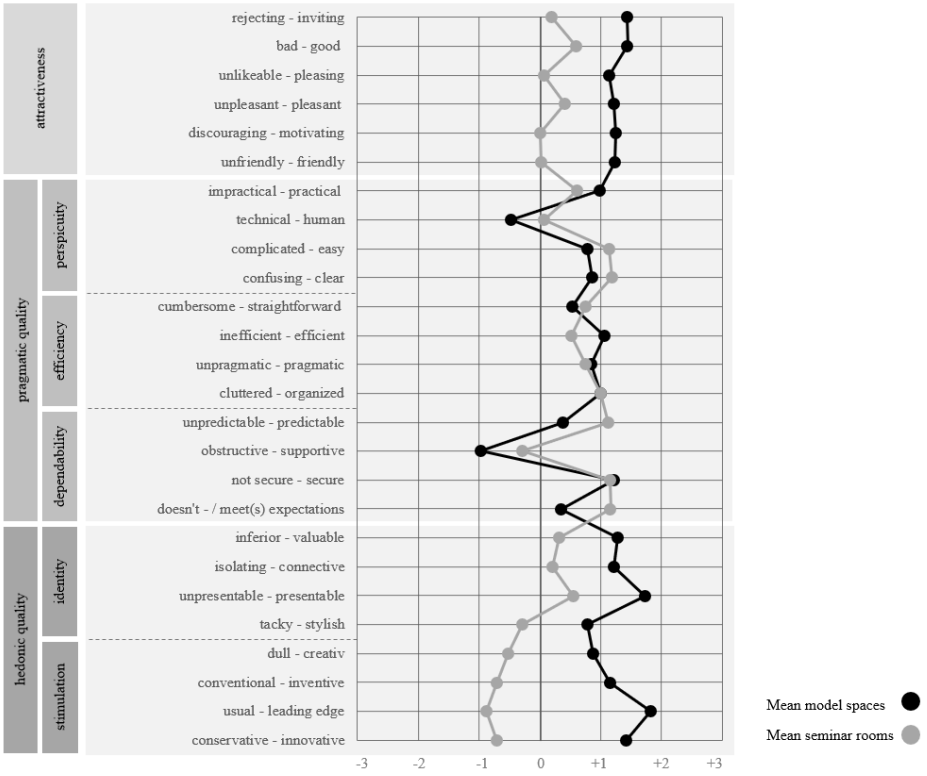
For the evaluation in phase 3, a mixed-method approach was used that combined a quantitative user experience survey with explorative, qualitative methods, such as semi-standardised interviews. The following presents initial findings from the quantitative survey, taken from the disciplinary field of human computer interaction and adapted to the context of learning environments, that was used to compare and contrast responses to the model spaces on the one hand and the university's standard seminar rooms on the other.

The international standard ISO 9241-210 defines user experience "a person's perceptions and responses that result from the use or anticipated use of a product, system or service". In contrast to an environmental perspective, which analyses variables of three-dimensional spaces, such as lighting, temperature, ventilation, acoustic, etc., the user experience approach focuses on requirements and expectations of students and lecturers within intended use case scenarios. The aim is to gain insights on functional and emotional aspects that support or hinder a positive user experience.

For the survey two standardised user experience questionnaires, "AttrakDiff2" (Hassenzahl et al., 2003) and "User Experience Questionnaire" (Schrepp et al., 2014), were combined and adapted. Since these questionnaires were developed for the evaluation of interactive products such as websites, software products or mobile applications, only those items that make sense in the context of hybrid working and learning environments were carried over (Ninnemann & von Blohn, 2021).

The survey uses a polarity profile with 26 bipolar items in three dimensions, attractiveness, pragmatic quality and hedonic quality (Hassenzahl et al., 2003; Rauschenberger et al., 2013). An item comprises two opposing attributes, such as rejecting/inviting, impractical/practical or dull/creative. Ratings in the negative area of the scale are associated with the negative attribute of the item, while the positive area indicates the respondent's assessment of the positive attribute (see Figure 4). The pragmatic quality aims to identify stressors in terms of functionality and suitability for use, while the hedonic quality takes into account emotional aspects such as identity and stimulation, which act as motivators from a more comprehensive perspective (Hassenzahl et al., 2003). Within the two dimensions of pragmatic and hedonic quality, five subcategories are differentiated: perspicuity, efficiency, dependability, identity and stimulation.

Figure 4. Responses to survey of the user experience of model spaces & standard seminar rooms



The paper-pencil-survey was conducted from May, 15 to June, 30 2023. Students and lecturers, who experienced the model spaces during class activities were invited to take part. Students (n = 191) and lecturers (n = 47) from two faculties, three study programmes on bachelor and master level participated.

As the excerpt shows (Figure 4), the users' (n = 238) responses across the majority of the evaluation criteria differ significantly between the model spaces and the standard seminar rooms, wherein the model spaces are perceived significantly more positive in all criteria of attractiveness and hedonic qualities as well as regarding two aspects (practical, efficient) of the area of pragmatic qualities. The largest differences are found here in the criterion stimulation. In this area the model spaces score consistently positive (leading edge, innovative, inventive, creative) and the seminar rooms consistently negative (usual, conservative, conventional, dull).

A negative assessment compared with seminar rooms is that the model spaces are perceived significantly more technical (vs. human) and significantly less easy, clear, straightforward and predictable. Model spaces and seminar rooms are both rated negatively as obstructive (vs. supportive). It is also interesting to note for which items there are no significant differences: This applies to the aspects of: (not) secure, organised vs. cluttered and (un)pragmatic.

As a preliminary result, it can be stated that the model spaces (16 items) are overall perceived significantly more positively in most aspects compared with the seminar rooms (7 items). In particular, they are rated significantly more favourably in the areas of attractiveness (more inviting, better, more

pleasing, pleasant, motivating and friendly) and hedonic qualities (more valuable, connective, presentable as well as more stylish, creative, inventive, leading edge and innovative).
In the area of pragmatic qualities, seminar rooms are rated as easier, clearer, more straightforward and predictable as well as more in line with user expectations. However, there are also aspects for which there are no significant differences: For example, the model spaces are not yet perceived as more secure, organised or more pragmatic.
The data provides further interesting insights regarding the comparison of students' and lecturers' perspectives as well as differences in terms of gender, age, study programmes and degree level and a more comprehensive publication is planned to analyse the quantitative and qualitative evaluation in depth. Overall, it can be stated that users are more attracted to and motivated by the model spaces, but functional and organisational aspects still have to be improved. First measures were implemented already including the development of instructions for the use of furniture and technology, the conceptualisation and realisation of a digital handbook (see QR code in Table 1) to feature instructional videos and 360° visuals with explanations, and the set up of support services, such as a weekly consultation hour for students, lecturers and administrative staff. Further, webinars in cooperation with the teaching- and learning-service centre were developed and offered to different user groups. All these actions have proven to be key in effectively linking pedagogy, space and technology.

8 Conclusions on the relevance of learning space organisation

By consistently applying the POST perspective in all phases, it was possible to effectively test different spatial settings and hopefully the insights gained in this experimentation can serve to inform future projects and strategies for the design of future learning environments. Looking beyond the model spaces themselves, their design and their reception by their users, towards the wider project aims, namely the processes of implementing innovative learning environments in the context of higher education, some initial insights emerge. The real-world laboratory practice has shown that the following relevant milestones on the levels of didactics, space and technology could be realised within the planned period:

- Spatial inventory and analysis of formal learning environments on the university campus
- Data collection and analysis of user needs and stakeholder requirements
- Analysis and transfer of the state of research on learning space design
- Research of technical solutions for hybrid settings
- Conception and implementation of the model rooms

At the organisational level, however, it should be noted that projects that not only seek to examine innovation processes on a theoretical level but that also involve infrastructural and administrative changes in the operation and management of a university face various systemic barriers. The following tasks required unexpectedly large amounts of time and effort that must be taken into account for projects which innovate on levels of spatial and technical infrastructure:

- Negotiation processes for locating spaces that are suitable and available to be equipped as innovative learning environments
- Coordination of measures and deadlines with administration and central services

- Coordination of measures and resources for the transfer of real-world laboratory projects to regular operations at universities
- Resources for further evaluation to support usage, operation and modification of innovative teaching and learning settings

The time-consuming and resource-intensive process of negotiating the basic framework for the and realisation of the model spaces has shown that a holistic, university-wide strategy for designing the university as a learning space is required. This might include the introduction of agile methods in university administration to respond to changing requirements for processes and structures in innovation processes so that decisions can be made more quickly and strategies to address acute problems and challenges can be coordinated at short notice. Crucially, real-world laboratory projects need to be integrated into regular administrative processes and structures from the outset to create clear responsibilities at the points where the research project interfaces with the university administration and to ensure a seamless transition from the real-world laboratory into regular operations.

9 Outlook

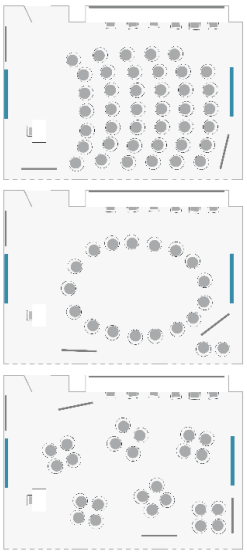
The project “Innovatives Lernraumdesign” has delivered insights into the implementation of innovative learning space design at universities. This was possible because funding was made available to invest in structural measures and equipment such as furniture and technology in addition to the personnel and material resources required for projects. As a result, even though the project naturally took place within a tight framework, solutions were not only conceived and discussed in theory, but could be examined in the reality of planning, implementation, use and operation. The insights gleaned from this, in particular the challenges that occurred at organisational levels over the course of the project, highlight that key aspects for the successful implementation of innovative learning environments cannot be captured or anticipated by only referring to existing findings on pedagogy, space and technology. Further experimentation is needed to address the technological and social challenges in a flexible, agile and sustainable way and to develop future-proof solutions that can be scaled up in the context of complex institutions such as universities. This points to a wide range of research desiderata as well as a lack of best practices, the latter evidenced also by the interest from different-level stakeholders from other institutions of higher education specifically with regards to the management of development and implementation processes. Importantly then, this also underscores the need for financial and human resources for learning space projects, to plan and implement the design and organisation of innovative learning environments beyond the exceptional context of a lighthouse project.

Table 1. Overview model spaces in the real-world laboratory

<table>
<tr><td colspan="3">POST perspective “Innovatives Lernraumdesign” (designing innovative learning spaces)</td></tr>
<tr><td>Pedagogy</td><td colspan="2">The furniture and technology supports student-centred and hybrid teaching/learning settings through four didactic modes: (1) input, (2) teamwork, (3) share, (4) discussion</td></tr>
<tr><td>Organisation</td><td colspan="2">The model spaces are located in one building and on one floor as an innovation hub. This supports the exchange between users, students and lecturers, as well as relevant stakeholders, administration, central services and researchers. The model spaces are included in the regular booking system for course planning and are also accessible to students as informal learning environments.</td></tr>
<tr><td rowspan="3">Space</td><td colspan="2">size: approx. 77 square metres / capacity: 44 students</td></tr>
<tr><td>Flexible Learning Environments (FLE)
Two model spaces are equipped as FLE with mobile furniture and tables and chairs on castors. This enables different configurations of the space with a wide range of options for interaction.</td><td>Active Learning Environments (ALE)
Two model rooms are equipped as ALE with fixed tables. Each table is assigned a monitor and analogue visualisation media to enable a wide range of options for interaction.</td></tr>
<tr><td>By conceptually linking furniture and audiovisual media technology, the model spaces support the move away from frontally organised teaching and learning settings (see right: seminar room at HTW Berlin) towards student-centred and hybrid teaching and learning scenarios.</td><td>  </td></tr>
<tr><td>Technology</td><td colspan="2">In all four model spaces, the audiovisual media technology for onsite and hybrid teaching is accessed via a central USB-C port and users control the audio and video settings via their own devices. The set-up is compatible with all operating systems and video conferencing systems.</td></tr>
<tr><td>POST</td><td colspan="2">Digital manual for the model spaces</td></tr>
</table>

Table 2. Overview Flexible Learning Environments (FLE)

FLE “Rollercoaster”
The name “Rollercoaster” indicates this model room’s flexibility and highlights its dynamic character. Swivel chairs with trays eliminate the need for tables and allow for easy and quick reconfiguration of the space. A long worktable with outlets and seating has been integrated into the whiteboard gallery to offer additional work and storage space.



FLE “Level Up”

“Level Up” describes the zoning of the space through the use of furniture at different levels. In the larger area, mobile folding tables can be flexibly set up or removed. In the smaller area, worktables each with four study/workstations with electrical sockets are available. The standing height of these worktables allows for eye-level interaction between instructors and students.

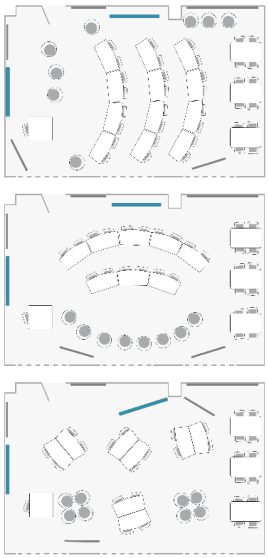
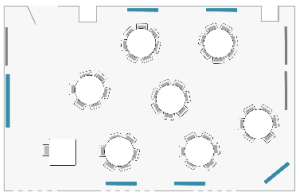
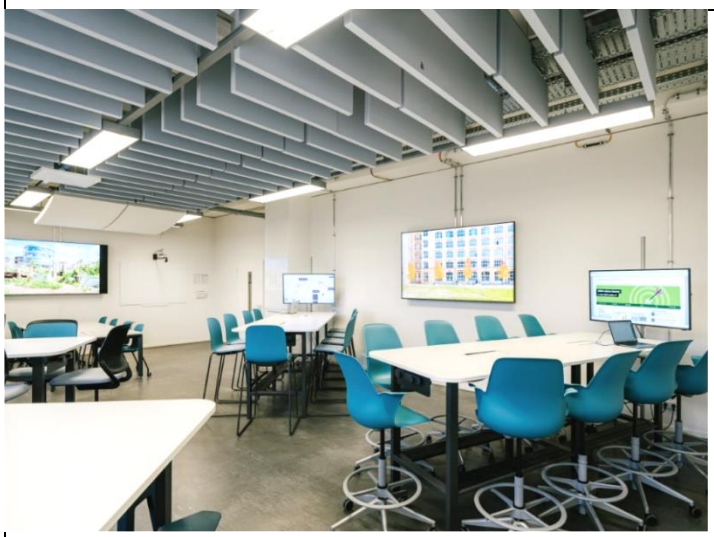
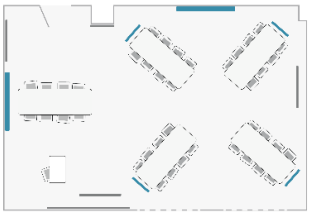


Table 3. Active Learning Environments (ALE)

ALE „O Mode“ (based on the concept of SCALE-UP classrooms)	
The name “O Mode” is inspired by the round worktables that are fixed in place. Each worktable is equipped with ceiling-suspended electrical sockets. Mobile monitors allocated to each worktable allow students to visualise and share information at any time.	
	
ALE “X Mode” (advancement of the SCALE-UP concept)	
The arrangement of the four large worktables fixed centrally in the shape of an x provides the name of the “X Mode”. A total of five worktables are equipped with electrical sockets. Mobile monitors allocated to each worktable allow students and teachers to share and visualise information at any time. The standing height of the worktables facilitates eye-level interaction between instructors and students.	
	

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Learning and working environments – co-creation methods and tools in use

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ABSTRACT

Purpose

In this paper, we describe and test co-creation methods and tools in several university case studies conducted in Finland. The case studies represent smaller and larger change processes in the learning and working environments on different university campuses and in different disciplines. The first question that we pose is, 'What kind of co-creation methods can be used in distinct phases of renovation projects?' The second question is, 'What kind of impact do the methods used have on the users and the project?'

Theory

In current design research and science, approaches to co-creation have evolved. There has been a shift towards recognising that user involvement in changing learning and working environments necessitates a transition from formal, hierarchical, and closed project structures to open, networked, and layered ones. The methods employed in user participation are a valuable source of tacit knowledge, contributing to future-oriented solutions.

Design/methodology/approach
The approach applied is a multiple case study method including data gathered by participatory action research and impact interviews of the representatives of the case studies. Multiple cases were selected to understand the similarities and differences between the cases and the impact on organisational learning.
Findings
Three types of impact were identified when using different methods to user involvement and co-creation of learning and working environments. They are *contribution impact, learning impact* and *future-orientation impact*.
Originality/value
Campus and learning environment developers and designers get an overview of the different co-creation methods used to understand the learning and working environments after Covid19. The research provides new insights to clustering the co-creation methods and their impact to diverse stakeholders in systematic change.

Keywords:
Co-creation, Learning environment, Working environment, Methods, Tools

1 INTRODUCTION

University is a landscape of learning and working environments where co-creation includes many stakeholders and bearers of knowledge of the digital, physical, and social aspects all integrated into the process: to create hybrid environments of the future, more resources will be allocated towards ICT furnishing instead of structural features (Ninnemann et al. 2020).
The emerging hybrid environments call for "co"-concepts: co-design to put users and communities at the heart of service design, co-production to allow users to participate in administration and delivery, co-creation to describe the involvement of customers in developing products and processes, and co-construction to describe working in collaboration (Sandström et al., 2022). The three terms, co-production, co-creation, and co-design are often used interchangeably, and may refer to studies with an emphasis on insights from diverse stakeholders in the design and/or implementation of an initiative (Grindell et al., 2022; Vargas et al., 2022). The evolution in design research from a user-centred approach to co-designing is changing the landscape of design practice (Sanders and Stappers, 2008), and design is increasingly recognised as a powerful transformative approach for changing organisations on a fundamental level (Kurtmollaiev et al., 2018; Calabretta et al., 2017).
This paper aims to describe and test co-creation methods and tools in several university case studies conducted in Finland. The case studies represent smaller and larger change processes in the learning and working environments on different university campuses and in different disciplines. The first question we posed was, 'What kind of co-creation methods can be used in distinct phases of renovation projects?' and the second, 'What kind of impact do the methods used have on users and the project?' The introduction is followed by insights to design research and the process of co-creation. The methodology and research design are presented in chapter three, and finally, the results and conclusion shed light on different cases in the context of university learning and working environments.

2 co-creation processes, methods, and tools

The driver of co-creation is the user and user experience. Research on the usability of workplaces has focused on usability seen as user experience and social relations between users and facilities. According to Lahti and Nenonen (2021), the iterative process used in design-science research in information systems can be applied in the co-creation of hybrid environments. The user experiences of present and remote participants are important to co-design (Lahti and Nenonen, 2021). Service design includes a procedure composed of different steps (Calabretta et al., 2017). E.g., the Double Diamond is a visual representation of the human-centred design and innovation process describing the steps taken in any design and innovation project, irrespective of the methods and tools applied (Riordan et al., 2024). Likewise, the PDCA cycle is a process-improving method that involves a continuous loop of planning, doing, checking, and acting. Each stage of the cycle contributes to the goal of identifying which business processes work and which of them need further improvement and learning from mistakes (Cheng and Lander, 2024). According to Nardelli and Scupola (2013), the involvement of users in the processes varies not only depending on the offered services, but also on the specific relation between users and the service.

The process includes diverse methods, e.g., observation and analysis, idea generation, designing, making a technical plan, and implementing this plan. Each step has its own set of methods and professional tools like layering, clustering, brainstorming, prototyping, modelling, sketching, lateral thinking, interviewing, storytelling, and moodboarding (Calabretta et al., 2017). The methods need to dive deep into the users' world. The evolving informal structures are a valuable source to identify user needs, dreams, and fears – a source that brings tacit knowledge out into the open and delivers the material needed for sustainable and future-proof solutions (Junginger & Sangiorgi, 2009). According to Kjølle et al., (2005) the use of boundary objects is appropriate in discussions and measurements of culture and workstyle, descriptions of (future) work, descriptions of physical concepts, analyses of patterns of use and in creative development of ideas for use and design. However, Star (2010) states that the boundary objects require social interaction among diverse stakeholders and might be challenging to finding consensus. Developing tools and instruments for the continuous dialogue between the building supply side and the organisational demand side is needed (Blakstad et al., 2010; Lindahl et al, 2011)

Evaluation of the process of co-creation is important. To indicate how buildings support organisational goals, the evaluation of participatory processes and the input of different methods is needed. (Blakstad and Knudsen, 2008; Lindahl et al, 2011). Participation in the co-creation should not be a formal must nor a disappointing formality that lacks consequences. (Heidenreich et al., 2024). The collaboration among building project partners, designers and engineers is an effort of professionals from different fields. The lean tools and techniques have been used to improve design quality by iterative communication (Ko, 2017). The iterative process ranges from the formulation of needs, requirements, and constraints from strategy to project, and a detailed brief in workplace planning and design. Fronczek-Munter (2016) extended the research in usability of buildings to include all design phases by defining usability briefing and proposing a usability briefing process model and usability evaluations. There, the briefing is a dynamic and continuous process throughout all the building phases: from pre-project, through design and construction phases to handover and in-use.

The Sociocracy 3.0 method is a collection of social tools for participative decision making (Sykäri et al, 2023). The tools are interlinked to the elements of sociotechnical design, IT design, and HR design to contribute to the practice of time- and place-independent work (van Amelsvoort and Van Hootegem, 2017). The method is inspired by sociocracy governance and includes practices like the four elements of circles, consent decision-making and double linking (Owen and Buck, 2020). Ninneman et al. (2022) propose a co-commitment process, where listening to the users, hearing their message, and discussing it to gain a common commitment in the context of the strategic goals is essential. Every wish does not come true, but participants can get an understanding of the reasons behind. Co-commitment gives place to different feelings, opinions, and perspectives, and lets them resonate in the dialogue. A co-committer is an individual committed to co-creating hybrid environments. Co-committers represent diverse stakeholders and interest groups, and this process can empower people to listen and discuss with a common sense of purpose. This leads the participants to the change and learning curve described in the U-theory created by Scharmer (2009). Generative listening is a source of tacit knowledge, innovation, and empowerment (Scharmer, 2009).

Heidenreich et al. (2024) emphasise that the "sweet spot" for co-creation is not static but varies across the adoption process - from a moderate level during pre-adoption to a heightened level in the post-adoption stages. This enriches the co-creation theory by demonstrating the fluidity of the co-creation "sweet spot" across various stages of the customer journey, emphasising the importance of adapting co-creation strategies based on evolving customer experiences and feedback.

To summarize, the processes, methods, and tools in the field of collaborative processes emphasise the role of the participant. The context and participation create is a sense of contribution, as well as learning during the process and learning from mistakes. Additionally, the methods and tools provide ways for learning among different actors that partake in the process. The sense of impact and the orientation towards the future are also part of the discussion.

3 research design and process

A qualitative research approach was found to best apply for solving the research problem. A cross-case study was conducted including working and learning environment cases from one university. The criteria for the cases were

1. They present distinct phases of a project (pre-project, project, and post-project)
2. They include a co-creation process
3. More than one method is used
4. The author or some of them have been part of the process

These cases were conducted with an action research approach to involve students, teachers, and staff of the university to report user needs and join in the design dialogue and transformation of working and learning environments in the cases, see Table 1. The researchers collected qualitative data on the process involved (Koshy, 2009). Cases 1, 2, 4 and 5 follow the principles implied in the usability briefing theory, and in case 3, the sociocracy process was conducted. Action research made it possible to explore how users are participating in the co-creation as part of the development and evaluation of learning and working environments at the university. The cases present distinct phases: pre-project, project, and post-project. Two of them were working environments and three focused more on learning environments, the last one also emphasising the services connected to the lecture theatre.

Table 1. Co-creation cases

Number	Case	Users involved	Time	Phase for
1	Working environment	400 office users	2022	Project and post-project
2	Learning environment	Students and staff, library, and student services	2022-2023	Pre-project
3	Working environment	162 office users	2021-2024	Pre-project and post-project
4	Learning environment	Students and teachers	2023-2024	Project
5	Learning environment and services	Students and teachers	2023	Post-project

Case 1 was a process to respond to the needs of multilocational, hybrid work in university administration. The unit of 600 people already had a flexible work culture, but the lack of diverse meeting facilities and an increase in remote working set new requirements for the main administration building (about 200 people). The co-creation process focused on understanding the user needs after Covid-19 experiences and responding to the recommendation of spending 2-3 days per week in the office. The seven-floor office building was transformed with a light refurbishment and rearrangement of furniture; no structural changes were made. The methods used were i. management workshop, ii. pop up workshops for users, iii. benchmarking, and iv. celebration of the achievements. The continuous improvement was encouraged by usability walk-throughs, and the use-rate data were collected. The authors (2) designed the co-creation process and conducted the activities.

Case 2 was a case study of a learning centre which needed an update to meet hybrid ways of studying. The facilities needed to support the local presence on campus and easy access to on-line education from campus. The co-creation methods included workshops, pilots, and observation. The author (1) designed the co-creation methods and participated in pop-up workshops and pilots together with the Helsinki University library.

Case 3 was a process of sociocracy applied in renovation process which included the relocation of 162 users from university support functions to activity-based flex offices. For initial planning, the unit's management had a say about floor planning and acted as a proxy for employee needs. The unit had conducted a survey to assess the preliminary needs. The employees had an active role in a series of furniture planning workshops. After these, the social transformation was co-created through sociocratic consent-based decision-making workshops. The author (1) participated in the workshops.

Case 4 was a co-creation process with users, a multidisciplinary technical team, and architects to respond to the needs of team-based learning in one faculty. The process included pop-up workshops for the students, teachers, and administration. Additionally, benchmark excursions to other campuses were made and data were also collected in other countries. The role of the author was to facilitate the workshops. A new method was conducted: an online do-it-yourself workshop, where the user journey through new types of learning environments was performed individually online. The outcome was a cozy and hybrid learning environment, where the classroom was renovated from two windowless

meeting rooms to one classroom supporting team based learning and other activating teaching methods. The author (1) conducted the co-creation process.

Case 5 was about the use of a new alternative lecture theatre to active lecture. A multifunctional lecture theatre with working terraces is suitable for interactive lectures, hybrid teaching, group working and e.g. poster sessions. Due to embedded technology and a new type of space, there is the need to co-create services to support the use of the new learning environment. The data was collected by interviews, workshops, and observation. The author (1) participated in the design of the case study.

The action research process included shorter and longer co-creation processes where the time-schedule, planning the co-creation with different stakeholders, documentations of different activities was used as data for this research. Multiple case study approach was used, generating themes and patterns from cross-case comparisons. The cross-case analysis was conducted by comparing the processes, methods, and outcomes. Co-design workshops were analysed as intrinsic phenomena but also instrumentally as examples of the selected process. The following clusters were identified during the analysis:

1. Methods and their effect
2. Learning in the process
3. Transformation in the process

4 Results

4.1 Methods in distinct phases

The selection of case studies from distinct phases of the project was informative. The content of the topics varied even though the method could have been same. The following table (Table 2) indicates the similarities and differences of the methods. One can see that the workshops are integrating all cases: pop up-workshops provide possibility to join according to participants own schedule and they can be organized e.g., as part of large events and involve large groups for ideation (crowdsourcing). The focused workshops are scheduled and targeted to a certain group of people under a certain topic e.g., sociocracy workshops, which lean on democratic participation and had a strict script connected to workplace change. The celebration and achievement of novel solutions at the end of the co-creation process is a tool, which is part of the process and a step towards learning to use the new place and the technologies in it.

Table 2. Co-creation methods in different cases

Frequency	Case 1	Case 2	Case 3	Case 4	Case 5
In all cases	Pop up workshops Celebration – open doors, Focused workshop (vision)	Focused workshops Pop up workshops (crowdsourcing)	Focused workshops (furniture) Focused workshop (Sociocracy) Celebration – open doors	Pop up workshops Celebration -open doors	Focused workshops
In two or one case only	Use of Miro-wall Usability walkthroughs	Interviews Observation Pilots	Experiments Use of Miro wall	Digital pop-up workshops Feedback with QR-code in space	Interviews Feedback in space with QR-code

The methods which were not used in all cases were e.g. usability walkthrough. It is a task-oriented usability inspection and analysis method following the typical user journey in a defined place or places. Observation is more objective inspection of places, while QR-code in place provide access to brief survey.

There are variety of digitally enabled methods like the use of collaborative workplace like Miro, where the participants can work synchronously during the workshops or asynchronously in between them. In case 5 the difficulties for reaching people in the scheduled digital workshops were tackled by providing an asynchronous digital workshop, which everyone can complete individually in their own time. The workshop included a set of tasks from orientation and introduction to new learning environment types and questions about the ways one could be using the features of the space. The feedback from the participants was promising, and the outcome and result provided material for both designers and the management of the faculty.

The use of co-creation results is different in the diverse phases of the co-creation process. The beneficiaries in the pre-project are the stakeholders preparing the project itself. In the project phase, the outcome of the co-creation process provides material for the organization's change management. In the post-project phase, the methods support users and stakeholders in developing services, not only the space itself.

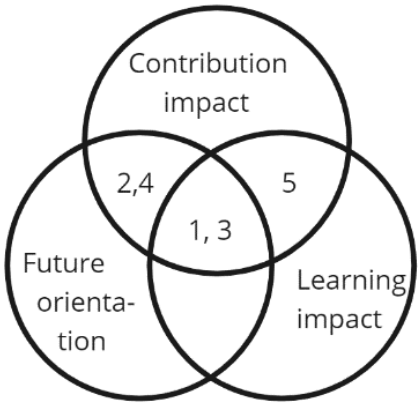
4.2 Impact

The impact of the chosen methods was identified in all five case studies by participatory observations. Additionally, feedback data was collected from multiple data sources and analysed in the research group. Most of the participants were not familiar with the systemic processes focusing on technical and physical solutions. The feedback from the diverse workshops was positive. There were frustrations about the contribution to the topics in the workshops. However, communication and expectation management were developed because of these experiences. The co-creation with students was a challenge because the students now participating in the workshops had not been present on campus because of covid lockdowns, hence they were not remarkably familiar with the built environments and spaces on campus.

The analysis of case studies identified three types of impacts achieved by using different methods to user involvement and co-creation of learning and working environment. They are *contribution impact, learning impact* and *future-orientation impact*. The impacts are illustrated in Figure 1. The first one was present in all cases as the participatory approach was noted and appreciated. Additionally, the design dialogue strengthened it. The second impact has different layers: to learn about the topic, to learn together and to teach peer to peer ways of working and finally to learn about the methods. The third impact is in connection with the future: one needs to let go of old habits and change behaviour towards the future.

In the first and third case study the co-creation strengthened their ability to transform the old ways of using the space in favour of more flexible use. The process descriptions and decision-making in the group helped the participants to lean on to the future. The learning environment cases provided possibilities to teach in a more active way with the orientation to increasing groupworks. The trend towards more active pedagogy sets requirements to the study spaces in a facilitated or self-directed context.

Figure 1. Three impacts of co-creation in the context of learning and working environments. The numbers refer to the cases.



4.3 Learning and transformation

After a thorough cross-case analysis, the cluster of *learning* appeared as one result. In case 1, the learning was about new ways of working and the essentials which help people build community after Covid-19. Simultaneously, the new ways of using self-study spaces were a learning point in the second case study. Learning about the collaborative decision-making process in case three was notable. In case four and five, the outcomes of the workshop were easy to scale to other campuses too. The ways to use the new learning environment are easy for the teachers who have chosen active learning approaches. The services supporting teachers in making the conscious choice and manage the new situation are essential, however not always physically present but also virtual – it can be easier to adapt to the complicated technology already earlier than during the event.

Cases 1 and 3 shed light on the workplace transformation in the context of academic support services. The participants had a sense of contribution in case one due to the continuous communication of what was happening monthly. In case three, the workshops connected to spatial layouts were not open to all employees, meaning that the employees felt not being heard at this stage. However, the transformation of the ways in which to use the new spaces were much more shared and the contribution to sociocracy workshops was significant. In case 1, people learned to know each other in pop-up workshops and were also teaching each other and spontaneously told the acute issues to their colleague. Informal characteristics of pop-up workshops provide the interaction climate, which makes it easy to communicate. In case 3, both participants and facilitators learned about the sociocracy method which emphasises skilful participation and listening to others.

Case 2 was the only case study from the pre-project phase. The methods used were in the first phase crowdsourcing and aiming to gather students' preferences. The second phase with pilots and more specific workshops provided more detailed and focused info and data. The pilots indicated the students about the improvement which would be possible to conduct eventually.

5 Conclusions

The study aimed to understand the co-creation processes, methods, and impact of co-creation on the users. The chosen five case studies provided rich data for the cross-case analysis, but the data remained light. The methods and their impact were identified but the comparison of the processes could have had a stronger role.

However, co-creation increases the experience of contribution. Therefore, the users feel more confidence towards co-creation and are willing to join more. The impact of learning was identified in the case studies, and it is important in terms of making the novel solutions usable and accepted: it is a matter of technical and physical usability of the co-created outcomes. Finally, the co-creation process has a change impact with the orientation towards the future. This means letting go and in consequence, learning.

The paper strengthens the tradition towards more user and even human-centric environments, where the process of co-creation with active methods and tools is as important as the outcome of the environments for learning and teaching in a post-covid world. The design dialogue and diverse ways to feed information and results back to the users on how participation has affected the environments are essential ways to motivate and encourage them. More research is needed to indicate that the impacts of co-creation can be identified, evaluated, and measured in the integrated physical and digital learning and working environments.

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Session 5C: Corporate Real Estate

Enhancing Agility in Corporate Real Estate: Development of an Occupancy Simulation Model for Space Optimization and Decision-making

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ABSTRACT

Determining the appropriate amount of office space to rent and maintain in the post-pandemic era is a complex challenge for companies. Striking the right balance between office space size and occupancy is an ongoing dilemma. Although the pandemic has stimulated this conversation, designing effective real estate strategies that respond to hybrid working and determining the optimal office size continue to be persistent challenges for many organizations. This paper demonstrates how space occupancy/spatial utilization measured at the building floor level over three years can provide future projections and insights about space usage. Specifically, it discusses the managerial concern about not providing enough space, a factor that often hinders significant reductions in corporate real estate footprint. Furthermore, this paper presents a simulation tool specifically tied to real estate cost savings, a percentage of reduction in space, and the associated risk of exceeding capacity. This simulation tool can be customized to match an organization's specific real estate costs and portfolio, and it can facilitate communication among corporate real estate, finance, HR, data analytics, and space planning teams.

Keywords

Space optimization, Space programming, Simulation, Occupancy management, Real estate costs

1 INTRODUCTION

Determining the appropriate size of office space to rent and maintain in the post-pandemic era presents a complex challenge for companies (McKinsey, 2021). Possessing excessive office spaces results in higher real estate costs and increased environmental impact, while overcrowded offices might hamper employees' productivity, work experience, and well-being (Vischer, 2007; Hua et al., 2011). Although the pandemic has stimulated this conversation, defining the optimal office size and designing effective real estate strategies that respond to hybrid working has remained a thirty-decade-long challenge for many organizations (Fawcett, 2009).

When a company downsizes its office space, various stakeholders might raise a critical question: What would future space occupancy look like? Erratic changes in space capacity can lead to two divergent outcomes: periods of peak occupancy that exceed the office's capacity or significant space underutilization. The potential occupancy exceeding the capacity can often spark aversion or fear of not having enough space, ultimately affecting stakeholders' decisions regarding future space needs. Conversely, providing abundant space is often perceived as a less risky decision to make, although it may result in lower space utilization (Fawcett, 2009).

As defining the appropriate office size remains a challenge, the goal of this study is to explore a new way to project future office space needs based on existing fine-grained space utilization data collected by environmental sensors.

1.1 Space occupancy and future projections

Space occupancy information is essential for understanding both current and future space usage. There is ample literature reporting data on downscaling trends in space and office building occupancy costs (Miller, 2013). Efficient space utilization reduces required square footage, and consequently, all related costs, such as rent, operation, and maintenance (Cooper et al., 2017). Optimizing space utilization also fits the facility management's (FM) sustainability goal in ensuring the full use of diminishing resources while minimizing the environmental impact (Alexander, 1994; Bröchner et al., 2019).

One of the most significant challenges in space optimization is addressing concerns about potentially insufficient space for future needs. Although a low utilization rate is observed in many buildings, and space-sharing is often identified as a facilities management response, uncertainty about demand makes it difficult to decide how much shared accommodation to provide (Fawcett, 2009). Providing too many workspaces incurs penalties due to unused space, whereas providing not enough workspaces might not meet employees' needs in daily work.

In practice, many facility managers aim at optimizing space utilization. But what specific utilization targets should be set? In response to these concerns, space occupancy simulations supported by advanced algorithms can provide valuable insights for projecting future space requirements (Fawcett, 2017).

This paper offers a basis for setting organization-specific utilization targets. It focuses on the management of office buildings, but the general methods and principles that we proposed here would also be applicable to other building types. We argue that the design of adaptive environments should seek to minimize the risk of over- and under-investment in adaptive features, where under-investment may be a more common shortcoming.

1.2 Space optimization for enclosed meeting rooms

Hybrid working practices with remote collaboration have significantly increased the demand for enclosed meeting spaces. Additionally, the costs associated with AV equipment, furniture and fixtures, acoustic glass partitions, and other technological equipment make meeting rooms a substantial part of the construction budget, which makes them a focus point for discussion during budget estimation and space planning processes.

In practice, the approach to estimating the space needs for meeting rooms is largely based on ratios. The number of meeting rooms and meeting room seats compared to the total number of workstations are normally determined based on benchmarking data from previous projects; for instance, each meeting room seat generally serves 3 to 5 workstations, with a ratio 1:3 to 1:5. Acceptable ratios for the number of meeting rooms to workstations might range from 1:15 to 1:20. This benchmarking information is mostly based on past experience or decisions made by design teams.

Space optimization for meeting rooms differs from optimizing single workstations as it involves counting both the number of rooms and seats. Although it is difficult to understand the needs for meeting spaces, modern sensor technologies enable the tracking of meeting times over extended periods, thus yielding valuable data for space planning. Various sensor technologies have been explored for their ability to measure space occupancy and utilization rates (Zhou, Hua & Liu, 2022). There is also a growing trend in the industry to project future space occupancy patterns based on existing space usage data (Fawcett & Chadwick, 2007).

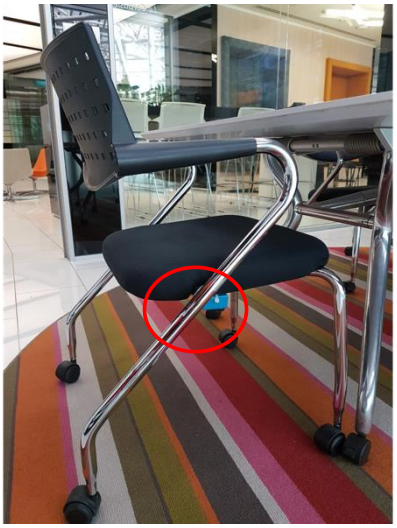
Despite the variety of methods available, such as sensors, people counters, badging, and manual observations, in practice, there were still few cases explored ways to make future space projections based on existing space use patterns. In previous studies, occupancy predication normally involves expertise in both data analytics and machine-learning algorithms. Dong et al. (2011) introduced a method involved four main steps: (1) collect environmental sensor data, (2) extract features from the data, (3) select the most relevant features, and (4) input the selected features to machine learning algorithms. In Ubiquitous Computing, few studies have explored occupancy presence prediction using models such as Recurrent Neural Network (Das & Kjærgaard, 2019). The high demand for expertise in complicated algorithms has made this type of information less accessible for facilities management practices in the industry. To fill this gap, this study presents a case study exploring a new method for future space projection based on existing space use patterns measured by sensor technologies.

2 Methodology

2.1 Data collection and analysis

The case study focuses on a relatively small office of a financial institution located in Canada. The office space had an approximate area of 800 m2 (8,611 ft2) and 79 individual workstations, along with open and enclosed collaboration areas. There were 15 meeting rooms in the office, with a combined total capacity of 56 seats. These meetings rooms occupied an area of 183.4 m2 (1,974 ft2). The data was taken from motion sensors (brand MySeat) attached to the seats within these meeting rooms, and these sensors recorded minute-by-minute seat occupancy data (Figure 1). MySeat's proprietary software automatically filters out any temporary motion detected during the office cleaning process, such as chair movements.

Figure 1. Occupancy sensors allocated under the seat



Data was collected every minute for ten consecutive working days. Typically, data recording occurred from 7:00am until 7:59pm. However, an exception was made on Day 4, where recording extended until 11:59pm. That totals 8,040 minutes (rows) of occupancy data (Table The intention for workplace strategists and designers in a case like this is to be able to generate tangible results for the end-users in the shortest time possible. Given these time constraints, the aim is to collect data for short periods of time and then use mathematical models to simulate additional periods. Occupancy data were logged in a matrix table using MS Excel. The variables included are: date, time of recording (by minute), day (1 to 10), meeting room name, and occupancy status.

Table 1. Table format used to collect and process the occupancy data

Recording Time			**Meeting Rooms Occupancy**													
Date	**Time**	**Day**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	***N***	***O***
Seat Capacity			4	2	2	5	1	8	8	1	4	3	4	4	3	3	4
17/6/2019	9:01:00 AM	1	1	0	0	0	0	0	…	…	…	…	…	…	…	…	…
17/6/2019	9:02:00 AM	1	2	0	1	0	0	1	…	…	…	…	…	…	…	…	…
17/6/2019	9:03:00 AM	1	2	2	2	1	3	0	…	…	…	…	…	…	…	…	…
17/6/2019	9:04:00 AM	1	0	0	2	0	3	4	…	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…

From the total of 8,040 minutes (rows) of occupancy data, 47.3% of the time (3,802 minutes), at least one meeting room was occupied, while 52.7% (4,238 minutes) of the time, all meeting rooms were unoccupied. From Table 2, we can note that on Day 10, no meeting rooms were occupied at any

recorded times, while on Day 3, at least one meeting room was occupied almost all day. From the data recorded, the peak occupancy (8 seats occupied) observed was in Rooms F and G (with eight seat capacity for both rooms).

Table 2. Count of minutes that recorded occupancy in any room.

Day number	Day of the Week	Count of minutes recorded	Count of minutes kept for the analysis	Count of minutes kept for the analysis
1	Monday	780	587	75.3%
2	Tuesday	780	75	9.6%
3	Wednesday	780	777	99.6%
4	Thursday	1020	481	47.2%
5	Friday	780	210	26.9%
6	Monday	780	581	74.5%
7	Tuesday	780	377	48.3%
8	Wednesday	780	595	76.3%
9	Thursday	780	119	15.3%
10	Friday	780	-	0.0%
Total		**8040**	**3802**	**47.3%**
Average		**804**	**422**	**-**

Prior to conducting simulations, all data points (minutes) where all rooms were unoccupied (4,238 instances) were excluded from the dataset, so the simulations only considered data in which at least one room was occupied. This step was taken to prevent the overconservative outcomes that typically arise in simulations, which can erroneously trend toward zero occupancy. The Markov Chain Monte Carlo (MCMC) model was used to run these simulations, using Python. There were two variables used: the period (minutes recorded) and the occupancy recorded at each given period.

On average, the number of minutes in which at least one meeting room was occupied was 380. To extend our understanding of occupancy patterns beyond the observed data, 1,000 periods were simulated, which would be close to expanding by 3 days the timeframe period of 10 days originally recorded. This simulated occupancy allows us to expand the amount of data available to determine the optimal size of the meeting rooms and reduce the uncertainty associated with potential over- or under-occupancy.

2.2 Meeting room optimization

The following considerations were reflected in order to find the optimal size and distribution of meeting rooms:

Consideration 1: Identify the size of meeting rooms. Meeting rooms come in standardized sizes 2, 4, 6, and 8 seats capacity. This analysis considers 8 seats as a maximum capacity requirement, but this will also depend on the requirements of users.

Consideration 2: Identify the size of meeting rooms suitable for each meeting size. A meeting room should be suitable to hold any meeting size, from 0% up to 100% of its capacity. In other words, if a meeting is held by two people, then there are four options of meeting room size: 2, 4, 6, or 8 seats (8 seats is the maximum capacity in any room in this specific case study). If a meeting is held by six people, then the two options of meeting room size would be 6 or 8 seats. This step is necessary to guarantee a level of comfort to users and efficiency, in which rooms larger than the number of occupants can be used, without having to create rooms for each discrete meeting size.

Consideration 3: Identify the occupancy or size of meetings occurring. This was given by the data recorded and simulated previously.

Consideration 4: Identify meetings occurring simultaneously. This step is necessary to identify the required number of meeting rooms needed, which is essential for optimization. To identify the meetings occurring simultaneously, two levels of analysis were created to narrow and simplify the analysis:

- ***Level 1*** grouped meeting sizes as follows:

Group 1.1: 1 to 2 people
Group 1.2: 3 to 4 people
Group 1.3: 5 to 6 people
Group 1.4: 7 to 8 people

- ***Level 2*** narrowed the grouping of simultaneous meetings as follows:

Group 2.1: 1 to 8 people
Group 2.2: 4 to 8 people
Group 2.3: 5 to 8 people

3 Results

3.1 Simulation outcomes

The simulated data for each room exhibits a similar rate of occupancy to the original data. For the original data, rooms were occupied 31% of the periods recorded (after eliminating all the periods when all the rooms were empty) on average, and in the simulated data, the average was 32%. Larger rooms with a capacity of 5 to 8 seats were occupied more time, averaging 34% of the periods recorded in the original data and 36% in the simulated data, compared to smaller rooms with a capacity of 1 to 4 seats, which were occupied 30% and 31%, respectively.

Level 1 Grouping: This analysis identified that the most common meeting size was between 1 and 2 people, accounting for 98% of all recorded and simulated periods recorded. As the size of the meetings increased, from 3 to 8 people, the likelihood of such meetings occurring simultaneously decreased significantly; only 4 simultaneous meetings occurred with 3 to 4 people, 2 meetings with 5 to 6 people, and only one meeting at a time with the size of 7 to 8 people. Based on the Level 1 Grouping analysis, it is concluded that at least 14 meeting rooms are necessary to accommodate the observed patterns of use (Table 3).

Table 3. Level 1 grouping of meetings happening simultaneously

	Count of meetings			
Max. count of simultaneous meetings	**1 to 2**	**3 to 4**	**5 to 6**	**7 to 8**
Total (data recorded and simulation)	14	7	2	2
Data recorded	10	7	2	2
Simulation	14	4	2	1

Level 2 Grouping: This second level analysis builds upon the initial findings, further defining the capacity requirements for the 14 meeting rooms identified in Level 1. The first constraint is given by the largest meetings expected to be held: 8-seat meeting room. From Level 1's analysis, it is evident that at least two meeting rooms of 8 seats are necessary (Table 4). Level 1 suggests two meeting rooms of 5 to 6 seats and seven meeting rooms of 3 to 4 seats (Table 3). However, Level 2 Grouping allows for further optimization based on actual usage data; the analysis shows that only seven simultaneous

meetings involving 3 to 8 people, indicating that the two 6-seat meeting rooms would not be required. This is possible assuming smaller meetings can still be held in larger meeting rooms. Eliminating these two meeting rooms of 6 seats can optimize the usage of space, reducing both the required square footage and the variability in room sizing during construction and renovation. Consequently, the most frequent meeting sizes, consisting of 1 to 2 people, can be hosted flexibly in any meeting rooms with capacity ranging from capacity 2 to 8 seats.

Table 4. Level 2 grouping of meetings happening simultaneously

	Count of meetings		
Max. count of simultaneous meetings	**1 to 2**	**3 to 8**	**7 to 8**
Total (data recorded and simulation)	14	7	2
Data recorded	13	7	2
Simulation	14	4	1

3.2 Space program

Based on the outcomes derived from Levels 1 and 2 analyses, the space program of meeting rooms for the office can be optimized (Table 5). This represents a reduced amount of area required, which in turn will decrease the resources needed, such as built walls, glass partitions, acoustic insulation, furniture, carpets, and audio-visual/video conferencing (AV/VC) equipment for each room. Given the relatively small size of the office, the optimized layout can yield a modest improvement, with approximately a 5% reduction in the total meeting area required and a 4% reduction in the number of seats needed (Table 5).

Table 5. Space programming

Meeting Room			Original				Optimized			
Capacity (Pax)	Unit Area (sqm)	Unit Area (sqft)	Quantity	Seatcount	Area (sqm)	Area (sqft)	Quantity	Seatcount	Area (sqm)	Area (sqft)
1	**2.3**	24.2	2	2	4.5	48.4		0	-	-
2	**8.0**	86.1	2	4	16.0	172.2	5	10	40.0	430.6
3	**13.0**	139.5	3	9	38.9	418.5		0	-	-
4	**13.0**	139.5	5	20	64.8	697.5	7	28	90.7	976.5
5	**16.2**	174.4	1	5	16.2	174.4		0	-	-
6	**16.2**	174.4	0	0	-	-		0	-	-
7	**21.5**	231.4	0	0	-	-		0	-	-
8	**21.5**	231.4	2	16	43.0	462.8	2	16	43.0	462.8
TOTAL			**15**	**56**	**183.4**	**1,973.9**	**14**	**54**	**173.7**	**1,869.9**

4 Discussion

The findings of this study reveal important implications for the design and utilization of meeting rooms in office environments. The data collected from motion sensors provides a detailed account of meeting room occupancy over a concise observational period of ten days. Notably, the occupancy data, collected at the minute level and cleaned of non-useful information (i.e., periods/times when all meeting rooms were unoccupied), served as the foundation for subsequent simulations using the MCMC method. Our analysis indicates that, on average, the rooms were occupied 31% of the recorded periods, which remained relatively stable in the simulation outputs at 32%. The simulation extended the dataset by approximately three days, enhancing the understanding of occupancy patterns without the need for prolonged data collection. This highlights the potential use of the MCMC method for

delivering timely results for stakeholders, including corporate real estate/facility directors, workplace strategists, and designers.

Level 1 and 2 analyses provided refined space requirements and proposed tailored room capacities and the number of required meeting rooms that align with actual usage patterns. This strategic planning can lead to more efficient use of office spaces and resources, potentially reducing the required square footage by approximately 5% and seating capacity by 4%. Considering the small office size for this case study, the impact of such reduction could be substantial for large office buildings and an organization's real estate portfolio. Additionally, the optimized space programming, which included three variations in room sizes (2, 4, and 8 seat capacities), brings standardization and efficiency in design and resource allocation compared to original meeting room variations (1, 2, 3, 4, 5, and 8 seat capacities). It should be noted that meeting room features and other office environmental characteristics were not considered as variables or factors contributing to usage.

5 Conclusion

This study explored simulation methods based on data collected by environmental sensors to provide useful occupancy projection information for future space programming and optimization. It contributes to practices for future office space demand forecasting, which is now an essential question for organizations and commercial real estate owners (Miller, 2014). Our results show impressive estimation accuracy after using our proposed MCMC model. In future works, we will attempt to further improve the performance of the occupancy estimation method by incorporating other space use information, such as headcounts, space size, function, and other environmental features.

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Integrating Organisational Culture, Organisational Structure, and Office Layout: A Systematic Review of the Literature

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ABSTRACT

Purpose: Integrating organisational structure and organisational culture in the design of office layouts can enhance organisational performance. Previous studies have explored the relationship between layout and culture, although few contributions addressed their connection with organisational structure. This systematic literature review addresses this gap in workplace research by examining the interplay between organisational culture, structure, and office layouts. **Method:** Following the PRISMA methodology for systematic reviews, Mintzberg's organisational structure framework was adopted as the starting point. Content analysis allowed synthesising relevant variables, methods, and theories. **Results:** 13 papers addressing relationships between structure, culture, and layout were identified. Organisational culture plays a pivotal role in influencing various organisational structure variables in workplace environments, and conversely, organisational structure variables contribute to shaping organisational culture. Furthermore, office layout variables may also influence structure and culture. However, our findings underscore the contextual nature of these relationships. The limited number of papers and prevalence of case studies constrain the generalisability of the findings. **Originality:** The study emphasizes the need for future research to delve into the interplay between organisational structure and culture in office layout design, particularly in addressing issues of communication, individual job characteristics, organisational change, productivity or innovation in the workplace. Moreover, more research is required to determine the direction of relationships between variables. Ultimately, this study contributes to establishing a foundation for integrating organisational structure, culture, and office layout in workplace design, while achieving alignment with organisational strategy.

Keywords
Organisational culture, Organisational structure, Office layout, Workplace, Systematic literature review.

1 INTRODUCTION

Organisational culture constitutes the firm's history, guiding newcomers' behaviour, while fostering employee commitment to management philosophy (Nanayakkara & Wilkinson, 2021). In turn, organisational structure reflects the configuration of the organisational system, formally established relationships, information flows, and work processes (Martínez-León & Martínez-García, 2011). Organisational culture and structure are closely intertwined (Chión et al., 2020; Zheng et al., 2010), and must be aligned towards intended organisational outcomes (Ehrhart & Schneider, 2016).
This alignment extends to workplace design (Heywood & Arkesteijn, 2017), since organisational culture manifests at different levels, including observable artefacts like office layouts (Schein, 1985), which influence employees´ satisfaction and performance (Maślikowska & Gibbert, 2019). Moreover, organisational structure constitutes a component of workplace design (Margaritis & Marmaras, 2007), and when aligned with office layouts, can enhance communication (Allen, 2007), and productivity (Sailer & Thomas, 2020). For instance, Nanayakkara et al. (2021) found that hierarchical cultures, characterised by high centralisation of decision-making (Cameron & Quinn, 2006), were associated with traditional office layouts to foster coordination, control, and internal efficiency. Conversely, clan cultures, outlined by centralisation and inter-team collaboration (Ibid), favoured activity-based work (ABW) offices, offering flexibility and autonomy (Nanayakkara et al., 2021).
Previous research has thus already explored relationships between organisational culture and layout, or layout and organisational structure, however, the number of studies is very limited. In addition, there is hardly an understanding of how to clearly and simultaneously integrate both culture and structure in workplace layout design.
This paper aims to comprehensively explore this three-way relationship by a systematic review of existing literature, drawing out the main theories, methodologies, variables, relationships between variables, and research gaps from the selected contributions.

2 INDICATORS FOR ORGANISATIONAL CULTURE, STRUCTURE, AND OFFICE LAYOUT

Organisational culture determines how members approach work-related behaviour, while organisational structure provides the framework through which such behaviour is coordinated and executed. Schein defines organisational culture as the "pattern of shared basic assumptions that a group learned as it solved its problems of external adaptation and internal integration that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems" (1985, p.17).
In turn, Mintzberg (1980) argues that organisational structure divides work processes into tasks achieving coordination between them, whereas coordination involves integrating work activities across organisational units (Yang et al., 2022).
Mintzberg´s framework differentiates several organisational structure variables:

- Centralisation concerns the decision-making system and distribution of power (Mintzberg, 1980);
- Complexity can be horizontal or vertical; Horizontal complexity describes the number of organisational units, and vertical complexity outlines the number of vertical levels (Pérez-Valls et al., 2019);
- Formalisation is the degree to which behaviour follows norms and rules (Yang *et al.*, 2022);
- Indoctrination involves formal processes to embed a particular organisational culture (Martínez-León and Martínez-García, 2011);
- Integration measures the interrelatedness between organisational units (Chen and Huang, 2007);
- Liaison devices involve mechanisms that foster informal communication, surpassing organisational boundaries (Mintzberg, 1980);
- Planning and control are mechanisms adopted to set, control, and achieve organisational goals (Ibid);
- Specialisation determines the number of tasks and their breadth for a specific job (Martínez-León and Martínez-García, 2011);
- Training regards standardisation of skills and knowledge (Mintzberg, 1980);
- Unit grouping refers to the criteria for arranging organisational units (Lee *et al.*, 2015);
- Unit size entails the number of individuals or units grouped into another unit (Mintzberg, 1980).

Along with synonyms, these therefore constitute the organisational structure and culture indicators adopted for the search strategy (see Table 1).

Table 1. Indicators for Organisational Structure and Culture

Centraliz/sation	Hierarchical (…):	- System
Complexity	- Configuration	- Type
Decentraliz/sation	- Level	- Unit
Departmentaliz/sation	- Structure	Structural (…):
Differentiation	(…) Organiz/sation:	- Arrangement
Formaliz/sation	- Social	- Configuration
Indoctrination	- Structural	- Design
Integration	- Structuring of	- Form
Interdependence	- Work	- Organiz/sation
Liaison devices	Organis/zational (…):	(…) Structure:
Planning and control	- Affiliation	- Cultural
Span of control	- Arrangement	- Corporate
Span of management	- Bound*	- Formal
Specializ/sation	- Chart	- Governance
Training	- Climate	- Hierarchical
Unit grouping	- Configuration	- Internal
Unit size	- Culture	- Leadership

Bureaucracy	- Form	- Management
(…) Configuration:	- Hierarchy	- Network
- Hierarchical	- Setting	- Social
- Organiz/sational	- Structure	- Work
- Structural	- Structuring	Structure of organiz/sations

Office layout involves the arrangement of workplaces and type of boundaries in an office (De Croon et al., 2005). Existing layout frameworks (e.g., Duffy & Powell, 1997) offer useful but not comprehensive lists of indicators. Therefore, Gjerland et al.'s (2019) search terms for office concepts were adopted (see Table 2).

Table 2. Indicators for Office Layout

Activity based office	Enclos* office	Office landscape
Activity based flexible office	Flex* office	Office layout
Activity flexible office	Free seating	Office type
Activity-related office	Hot desking	Open plan office
Agile office	Innovative office	Open workplace
Bürolandschaft	Integrated workplace concept	Open workspace
Cell office	Landscaped office	Open* office
Cellular office	Lean office	Shared office
Closed office	Multi-person office	Shared-room office
Cocoon concept	Non territorial office	Spatial structure
Cocoon office	Non territorial workplace	Team office
Combi office	Non territorial workspace	Workplace concept
Concentration office	Office concept	Workspace concept
Concentration workplace	Office design	Workplace layout
Desk-sharing	Office innovation	Workspace layout

3 METHOD

This review followed PRISMA guidelines, ensuring comprehensive and transparent reporting of results (Liberati et al., 2009). Initially, two separate search queries were formulated with indicators from tables 1 and 2, using Boolean operator OR. Then, they were combined using Boolean operator AND. Articles were obtained from Scopus and Web of Science, where indicators had to appear in titles, abstracts or keywords. Unrelated fields were excluded (e.g. biology). Searches took place in March-April 2023, yielding a total of 2144 items. Duplicate papers were detected using Zotero (n=350), leaving 1794 unique papers.

Study selection criteria included:

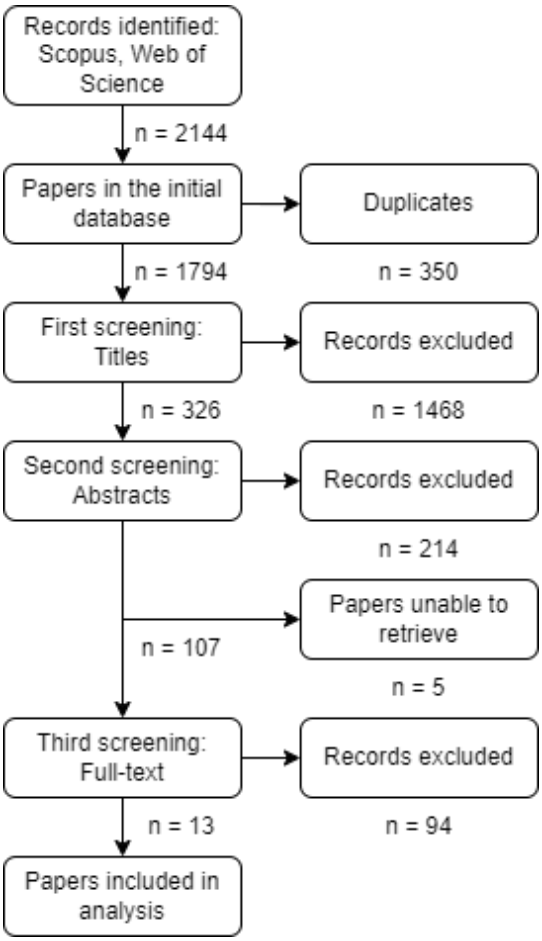
- Empirical studies only, excluding theoretical or opinion papers, historical overviews, and conference proceedings.
- Studies must report outcomes related to organisational structure, culture, and layout.
- Units of analysis were individuals or organisations occupying workplaces.

- Study settings were physical offices, excluding settings focusing on the home workplace.
- Articles were written in English and published in scientific journals.

Selection criteria were applied at all screening stages. If a particular criterion was unclear, the paper advanced to the next phase. The initial screening phase yielded 326 articles after examining titles. In the second phase, 112 articles remained after scanning abstracts. Five papers could not be retrieved, leaving 107 items. After full-text examination, 13 papers remained for analysis (see Figure 1). Data was analysed using a Microsoft Excel charting form, and synthesized into the following categories:

- General study information: title, authors, journal, publication year, and country.
- Research design, time frame, and methodologies adopted.
- Organisational structure variables.
- Office layout variables.
- Organisational culture variables.
- Relationships between variables.

Figure 1. Screening process



4 RESULTS

4.1 General paper information

Table 3 displays the final selection of articles, encompassing studies from 11 different countries and 12 distinct journals.

Table 3. Final list of articles

Authors	Journal	Country
(Nanayakkara et al., 2021)	Journal of Management & Organisation	Australia
(Ferguson et al., 2020)	Child & Family Social Work	UK
(Smollan & Morrison, 2019)	Journal of Organisational Change Management	New Zealand
(Göçer et al., 2018)	Ergonomics	Turkey
(Nenonen & Lindahl, 2017)	Journal of Facilities Management	Finland, Sweden
(Skogland, 2017)	Journal of Corporate Real Estate	Norway
(Zerella et al., 2017)	Journal of Environmental Psychology	Australia
(Brown et al., 2010)	Facilities	Canada
(Kim & Juan, 2011)	African Journal of Business Management	N/A
(Martens, 2011)	Facilities	UK, Netherlands
(Thanem et al., 2011)	International Journal of Work Organisation and Emotion	Sweden
(McElroy & Morrow, 2010)	Human Relations	USA
(Koch, 2003)	Engineering, Construction and Architectural Management	Denmark

4.2 Research approaches

Qualitative methods were adopted in 54% of papers, while quantitative and mixed methods each represent 23% of articles. The majority adopted case study strategies (69%), followed by survey research (31%). Cross-sectional studies comprised 77% of articles, with longitudinal research representing the remaining 23%. Semi-structured interviews were performed in 62% of studies, followed by questionnaires (42%), and ethnographical studies (31%). Finally, the unit of analysis involved employees (38%), organisations (31%), workplaces (23%), and organisational units (8%).

Table 4. Summary of methodological choice. Frequencies (percentages)

Methodological choice	Quantitative	3 (23%)
	Qualitative	7 (54%)
	Mixed Methods	3 (23%)
Research strategy	Case Study (single and multi-case studies)	9 (69%)
	Survey Study	4 (31%)
	Ethnographical Study	1 (8%)
	Experimental Study	1 (8%)
Time Horizon	Cross-sectional	10 (77%)
	Longitudinal	3 (23%)
Data gathering techniques	Semi-structured interviews	8 (62%)
	Questionnaire	6 (46%)
	Ethnographical studies	4 (31%)
	Company documents	3 (23%)
	Secondary data	2 (15%)
	Location tracking	1 (8%)
	Focus groups	1 (8%)
Unit of analysis	Employees	5 (38%)
	Firm/organisation	4 (31%)
	Workplace	3 (23%)
	Organisational unit	1 (8%)

4.3 Theories

A total of 21 theories, models, and frameworks were identified. In particular, some theories were of special interest:

- Theories connecting layout and structure. In relation to formal work processes, Wallas' Four-staged Creative Process Theory (Martens, 2011) outlines creative work stages, the Trumpet Model of Product Development Process (Ibid) details product development phases, whereas the Flow-state Model (Ibid) explains a specific state in creative work. These were linked to specific spatial settings supporting each phase, or state. The Cost and Benefits Model (Ibid) suggests that physical workplaces enhance work processes and organisational performance. In turn, Foucaultian Theory (Thanem et al., 2011) highlights how hierarchical observation in open plans facilitates exerting power over individuals. In this regard, De Certeau's Theory of Tactics (Ibid) explains how employees navigate within a structured and controlled environment defined by rules. Through the use of tactics, individuals use and adapt office layouts to resist and subvert such environments.
- Theories linking layout and culture. Davis' physical settings framework (McElroy & Morrow, 2010), along with Schein´s organisational culture theory (McElroy & Morrow, 2010; Skogland, 2017; Smollan & Morrison, 2019) outlined office layout´s capabilities for expressing cultural values, beliefs, and assumptions. Cameron and Quinns' Competing Values Framework (Nanayakkara et al., 2021; Zerella et al., 2017) categorises cultural typologies, which are related with office typologies. Furthermore, Lewin's 3-stage Model of Organisational Change (McElroy & Morrow, 2010; Skogland, 2017), which distinguishes steps in organisational change, is linked to office layout's ability to freeze or unfreeze cultural patterns.

- Theories relating structure and culture. Systemic theory (Ferguson et al., 2020) views work influenced by culture, social structure, and other factors, as work processes cannot be reduced to the single influence of office layout design. Also, Leavitt's Model of Organisational Subsystems (Kim & Juan, 2011) describes organisations in terms of interconnected parts, including technology, structure, people, and culture.
- Last, Koch's Knowledge Management Model (Koch, 2003) argues that organisations can manage knowledge through organisational structure, office design, and culture, among other elements.

4.4 Variables identified

Table 5 displays all 21 office layout variables identified. Among these, "office type" is found in 11 studies, comprising 8 flexible settings, 4 open offices, 2 combi offices, and 1 private office. "Function of settings", identified in 10 papers, regards the intended work activity that each setting accommodates. "Spatial eligibility", covered in 8 studies, determines the allocation criteria of organisational units and individuals within office layouts. However, variables such as "layout shape", or "spatial zoning" received limited attention.

Table 5. Office layout variables

Office layout variable	Frequency
Office type	11
Function of settings	10
Spatial eligibility	8
Image / Symbolic value	7
Desk ownership / Hot-desking	6
Openness	6
Spatial proximity / Co-location	6
Diversity of spatial settings	4
Flexible settings	4
Number of occupants / Density	4
Customisation	3
Vertical separations	3
Number of floors	2
Office area	2
Workstation design	2
Layout shape	1
Plants & Greenery	1
Spatial accessibility	1
Spatial zoning	1
Standardisation	1
Windows / Natural light	1

Organisational culture variables were categorised into descriptors of culture and cultural typologies. Typologies classify organisations based on common characteristics that provide a broad lens for understanding organisational cultures. For instance, collaborative, individualistic, and hierarchical cultures were each identified in 4 studies, with egalitarian cultures being described in 3 papers. In turn,

descriptors of culture referred to specific attributes of culture, that may describe overarching cultural typologies. In this regard, most studies regarding the office layout as a cultural artefact that symbolises culture. Other descriptors of culture were less frequently addressed. In total, 15 descriptors of culture, and 14 cultural typologies were identified (see Table 6).

Table 6. Organisational culture descriptors and typologies identified

Descriptors of culture	Frequency	Cultural typologies "(...) culture"	Frequency
Cultural artefact/symbol	9	Collaborative	4
Formalisation	3	Hierarchical	4
Team / organisational identity	3	Individualistic	4
Attachment / sense of belonging	2	Egalitarian	3
National / local culture	2	Clan	2
Support	2	Adhocracy	1
Trust	2	Collective	1
Fairness	1	Confidentiality	1
Flexibility of management	1	Creative	1
Individual identity	1	Fixed-flexible	1
Innovation	1	Knowledge-sharing	1
Organisational climate	1	Market	1
Organisational commitment	1	Performance-oriented	1
Power distance	1	Supportive	1
Professional control / autonomy	1		

Organisational structure variables remained the same as in section 2, with the addition of the informal structure, organisational flexibility, and job characteristics (see Table 7). Integration was addressed in most studies, followed by liaison devices, planning and control, and unit grouping.

Table 7. Organisational structure variables

Organisational structure variables	Frequency
Integration	9
Liaison devices	6
Planning and control	6
Unit grouping	6
Formalisation	5
Centralisation	4
Complexity (horizontal and vertical)	4
Job characteristics	4
Indoctrination	3
Specialisation / job type	3
Organisational flexibility	2
Training	2
Unit size	2
Informal structure	1

4.7 Integrating organisational structure, culture, and office layout variables

The office layout constitutes a cultural artefact capable of symbolising organisational culture (e.g. Brown et al., 2010; Göçer et al., 2018; Koch, 2003). Dichotomies such as flat or egalitarian versus hierarchical, or collective versus individualistic cultures were helpful to elucidate differences, as some layout characteristics favoured specific cultural types. For instance, hierarchical cultures were supported with customisation of work settings (Göçer et al., 2018), desk ownership (Brown et al., 2010), and differentiation of settings (Zerella et al., 2017). Flat or egalitarian cultures were defined by flexible settings (Nanayakkara et al., 2021), definition of spatial settings according to function (Brown et al., 2010), open-plans (McElroy & Morrow, 2010; Skogland, 2017), and diversity of spatial settings (Skogland, 2017). Some office types fostered particular cultures, such as ABW offices for clan cultures (Nanayakkara et al., 2021). Collaborative cultures were more commonly associated with open-plan settings as opposed to cubicles (Smollan & Morrison, 2019), and ABW offices fostered clan cultures, that involved a high degree of professional control -i.e. autonomy- (Nanayakkara et al., 2021). Table 8 displays all relationships identified between office layout variables and cultural descriptors and typologies.

Table 8: Office layout – Organisational culture relationships. Frequencies above 1 in parenthesis

Layout variables	Culture descriptors	Cultural typologies
Customisation	Cultural artefact (2), Individual identity (2)	Hierarchical (2), Individualistic
Desk ownership / Hot-desking	Cultural artefact (2), Individual identity, Power distance	Clan, Hierarchical (2), Individualistic
Flexible settings	Fairness, Support, Trust	Clan, Creative, Egalitarian / Flat, Fixed-flexible, Performance-oriented
Function of space		Clan, Collaborative (2), Creative, Egalitarian / Flat
Image / Symbolic value	Cultural artefact (9)	Collaborative, Collective, Creative, Egalitarian / Flat
Number of occupants / Density		Collaborative
Office type	Cultural artefact, Support	Clan, Collaborative (2), Egalitarian / Flat, Supportive
Openness (and visibility)	Cultural artefact, Formalisation, Innovation, Professional control	Clan, Collaborative (3), Collective, Confidentiality, Creative, Egalitarian / Flat (5), Performance-oriented
Spatial accessibility	Cultural artefact	Collective, Egalitarian / Flat
Spatial differentiation / Workstation equality	Cultural artefact, Power distance	Collective, Clan, Egalitarian / Flat, Hierarchical (2)
Spatial eligibility		Collaborative, Knowledge-sharing
Spatial proximity / Co-location	Attachment, Team identity, Trust	Clan, Collaborative, Creative, Egalitarian (2)
Spatial zoning	Team identity	
Vertical separations		Collaborative
Windows / Natural light		Collaborative

Office layout variables also supported organisational structure, to enable the functioning of the work system (Ferguson et al., 2020). In particular, vertical complexity -i.e. hierarchical levels- was reinforced by desk ownership (Nenonen & Lindahl, 2017), and spatial allocation (Smollan & Morrison, 2019). Conversely, vertical complexity is undermined by adopting open-plan layouts (Ibid), or increasing spatial proximity (Skogland, 2017). Liaison devices, which foster communication beyond the formal structure, were facilitated by implementing hot-desking (Thanem et al., 2011), or ABW offices (Nanayakkara et al., 2021). Integration, or formal communication across different organisational units, was enabled through allocating teams in proximity (Ferguson et al., 2020), and increasing openness (Martens, 2011). Planning and control were perceived as a challenge in flexible settings (Kim & Juan, 2011), but facilitated in open-plan settings (McElroy & Morrow, 2010). Furthermore, formalisation -i.e. rules determining behaviour- increased in open-plan (Ibid), and flexible settings (Kim & Juan, 2011), to enable flexible ways of working. Table 9 displays all relationships identified between office layout and organisational structure variables.

Table 9: Office layout – Organisational structure relationships. Frequencies above 1 in parenthesis

Layout variables	Structure variables
Customisation	Job characteristics
Desk ownership / Hot-desking	Vertical complexity, Informal structure, Liaison devices, Organisational flexibility, Planning and control (3)
Flexible settings	Formalisation, Informal structure, Job characteristics, Organisational flexibility, Planning and control (2), Specialisation
Function of settings	Integration, Specialisation
Image / Symbolic value	Horizontal Complexity, Formalisation (2), Liaison devices
Layout shape	Liaison devices
Number of floors	Integration, Liaison devices
Office type	Centralisation, Formalisation (2), Integration (2), Liaison devices, Planning and control, Unit size (2)
Openness (and visibility)	Vertical complexity, Formalisation (2), Informal structure, Integration (4), Liaison devices (2), Planning and control (3), Unit size
Spatial differentiation / Workstation equality	Vertical complexity (4), Informal structure, Job characteristics
Spatial eligibility (allocation criteria)	Vertical complexity (2), Integration, Liaison devices, Unit grouping (4)
Spatial proximity / Co-location	Vertical complexity, Integration (2), Liaison devices, Specialisation
Standardisation	Informal structure, Organisational flexibility

Relationships between organisational structure and culture are displayed in Table 10. Notably, formalisation was identified as a descriptor of both culture and structure (Brown et al., 2010). Multiple structural variables were claimed to affect organisational culture, including horizontal (Koch, 2003) and vertical (Nenonen & Lindahl, 2017) complexity, indoctrination (Nanayakkara et al., 2021), organisational flexibility (McElroy & Morrow, 2010), and planning and control (Ibid). Vertical complexity was extensively adopted as a descriptor of hierarchical cultures (e.g. Göçer et al., 2018), along with formalisation (Nanayakkara et al., 2021), or and planning and control. Conversely, flat/egalitarian cultures were defined by low vertical complexity (Koch, 2003), and high integration across

organisational units (Skogland, 2017). High integration (Smollan & Morrison, 2019), along with collaboration beyond the structure -i.e. liaison devices- (Thanem et al., 2011), were typical of collaborative cultures, whereas individualistic cultures were defined by increased vertical complexity (Brown et al., 2010). In creative cultures, non-adherence to rules is common, requiring low formalisation and flexible workplace arrangements that allow for self-expression (Martens, 2011).

Table 10: Organisational structure – Organisational culture relationships. Frequencies above 1 in parenthesis

Organisational structure variables	Culture descriptors	Cultural typologies
Centralisation	Power distance	
Complexity (horizontal)	Overall culture	
Complexity (vertical)	Cultural artefact (4), Overall culture	Clan, Egalitarian / Flat (2), Hierarchical (3), Individualistic
Formalisation	Formalisation, Team identity, Overall culture (2)	Egalitarian / Flat, Hierarchical, Knowledge-sharing
Indoctrination	Overall culture	
Integration	Cultural artefact, Team identity	Clan, Collaborative (4), Egalitarian / Flat (3), Knowledge-sharing
Job characteristics		Egalitarian / Flat
Liaison devices	Team identity	Adhocracy, Clan, Collaborative (2), Egalitarian / Flat (2), Individualistic
Organisational flexibility	Flexibility of management, Innovation, Overall culture	Egalitarian / Flat
Planning and control	Cultural artefact, Power distance, Overall culture	Collaborative culture, Egalitarian / Flat, Hierarchical
Specialisation		Hierarchical
Unit grouping		Egalitarian / Flat, Knowledge-sharing
Unit size		Collaborative, Supportive

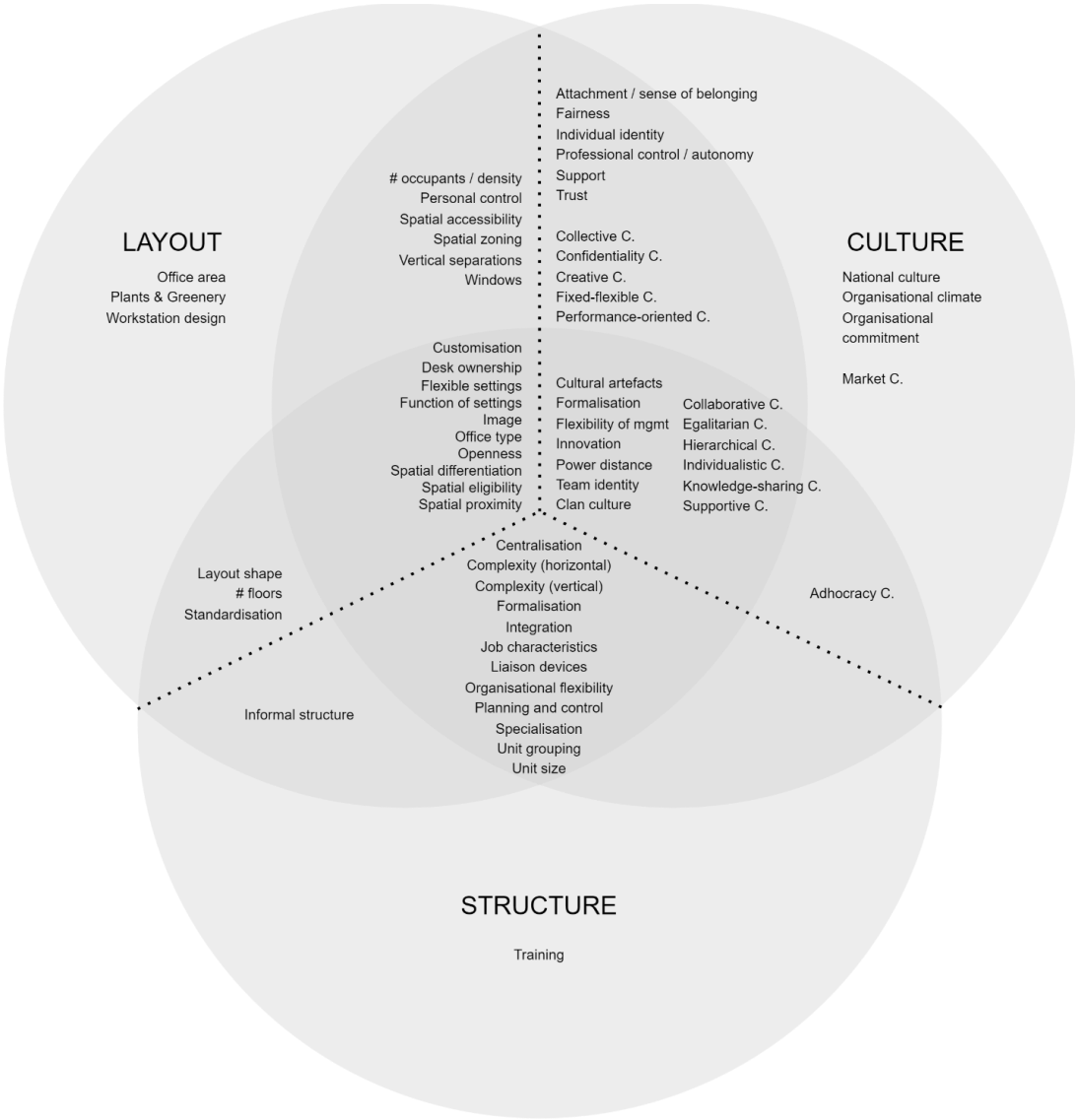
Relationships between organisational culture, structure, and layout are summarised in Figure 2, which illustrates a Venn diagram incorporating all identified variables, categorizing them into distinct areas based on their interrelations with variables from other categories. Areas without overlapping encompass identified variables that lack relationships with variables from other dimensions. Variables in the central region exhibit relationships with at least one variable of each respective dimension (e.g., openness is related with professional control and integration). Overlapping areas between two circles encompass variables associated with any number of variables from one different dimension.

5 DISCUSSION AND CONCLUSIONS

This systematic review identified 13 papers discussing the relationship between office layout, organisational structure, and organisational culture. Findings suggest that organisational structure contributes to shaping organisational culture, and vice versa. This is consistent with previous claims that organisational structure and culture are intrinsically interrelated (Chión et al., 2020; Zheng et al.,

2010). Moreover, results indicate that office layout must align with both culture and structure. This paper provides a foundation for integrating office layout, organizational structure, and culture, offering insights into how CRE strategy can align with organizational strategy (Heywood & Arkesteijn 2017).
However, search indicators addressing organizational culture were limited, and only 13 articles were identified. More variables and relationships between layout, structure, and culture may exist. Also, relationships between variables from the same dimensions were not taken into account: e.g. formalisation may affect integration; or national culture affects hierarchical culture.
Future research could delve into relationships between culture and layout, or layout and structure. Also, more empirical work is needed to identify potential relationships and variables, as well as direction of relationships, which are not addressed in this review. This could facilitate the development of a theory elucidating the interconnections among structure, culture, and layout.

Figure 2: Venn diagram of relationships across office layout, organisational structure, and organisational culture variables (C.=culture)



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Sustainability-oriented Employer Branding: Identifying Real Estate-Related Requirements of Employees

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ABSTRACT

In the current dynamic business environment, companies are faced with a wide range of economic and social changes. Through the ongoing war for talent, employer branding is becoming increasingly relevant for companies to attract and retain employees. Simultaneously, the change in social values leads to sustainability becoming a decisive criterion for many employees when choosing their employer. In response to these changes, many companies are focusing on a sustainability-oriented employer brand.

Corporate real estate (CRE) can contribute to the employer branding success by meeting the employee's sustainability requirements and communicating the sustainability-oriented employer brand. However, the increasing pluralisation of social values means that the sustainability orientations and employee requirements can differ greatly from one another. Therefore, companies and their corporate real estate management (CREM) must know their employer brand target group and which sustainability requirements they place on CRE.

The aim of the present study is to analyse these real estate-related sustainability requirements of employees. By examining the relevance of the respective sustainability dimensions (ecological, economic, social) from the employees' perspective, a "fit" between employee requirements and CRE can be established in order to contribute to successful employer branding. This study analyses survey data from $N = 937$ German office workers. Hierarchical cluster analysis is applied to identify employee groups and their assessment of the relevance of the sustainability dimensions in the real estate context.

The cluster analysis reveals a general importance of all three sustainability dimensions for the identified employee groups. However, user satisfaction and, thus, social sustainability are rated highest for all identified groups. The results suggest that the perception of sustainability-related impacts of office properties has a decisive influence on the employees' assessment. Thus, CREM can

positively influence the perception of the company's real estate as well as the company itself through sustainable action.

Keywords
Employer Branding, Sustainability, War for Talent, Corporate Real Estate Management

1 INTRODUCTION

With the ongoing "war for talent", i.e. the competition for qualified talent in the labour market, companies are faced with the challenge of differentiating themselves from their competitors to attract and retain qualified employees (Backhaus & Tikoo, 2004; Lievens & Slaughter, 2016; Monteiro et al., 2020). At the same time, a change in societal values, including a growing awareness of sustainability, combined with the privileged position of skilled workers in the labour market, has led to sustainability becoming an increasingly decisive factor for many employees when choosing their employer (Yasin et al., 2022; Coelho et al., 2022; Reis & Braga, 2016; Levin & Mamlok, 2021; Klimkiewicz & Oltra, 2017). In response to these changes, more and more companies focus on sustainability-oriented employer branding to increase their recruitment success (Ronda et al., 2018; Yasin et al., 2022; Muisyo et al., 2021).

Within employer branding efforts, corporate real estate (CRE) is increasingly receiving attention. By meeting employees' real estate-related needs and effectively communicating the (sustainability-oriented) employer brand through CRE, it holds tremendous potential to contribute to the employer branding success (Appel-Meulenbroek & Omar, 2021; Maier et al., 2022; Ronda et al., 2018; Pfnür et al., 2021). To utilise CRE within the war for talent, a "fit" between employee requirements, the employer brand and the resulting real estate strategy is essential (Appel-Meulenbroek & Omar, 2021; Khanna et al., 2013). A significant challenge in this regard is the increasing pluralisation of values and, therefore, the employees' individual sustainability orientation. Differences in values between generations and ongoing individualisation are leading to varying values and sustainability orientations among individual employees (Reis & Braga, 2016; Levin & Mamlok, 2021; Casalegno et al., 2022; Santos et al., 2017). They can be described by the differing focus on the social, ecological, and economic dimensions of sustainability (UN, 1987; Purvis et al., 2019). For companies and their corporate real estate management (CREM), this results in the challenge of identifying the sustainability requirements different employee groups place on CRE and, therefore, contribute to successful employer branding.

Although current research recognised the relevance of sustainability from an employee perspective within CRE as well as within employer branding (Ronda et al., 2018; Yasin et al., 2022; Muisyo et al., 2021; Lee, 2016; Feige et al., 2013), there is no specific examination of the sustainability-related requirements of different employee groups in the real estate context. Therefore, this study aims to examine real estate-related sustainability requirements to derive how CREM can contribute to successful employer branding. In addition, a distinction between different employee groups is made. For this purpose, an explorative analytical approach using hierarchical cluster analysis with N = 937 German office workers is applied to identify employee groups and their respective assessment of the relevance of the three sustainability dimensions (social, ecological and economic) in the real estate context. This study offers insights for further research into specific real estate-related attributes that

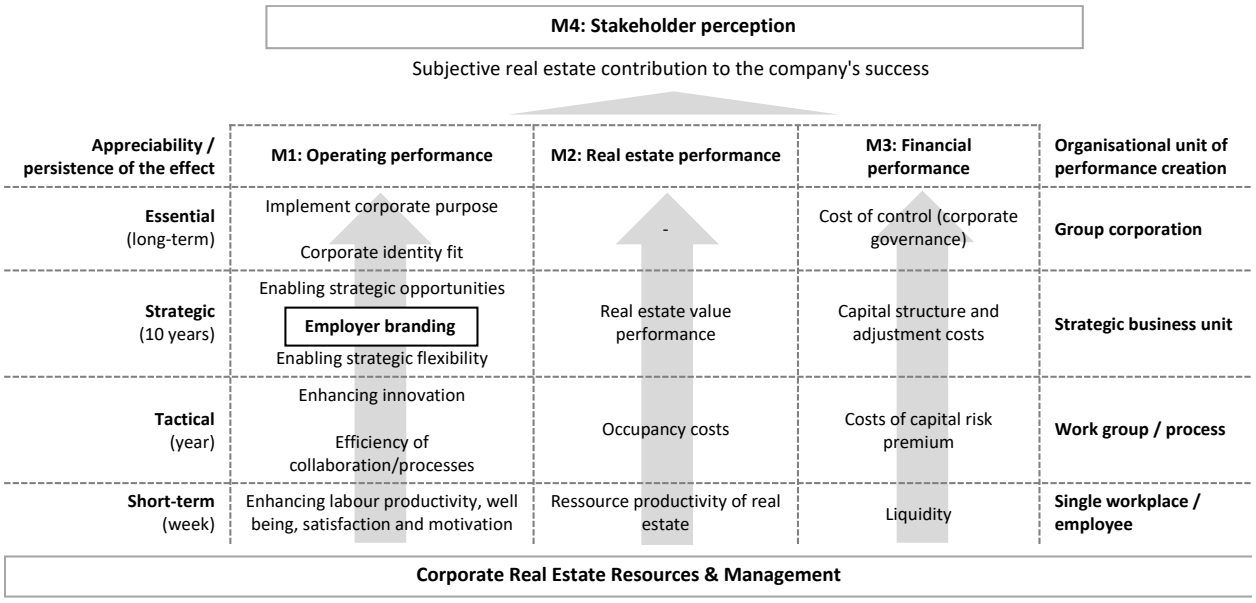
contribute to successful sustainability-oriented employer branding. Further, a theoretical basis for integrating CRE into employer branding efforts is provided.

2 Theoretical BackgrounD

2.1 Companies' Success and Corporate Real Estate Management

CRE and its management hold great potential to influence a company's success significantly. A variety of approaches to the success contribution can be found in the literature (e.g. Lindholm et al., 2006; Krumm & de Vries, 2003; Hill, 2001; Nourse & Roulac, 1993; Lindholm, 2008; Scheffer et al., 2006; Amos & Boakye-Agyeman, 2023), which Pfnür et al. (2021) combined into a holistic model that includes detailed success parameters and tested empirically. According to this holistic model, the origin of this contribution to success is based on various "performance drivers", which can be categorised into four different performance mechanisms (financial-, real estate-, operating performance and stakeholder perception, see Figure 1) (Pfnür et al., 2021). The operating performance is considered to have the most significant relevance in increasing companies' success (Pfnür et al., 2021). It encompasses all real estate-related performance drivers that contribute to an optimised cost-benefit ratio of the property by creating added value. In addition to operating performance drivers such as increasing labour productivity or enabling collaboration/processes, a particular relevant performance driver is the CREM's contribution to employer branding (Pfnür et al., 2021). This contribution of CREM to employer branding and, therefore, the company's success can be explained by various aspects, as explained below.

Figure 1. Corporate real estate management and its contribution to companies' success (own illustration, following Pfnür et al., 2021; Pfnür, 2019)



2.2 Determinants of Employer Branding

Ambler and Barrow (1996, p. 187) define the *employer brand* as "the package of functional, economic and psychological benefits provided by employment, and identified with the employing company". The employer brand is an integrative aspect of the corporate brand directed towards the labour market (Mokina, 2014; Moroko & Uncles, 2008). It creates an image of the company as an employer among (potential) employees (Lievens & Slaughter, 2016; Younis & Hammad, 2020; Backhaus & Tikoo, 2004). *Employer branding*, on the other hand, can be defined as a "process of building an identifiable and unique employer identity, and the employer brand as a concept of the firm that differentiates it from its competitors." (Backhaus & Tikoo, 2004, p. 502) This process includes the communication of the employer brand to current and potential employees (Backhaus & Tikoo, 2004; Figurska & Matuska, 2013). Thereby, the main objectives of employer branding are attracting and retaining (potential) employees (Dell, 2001; Backhaus & Tikoo, 2004).

Research findings indicate that employees are more likely to apply to a company when their inherent needs, values and preferences align with the envisioned benefits offered by the company (Botha et al., 2011; Saini et al., 2014). Thus, to attract and retain employees, it is crucial for companies to (1) identify the employee target group needs (Saini et al., 2014), "enabling companies to offer benefits in alignment with these needs" (Botha et al., 2011, p. 5) and (2) communicate the employer brand message that reflects those required benefits (Saini et al., 2014; Balmer & Gray, 1999). These two aspects are utilised in the following to examine the relationship between CRE and (sustainability-oriented) employer branding.

2.3 Corporate Real Estate Management and its Contribution to Sustainability-oriented Employer Branding

Regarding employee target group needs, employer branding attributes encompass a wide range, from salary to development opportunities and beyond (Maxwell & Knox, 2009; Jain & Bhatt, 2015). However, the physical working environment (e.g. workplace attributes) and, thus, CRE are receiving increasing attention in this context (Backhaus & Tikoo, 2004; Appel-Meulenbroek & Omar, 2021; Maier et al., 2022; Ronda et al., 2018). Similarly, sustainability-oriented attributes are also becoming increasingly relevant in the context of employer branding attributes, which once again emphasises the current importance of sustainability-oriented employer branding (Ronda et al., 2018; Yasin et al., 2022; Muisyo et al., 2021).

At the same time, a growing pluralisation of employees' values and needs (Reis & Braga, 2016; Levin & Mamlok, 2021) and a pluralisation of the employees' individual sustainability orientation can be observed (see, for example, Casalegno et al., 2022; Handayani et al., 2020; Klimkiewicz & Oltra, 2017). Therefore, it is expedient for companies to analyse the employees' sustainability-related needs according to different employee groups and differentiate those needs into individual focuses on the sustainability dimensions: social, ecological, and economic. Within employer branding, the technique of market segmentation is often utilised to address the segmented needs of different employee target groups (Moroko & Uncles, 2009; Botha et al., 2011). Consequently, it is crucial for CREM to identify the sustainability-oriented needs of employees they place on the CRE, segmented into the assessment of the importance of the user requirements (e.g. social dimension), the environmental (e.g. ecological

dimension) and economic sustainability requirements. In the context of CRE, social sustainability can be interpreted as a combination of well-being, user satisfaction, functionality and cultural aspects, which thus primarily addresses the user's requirements (Zimmermann et al., 2019; Larsen & Jensen, 2019; Wolf, 2020). Ecological sustainability refers to the protection of the environment and natural resources, while economic sustainability refers to the investment quality of the building, i.e. the optimisation of life cycle costs, the improvement of economic efficiency and the preservation of economic values (Zimmermann et al., 2019; Wolf, 2020). Thus, a "fit" between employee requirements, property strategy and the sustainability-oriented employer brand can be established.

Another aspect considered in this study, which explains the relationship between CRE and employer branding, is the communication of the sustainability-oriented employer brand. According to the signalling theory (Spence, 1973), companies can be considered as signallers that transmit a message, i.e. the employer branding attributes (signal), to (potential) employees (receivers) through signal channels to communicate the employer brand (Karanges et al., 2018; Yasin et al., 2022; Maier et al., 2022). These channels can be differentiated into primary, secondary and tertiary channels (Khanna et al., 2013; Balmer & Gray, 1999). The primary communication channel is focused on communication using the company's products or services and, therefore, the company's core activity. The secondary communication channel uses advertising and visual identification systems, e.g. logos or symbols, and the tertiary communication channel describes communication via verbal message transmission from third parties, e.g. word-of-mouth advertising (Khanna et al., 2013; Balmer & Gray, 1999). Following this approach, CRE belongs to the secondary communication channel as it enables a representation of the employer brand through visual elements such as architectural design or workplace characteristics (Khanna et al., 2013). Consequently, CRE can serve as a channel for communicating the employer brand signal to potential employees, highlighting the employer brand attributes and offered benefits and thus influencing the perception and expectations of the company as an employer. In communicating the sustainability-oriented employer brand, the perception of the sustainability-related impact of CRE, differentiated according to the three sustainability dimensions, is an essential factor in contributing to successful employer branding.
In order to adequately support sustainability-oriented employer branding, two key factors are therefore essential for CREM: (1) Identifying the employees' sustainability requirements on the property, differentiated according to social, ecological and economic sustainability requirements, and (2) identifying the employees' perception of sustainability-related effects of CRE.

3 Methodology

3.1 Data Collection

Data was collected through an online survey using the platform clickworker.de between September 20 and October 6, 2022, addressing German office workers. The answers obtained via crowdsourcing platforms can be considered reliable (Lutz, 2016). The study design utilised a closed, seven-point Likert scale (ordinal scale, ranging from 1 "strongly disagree" to 7 "strongly agree") and an interval scale (0% to 100%, in which the sum of corresponding items must be 100%) for most items. In total, 937 office workers completed the online survey. After data cleaning, whereby respondents were excluded due to

failed attention tests, 880 respondents remained in the sample. The sample consists of 45.1% male and 54.4% female respondents. The average age of the sample is 38.07 years (standard deviation=11.11), and the average household size is 2.4 persons (standard deviation = 1.26). All analyses were performed with IBM SPSS Statistics.

3.2 Principal Component Analysis (PCA)

Principal component analysis (PCA) using VARIMAX rotation was performed to reduce the number of correlated items in the data set into uncorrelated constructs (the principal components) (Jolliffe, 2014). The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (overall MSA) amounts to 0.741 (> 0.50, Kaiser and Rice, 1974), and Bartlett's test of sphericity is significant ($\chi 2$ (36) = 3084.62, $p \leq 0.001$). Thus, the data is suitable to perform the PCA. According to Kaiser's rule, the number of components was determined by the number of components with eigenvalue > 1 (Abdi & Williams, 2010; Kaiser, 1960). The result of the PCA is shown in Appendix 1. The three components explain 68.4% of the variance of the nine items. Therefore, the PCA reduced nine items into three components: *ecological, economic,* and *social perception of office properties*. The components were formed by averaging the items according to the results of the PCA (DiStefano et al., 2009).

3.3 Cluster Analysis

After compressing items into components, a hierarchical agglomerative cluster analysis was performed to identify different employee groups and their assessment of the relevance of the sustainability dimensions in the real estate context. Therefore, the three identified variables resulting from the PCA and the assessment of the importance of the user requirements (e.g. social sustainability) and the ecological and economic sustainability requirements are used for clustering. Additionally, the socio-demographic variables age and gender, as well as the required prioritisation of CREM, e.g., the required focus within the real estate strategy according to the three sustainability dimensions, were used in further analysis to allow a more differentiated interpretation of the results.

Table 1 shows the descriptive statistics of the clustering variables and the additional variables age, gender, and required prioritisation of CREM according to the three sustainability dimensions. The statistics show that the social dimension of sustainability is rated highest in all variable groups regarding sustainability (perception, importance, and the required prioritisation of CREM).

Table 1. Descriptive Statistics of Cluster Variables and Further Variables

Variable	Mean value $\bar{x}$	Standard Deviation	Scale
Social perception of office properties	5.08	0.861	7-point-Likert (ordinal)
Ecological perception of office properties	3.78	1.475	7-point-Likert (ordinal)
Economic perception of office properties	2.95	1.479	7-point-Likert (ordinal)
Importance of user requirements	44.43	19.276	Interval scale
Importance of ecological sustainability requirements	28.10	17.213	Interval scale
Importance of economic sustainability requirements	27.47	16.681	Interval scale
Required prioritisation CREM: Workplace quality (social)	5.71	1.031	7-point-Likert (ordinal)
Required prioritisation CREM: Environmental impact (ecological)	4.73	1.504	7-point-Likert (ordinal)
Required prioritisation CREM: Investment quality (economic)	3.80	1.497	7-point-Likert (ordinal)
Age	38.07	11.110	Metric
Gender			
Male	45.1%	-	Nominal
Female	54.4%	-	Nominal
Other	0.5%	-	Nominal

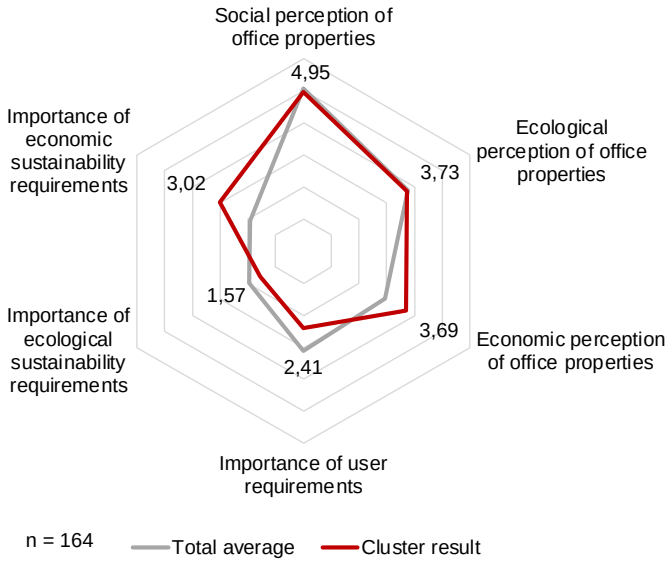
Before performing the cluster analysis, outliers were identified using the single linkage method and complementary graphical analysis of the dendrogram (Satari et al., 2019; Lara et al., 2020). As a result, 31 respondents were excluded from further analysis. In order to achieve the final cluster solution, Ward's method was applied, using standardised variables and Squared Euclidean Distance as the proximity measure. The optimal number of clusters was determined using the Calinski–Harabasz index (Variance Ratio Criterion) (Calinski & Harabasz, 1974), resulting in three clusters. The results were optimised using k-means clustering. Therefore, the mean values of the standardised cluster solution were used as cluster centres for the analysis using k-means. (Backhaus et al., 2021) The goodness of fit of the clustering results was tested using discriminant analysis (Backhaus et al., 2021), whereby 97,3% of the original grouped cases were correctly classified.

5 Results

The description of the results pays particular attention to the cluster-forming variables. Additionally, the cluster results are supplemented by the socio-demographic characteristics of age and gender and the required prioritisation of CREM according to the three sustainability dimensions. Appendix 2 provides a comprehensive overview of the emerging characteristics of the three clusters, including the further variables. The cluster names were chosen based on the dominant characteristics within the clusters.

The first cluster, the "investors", rates the importance of economic sustainability (e.g. investment requirements; $\bar{x} = 43.16$) highest compared to other clusters. Simultaneously, these cluster members are most aware of the economic impact of the office properties ($\bar{x} = 3.70$) and are therefore characterised by a high focus on the economic sustainability dimension (see Figure 2). Examining further variables, the required prioritisation of CREM aligns with the cluster results as they demand CREM to focus on the property's investment quality ($\bar{x} = 4.44$). With an average age of 35.76 years, the "investors" represent the youngest demographic among all clusters. With 64.2% male and 35.8% female respondents, the gender distribution reflects a clearly male-dominated cluster. The cluster contains 37% of respondents from the overall sample.

Figure 2. Cluster characteristics of the "investors"[13]

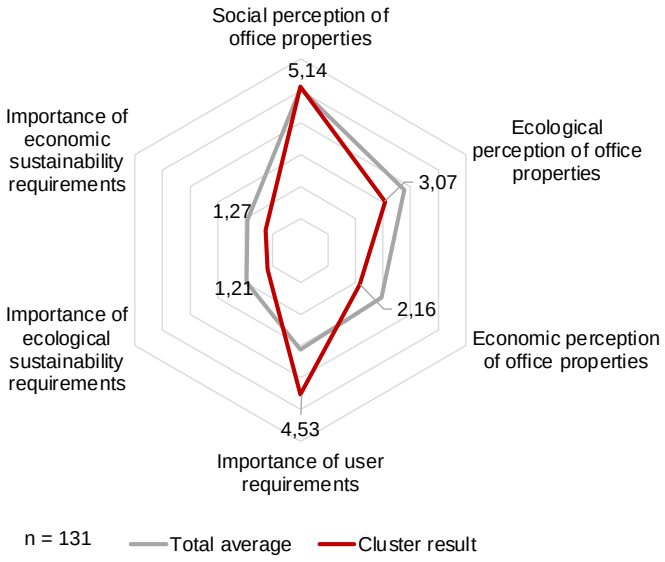


The second cluster, the "hedonists", rate the user requirements, e.g. social sustainability, highest compared to ecological and economic requirements as well as in the direct cluster comparison ($\bar{x} = 64.65$). At the same time, the ecological ($\bar{x} = 17.24$) and economic ($\bar{x} = 18.12$) requirements are rated lowest in direct cluster comparison. Regarding the sustainability-related perception of office

[13] The values of the importance variables were scaled down to a 7-point scale to facilitate visualisation of the results. Therefore, the values displayed in the figures do not align with those of the results shown in Appendix 2.

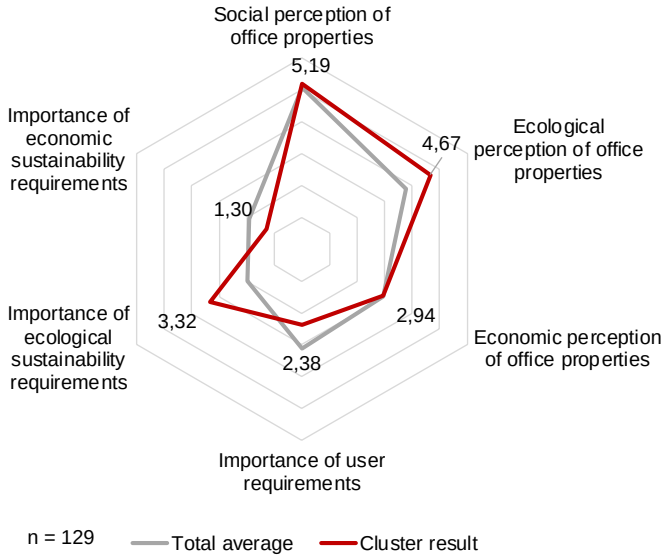
properties, the social impact of the property is clearly perceived strongest in this cluster ($\bar{x} = 5.138$) (see Figure 3). Consistent with the results derived from the cluster variables, this cluster requires CREM to prioritise the social dimension, e.g. workplace quality, within its real estate strategy ($\bar{x} = 6.09$). Examining the socio-demographics of the "hedonists" reveals that they form the oldest cluster with an average age of 41.07 years. The gender distribution of this cluster matches the descriptive statistics of the data set, with 45.3% female and 54.0% male respondents in this cluster. The cluster contains 34% of respondents from the overall sample.

Figure 3. Cluster characteristics of the "hedonists"



The last cluster, the "environmentalists", is characterised by a strong focus on ecological sustainability. Hence, the assessment of CRE's importance of ecological sustainability requirements ($\bar{x} = 47.47$) is rated far higher compared to the first and second clusters. Aligning with these results, cluster members have the highest ecological perception regarding the impact of office properties ($\bar{x} = 4.67$) (see Figure 4). At the same time, they require CREM to prioritise the environmental impact of CRE and, therefore, environmental sustainability ($\bar{x} = 5.77$). With an average age of 37.53 years, the age of the respondents in this cluster is slightly below the average age of the data sample. Regarding the gender distribution, the "environmentalists" cluster is clearly female-dominated, with 56.6% female and 42.6% male respondents. The cluster contains 30% of respondents from the overall sample.

Figure 4. Cluster characteristics of the "environmentalists"



6 Discussion and conclusion

The study aims to analyse employees' real estate-related sustainability requirements by examining the relevance of the sustainability dimensions (ecological, economic, social). Based on cluster analysis, three clusters are formed, and valuable information about the different requirements along the clusters is obtained.

The aspect that stands out particularly when analysing the results is that the clusters, i.e. the identified employee groups, differ precisely according to the three sustainability dimensions. Additionally, the size of the respective clusters shows that the cluster groups are almost equally distributed. The clusters' characterisation includes all sustainability-related variables such as the relevance of the sustainability dimensions, the perception of sustainability-related impacts, as well as the required prioritisation of CREM according to social, ecological and economic aspects. Therefore, the characterisation according to the three dimensions is highly consistent in the present analysis. Furthermore, the perception of the sustainability dimensions aligns with the assessment of the importance of the sustainability dimensions, suggesting a link between the perception and the assessment. However, a look at the overall sample shows that user requirements and, therefore, social sustainability are particularly important to all employees. Examining the socio-demographics of the clusters reveals that the first cluster, the "investors", is male-dominated, and the third cluster, the "environmentalists", is female-dominated. These results are consistent with previous research on gender-specific differences in sustainability orientation (Niessen-Ruenzi & Mueden, 2023; Hira & Loibl, 2008; Charness & Gneezy, 2010; Zhao et al., 2021; Kaakeh et al., 2021; Yasin et al., 2022). Regarding the average age of the clusters, the "investors" tend to be younger than the average, and the "hedonists" who focus on the user perspective, e.g. social sustainability, tend to be older employees. The "environmentalists" form the middle group and show no age-specific characteristics. Similar to the gender distribution, the age distribution corresponds to previous research on age differences in the

three sustainability dimensions (Casalegno et al., 2022; Bhargava & Hasija, 2018; Pfnür & Höcker, 2023).

Implications for CREM in the context of employer branding can be derived from the results of the previous study. Even though the respondents found the different sustainability dimensions relevant to varying degrees, the results clearly show that sustainability remains three-dimensional – even in the context of real estate. Thus, different employee groups focus on different dimensions of sustainability and, therefore, place different requirements on the CRE, i.e. investment quality, workplace quality and environmental quality, that must be met. For CREM, therefore, focussing on a single sustainability dimension to meet the needs of employees and communicate the employer brand is unsuitable for attracting and retaining (potential) employees. Instead, providing sufficient space for all three sustainability dimensions within the real estate strategy is essential to support the sustainability-oriented employer brand adequately.

Even though the results clearly show that all three sustainability dimensions have a particular relevance depending on the different employee groups, the results indicate that employees strongly see themselves in their role as office users, even if ecological and economic aspects are also considered highly relevant. At the same time, employees see CREM as responsible for creating a high-quality workplace. For CREM, user requirements must be given a particularly high priority within the real estate strategy in order to successfully contribute to employer branding.

Looking at the property's sustainability-related perception, it can be clearly observed that employees perceive the property and its sustainability impact and require CREM to prioritise sustainability within their activities. From a CREM perspective, employees demand a sustainability-driven approach towards the CRE, which can be interpreted as a direct mandate to CREM.

Finally, as already stated, the employer brand is communicated mainly through visual elements in the real estate-related context. The difficulty in the context of sustainability is that many activities that increase the sustainability quality of the CRE, e.g., activities to reduce CRE emissions, are not directly visible to employees. CREM must, therefore, develop creative solutions to make these sustainability-enhancing measures at least indirectly visible and thus increase awareness of the sustainability-enhancing activities.

The present study has some limitations. Although the study reveals the real estate-related relevance of the different sustainability dimensions and their perception from an employee perspective, no differentiation is made regarding specific sustainability attributes of the property. It is conceivable that specific attributes have more influence on increasing attractiveness in the context of employer branding than others. Further studies could investigate specific real estate attributes in the context of sustainability-oriented employer branding to derive operational recommendations for CREM action. Furthermore, there is a general risk that the results of the relevance assessment could be distorted by the socially desirable response behaviour of the participants. Additionally, the use of crowdsourcing platforms to conduct surveys is widely discussed. Using a different survey method and methods that mitigate the possible bias could examine this effect, counteract it and deliver more objective results. Moreover, the cluster results indicate a link between the perception and relevance assessment of the sustainability of CRE. Future research could investigate this link in more detail in order to examine both aspects in a holistic approach. Lastly, examining the cluster formation based on further socio-

demographic and personality-related variables could enable a more in-depth analysis of the identified employee groups.

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Appendix

Appendix 1. Rotated Component Matrix

	1	2	3
Ecological perception of office properties			
I am concerned about my quality of life due to the environmental impact of the construction and operation of office properties.	0.898		
I am concerned about the quality of life of future generations due to the environmental impact of the construction and operation of office properties.	0.911		
Office properties have a strong impact on my environment and quality of life due to their environmental impact (e.g. CO2 emissions during construction and operation).	0.853		
Economic perception of office properties			
I am considering an (indirect) investment in office properties for my private retirement provision.		0.897	
Office properties are an attractive asset class.		0.835	
Office properties have a strong influence on my personal finances due to their role in the capital market.		0.871	
Social perception of office properties			
Office properties alone can only demoralize, not motivate. (Inverted)			0.635
I am satisfied with the workplace in my company's office.			0.593
Office properties have a strong influence on my work life due to their function as a workplace.			0.701

							Required prioritisation CREM:				
	Social perception of office properties	Ecological perception of office properties	Economic perception of office properties	Importance of user require-ments	Importance of ecological sustainability require-ments	Importance of economic sustainability require-ments	Work-place quality (social)	Environ-mental impact (ecological)	Investment quality (economic)	Age	Gender
Mean	4.9478	3.7263	3.6922	34.38	22.46	43.16	5.42	4.34	4.44	35.8	f: 35.8 m: 64.2 o: 0.9
Mean	5.138	3.0678	2.1591	64.65	17.24	18.12	6.09	4.24	3.28	41.1	f: 45.3 m: 54.0 o: 0.7
Mean	5.1912	4.6653	2.9389	34.02	47.47	18.51	5.65	5.77	3.61	37.5	f: 56.6 m: 42.6 o: 0.8
Mean	5.0836	3.7829	2.9548	44.43	28.1	27.47	5.71	3.8	4.73	38.1	-
n	849	849	849	849	849	849	849	849	849	849	f: 383 m: 462 o: 4
s	0.86098	1.47449	1.47904	19.276	17.213	16.681	1.031	1.497	1.504	11.1	-
min	2.33	1	1	0	0	0	2	1	1	18	-
max	7	7	7	100	98	100	7	7	7	74	-

1: The investors	
2: The hedonists	
3: The environ-mentalists	
Total	

Return to Office: The importance of the physical workplace and organisational culture

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ABSTRACT

As a result of the transformation of work, organisations and employees find themselves in a hybrid working world. Due to the perceived personal and work-related benefits, employees prefer to perform large parts of their work from home. At the same time, some organisations would like to see their employees back in the office more often. While, in the accompanying return-to-office debate, some organisations are focusing on restricting employee flexibility, others are asking themselves how they can increase the desire of employees to work in the office again through an attractive workplace design. The discussion about increasing employees' desire to work in the office focuses on improving the physical workplace, but the role of organisational culture has so far been excluded from the debate. Organisational cultures influence employee behaviour; therefore, an office-centric organisational culture could influence the desire to work in the office.

Against this background, this study uses hierarchical moderated multiple regression analysis to examine the significance of real estate resources and organisational culture for the desire to work in the office. The empirical analysis considers survey data from $N = 453$ German employees.

The study results suggest that employees can be lured back to the office by upgrading the quality of the workplace. In addition, the study demonstrates the moderating influence of an office-centred culture on the relationship between employees' satisfaction with their office workplace and the share of working hours they want to spend in the office. The study thus provides guidance in the debate on strategies for returning employees to the office and offers indications for workplace planning and organisational and management-related adaptation.

Keywords
Organisational culture, Choice of workplace, Hybrid work, Return to office

1 INTRODUCTION

Organisations and employees find themselves in a hybrid working environment as the pandemic subsides. Knowledge work is now also carried out outside the office. Working from home and third places such as coworking spaces or cafés are well-established work location alternatives (Bouncken and Gantert, 2021). Employee preference for these locations is individual and depends on personal, work-related, and environmental factors (Höcker et al., 2022). Nevertheless, many employees recognise the benefits of working away from the office, for example, for their well-being, health, and work-life balance (Fan and Moen, 2023; Yang et al., 2023). This is why employees want to spend large parts of their work time away from the office. Moreover, hybrid work is not just a convenience for employees but also benefits their companies. Research shows that hybrid work leads to higher job satisfaction, increased productivity and improved retention, which in turn contributes to the organisation's success (Bloom et al., 2024; Bloom et al., 2015; Fonner and Roloff, 2010).

Nevertheless, in the face of a tense economic situation, some managers argue that working outside the office jeopardises individual productivity and, therefore, the company's overall success. Therefore, some organisations are pursuing a strategy of mandating that their employees work in the office again. Ding and Ma (2024) show that this is often only ostensibly about improving company performance. Instead, the mandatory return to the office is used to blame employees for companies poor performance in the past and to increase control over employees. At the same time, the authors show that mandatory working in the office does not increase organisational success. After implementing return-to-office mandates, there is neither an improvement in financial performance nor an increase in company values (Ding and Ma, 2024). Moreover, in a personnel situation that is already tense due to demographic change and the shortage of skilled workers, the obligation to work in the office reduces employee satisfaction and could even increase the willingness of employees to resign (Igbaria and Guimaraes, 1999; Singh and Sant, 2023; Parent-Lamarche and Marchand, 2023). Thus, forcing employees back to the office is not a successful strategy.

However, there may be good reasons for companies to have their employees back in the office more often again, such as to facilitate collaboration and innovation or to support employer branding (Pfnür et al., 2021b). Nevertheless, companies need to find different ways to return employees to the office, apart from forced returns. One way could be for organisations to attract employees back to the office. In research and practice, interest in adapting real estate resources to the newly formulated requirements in a hybrid working world is growing. There seems to be a belief that office property must undergo a qualitative upgrade in order to be perceived as attractive among the various workplace alternatives (Appel-Meulenbroek et al., 2022; Sailer et al., 2022; Babapour Chafi et al., 2022). This is based on the assumption that a higher level of satisfaction with the office workplace (further referred to as office workplace satisfaction) is accompanied by a higher desire to spend work time in the office (further referred to as desired office time share). In their study on the decline in quantitative demand for office property due to teleworking, Gupta et al. (2023) show that high-quality office buildings are protected from stranding due to this flight to quality.

So far, organisational culture has yet to be considered in the debate. While the possibility of losing organisational culture in hybrid work settings is much discussed (Gibson et al., 2023), voluntarily bringing employees back to the office by adapting the organisational culture has yet to be addressed. However, organisational culture significantly influences the behaviour and work practices of the organisation's members (Schein, 1985; Schein, 1992; Brunetto, 2001; Nanayakkara and Wilkinson, 2021). Due to the uniqueness of organisations, organisational culture is individual and has different facets. The influence of office workplace satisfaction on the desired office time share could be stronger or weaker depending on the degree to which an organisational culture emphasises presence in the office (further referred to as in-office culture).

Against this background, this study first addresses the research question (RQ1): *What influence does the perceived attractiveness of the office workplace have on employees' desired office time share?* It then examines the second research question (RQ2): *Does in-office culture moderate the relationship between office workplace satisfaction and desired office time share?* Survey data from *N* = 453 German office employees are analysed to answer this question. The results of the study help make informed decisions in the ongoing return to office debate. They not only support workplace planning but also provide important impulses for the organisational adaptation of corporations.

2 THEORETICAL FRAMEWORK AND HYPOTHESES DEVELOPMENT

2.1 Office workplace satisfaction and the desire to work in the office

Even before the COVID-19 pandemic, many studies analysed the determinants of employees' office workplace satisfaction and their choice of work location. Office workplace satisfaction is determined by three dimensions. On the one hand, it depends on personal as well as work-related factors (Rothe et al., 2011; Budie et al., 2018). On the other hand, the relationship between property-related factors and office workplace satisfaction has also been investigated. For example, a large body of literature deals with the influence of the indoor environment (e.g. noise, light, temperature, and ventilation, but also openness, density and perceived privacy) (Frontczak et al., 2012; Hills and Levy, 2014; Kent et al., 2021; Appel-Meulenbroek et al., 2022) and the employees' control over IEQ factors (Rothe et al., 2011; Hills and Levy, 2014; Kwon et al., 2019) on office workplace satisfaction. In addition, the functionality of the workplace (Hills and Levy, 2014; Nanayakkara et al., 2021b), location criteria associated with the workplace (Hills and Levy, 2014; Wisuchat and Taecharungroj, 2022), the office layout (Danielsson and Bodin, 2009; Kwon and Remøy, 2020) or personal and work-related services associated with the property (Rothe et al., 2011) also influence office workplace satisfaction.

The offices' role in a hybrid working environment is questioned due to experiences made during the COVID-19 pandemic. Many employees prefer working from home over working in the office (Vyas, 2022; Yang et al., 2023). In particular, activities carried out in the office shift (Appel-Meulenbroek et al., 2022; Sailer et al., 2022). From this observation, researchers and practitioners conclude that the quality of office space must increase in the future in order to increase employees' desired office time share. Babapour Chafi et al. (2022), for example, analyse that employees expect office space to be upgraded when they return to the office due to their positive experience of working from home. Yang et al. (2023) conclude from their study on the influence of working from home on the evaluation of the physical working environment that organisations need to increase employee office workplace satisfaction.

Gupta et al. (2023) examine the quantitative demand for office space change due to increased work from home. They observe that higher-quality office buildings are due to the flight to quality at a lower risk of becoming stranded because of decreasing demand for office space. Sailer et al. (2022) argue that organisations in a hybrid working environment demand less space overall. However, the space that is still required has to be of high quality so that employees are attracted to the offices and their desired office time share increases.
Only a few studies investigate the extent to which the quality and, thus, office workplace satisfaction actually influences employees' choice of work location in a hybrid working environment (Appel-Meulenbroek et al., 2022). However, based on the above explanations, it can be assumed that the desire to work in the office increases with growing office workplace satisfaction. The first hypothesis is therefore:

H1: Higher office workplace satisfaction is associated with a higher desired office time share.

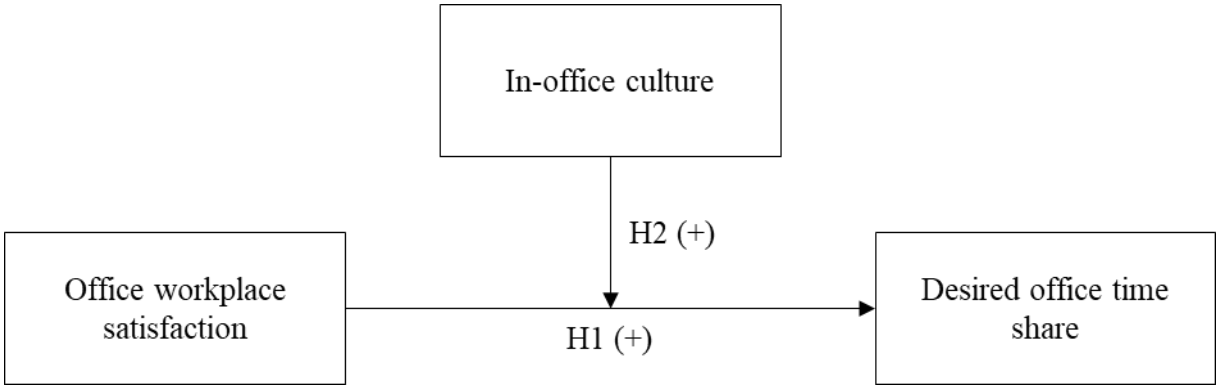
2.2 The moderating effect of in-office culture

Organisational culture is defined as "the sum total of what a given group has learned as a group, and this learning is usually embodied in a set of shared, basic underlying assumptions that are no longer conscious, but are taken for granted as the way the world is." (Schein, 1993, p. 705) Organisational culture can be divided into three levels. The underlying assumptions are the lower level of Schein's model. The second level comprises the espoused values of the organisation. They represent the organisation's declared or operationalised governing rules (Gagliardi, 1990; Meissonier et al., 2013). Artefacts represent the top level of the model. They are the observable manifestation of the underlying assumptions. Artefacts include, for example, the physical office layout, observable rituals, or the behaviour of organisation members (Nanayakkara and Wilkinson, 2021).
In the context of workplace research, the influence of office layout on organisational culture (Kallio et al., 2015; Nanayakkara et al., 2021a; Nanayakkara et al., 2021b; Nanayakkara et al., 2023) and the relationship between organisational culture and office design (van der Voordt et al., 2003) are investigated. Nanayakkara and Wilkinson (2021) describe that adapting the real estate resource and how organisations work must be aligned with organisational culture. However, despite the links between organisational culture, workplace and work practice, little attention is paid to organisational culture as a potential solution in the return to office debate. As organisational culture influences employee behaviour (Schein, 1985; Schein, 1992; Brunetto, 2001; Nanayakkara and Wilkinson, 2021), in-office culture could further increase the effect of office workplace satisfaction on desired office time share. In contrast, if the increase of office workplace satisfaction, viewed as a prerequisite for returning to the office, is neglected, in-office culture could hurt the relationship on the desired office time share. Then, the necessary alignment between workplace, work practice and organisational culture is missing (Nanayakkara and Wilkinson, 2021). In other words, in-office culture could moderate the relationship between office workplace satisfaction and the desired office time share. Consequently, the second hypothesis is:

H2: In-office culture moderates the positive relationship between office workplace satisfaction and desired office time share. The relationship is stronger for employees with a high in-office culture than for those with a low in-office culture.

The presumed relations are summarized and illustrated in Figure 1.

Figure 1. Research model



3 Methodology

3.1 Data collection and sample

The data analysed in this study were collected as part of a broader research agenda on hybrid work and the future of offices. To this end, programmed questionnaires were distributed via a crowdsourcing platform.

Crowdsourcing platforms offer the opportunity to acquire survey participants efficiently and cost-effectively. The data obtained are of the same or even better quality as data obtained through traditional survey forms (Behrend et al., 2011; Buhrmester et al., 2011; Goodman et al., 2013). Due to the collection process, sampling is classified as non-probability sampling. Following the recommendations of McEwan (2020), the representativeness was continuously checked during data collection using socio-demographic variables to address associated biases (e.g. self-selection bias). Data were collected in two survey waves, mitigating common method bias. In addition, attention tests were implemented in both survey waves.

The surveys were aimed at the population of German employees working in offices. Data were collected in autumn 2022 (first wave) and spring 2023 (second wave). Using a unique identifier, the questionnaires from both survey waves are matched and assigned to individual respondents. A total of $N = 467$ respondents completed both questionnaires. After data cleaning due to missed attention tests or inconsistent response behaviour, a sample size of $N = 453$ remains. The sample comprises 181 women (40.0 %), the average age is 38.53 years (standard deviation: 10.85), and the average household size is 2.40 persons (standard deviation: 1.20). The participants come from different companies in Germany. On average, they spend 61.74 % of their work time on concentrated individual or desk work (standard deviation: 24.28 %).

3.2 Measures

Office workplace satisfaction (independent variable) is measured with three items according to Pfnür et al. (2021a) and Jurecic et al. (2021). The instrument does not emphasise singular determinants of office workplace satisfaction but represents a general assessment. Nevertheless, it is suitable for the purpose of this study, as the study does not aim to determine which property-related aspects influence the desired office time share. Instead, the effect of the interplay between office workplace satisfaction and in-office culture on desired office time share is investigated.

In this study, *in-office culture* (moderator) is understood as an organisational culture that, in facets, emphasises employee presence in the office. To the authors' knowledge, no instrument for measuring *in-office culture* exists. However, Employee behaviour is influenced by organisational culture (Schein, 1985; Schein, 1992; Brunetto, 2001; Nanayakkara and Wilkinson, 2021). An organisation's true culture is often not reflected in its declared culture but in the daily behaviour of its employees (Kilmann, 1985; Brunetto, 2001). Therefore, it seems appropriate to examine the company's culture based on the employees' behaviour and observations. Following Schein's definition of organisational culture (1985, 1992), three items were formulated for the measurement, representing the different levels of organisational cultures. The first item asks about underlying assumptions ("It is part of the corporate culture to work in the office.") The second item is aimed at the organisation's governing rules ("My (direct) superiors prefer me to work in the office."). It thus refers to the level of espoused values. The third item asks about the observed behaviour of the organisation's employees ("My colleagues work in the office."). It thus represents the level of artefacts.

To determine the *desired office time share* (dependent variable), respondents were asked to indicate how they would like to distribute their weekly working hours between different work locations. In addition to the office workplace, the home workplace and third locations, such as coworking spaces, cafés, and lounges, were also considered. The variable used in the analysis represents the percentage of work time respondents would like to spend in the office.

In addition, *age*, *household size* (metric), and *gender* (binary with 1= female) are included in the analyses as control variables. The items of *office workplace satisfaction* and *in-office culture* were measured on 7-point Likert scales (1 = strongly disagree to 7 = strongly agree). The Cronbach's alphas of the scales of over 0.8 indicate high reliability. They are shown in Table 1, together with the descriptive statistics.

The first survey, conducted in autumn 2022, collected the control variables, the independent variable *office workplace satisfaction*, and the dependent variable *desired office time share*. The second survey, conducted in spring 2023, collected the moderator variable *in-office culture* separately.

Table 1. Constructs, items and descriptive statistics

Construct	Items	Mean value	Standard deviation	Cronbach ’s Alpha
Office workplace satisfaction	I am very satisfied with my office workplace.	5.25	1.31	0.896
	I enjoy working at my office workplace.	5.17	1.40	
	I have fun working in my (company) office.	5.02	1.43	

In-office culture	It is part of the corporate culture to work in the office.	4.55	1.81	0.853
	My (direct) superiors prefer me to work in the office.	4.32	1.98	
	My colleagues work in the office.	4.21	1.79	
Desired office time share	How many percent of your work time would you want to spend in the office if you could allocate your work time completely independently?	39.80	27.44	-

3.3 Empirical approach

A hierarchical moderated multiple regression analysis is conducted to test the hypotheses with *desired office time share* as the dependent variable. Model 1 contains only the control variables *age*, *gender* and *household size* as independent variables. In Model 2, *office workplace satisfaction* and *in-office culture* are added as explanatory variables. Model 3 adds the interaction term (*office workplace satisfaction* × *in-office culture*) to analyse the moderation effect. Following the recommendations of Aiken and West (1991), the interacting independent variables are mean-centred, which, according to Hayes (2022), makes the regression coefficients interpretable regardless of the scaling of the independent variables. The analyses are carried out using R 4.3.2.

4 Results

The results of the hierarchical regression are shown in Table 2. The F-statistics of all three regression analyses are significant (Model 1: $F = 2.22$, $p < 0.1$; Model 2: $F = 26.83$, $p < 0.01$; Model 3: $F = 24.58$, $p < 0.01$). This indicates that the models fit the data well. The changes in R^2 are significant, which indicates an improvement in the models due to the addition of further explanatory variables.

The results of Model 2 show that *age* ($B = 0.318$, $p < 0.01$), *office workplace satisfaction* ($B = 7.903$, $p < 0.01$) and *in-office culture* ($B = 4.823$, $p < 0.01$) have a significant positive effect on the *desired office time share*. This finding supports hypothesis 1 (Higher office workplace satisfaction is associated with a higher desired office time share).

In Model 3, the moderating effect of *in-office culture* is significantly positive ($B = 1.699$, $p < 0.01$). Thus, hypothesis 2 (In-office culture moderates the positive relationship between office workplace satisfaction and desired office time share. The relationship is stronger for employees with a high in-office culture than for those with a low in-office culture.) is supported as well.

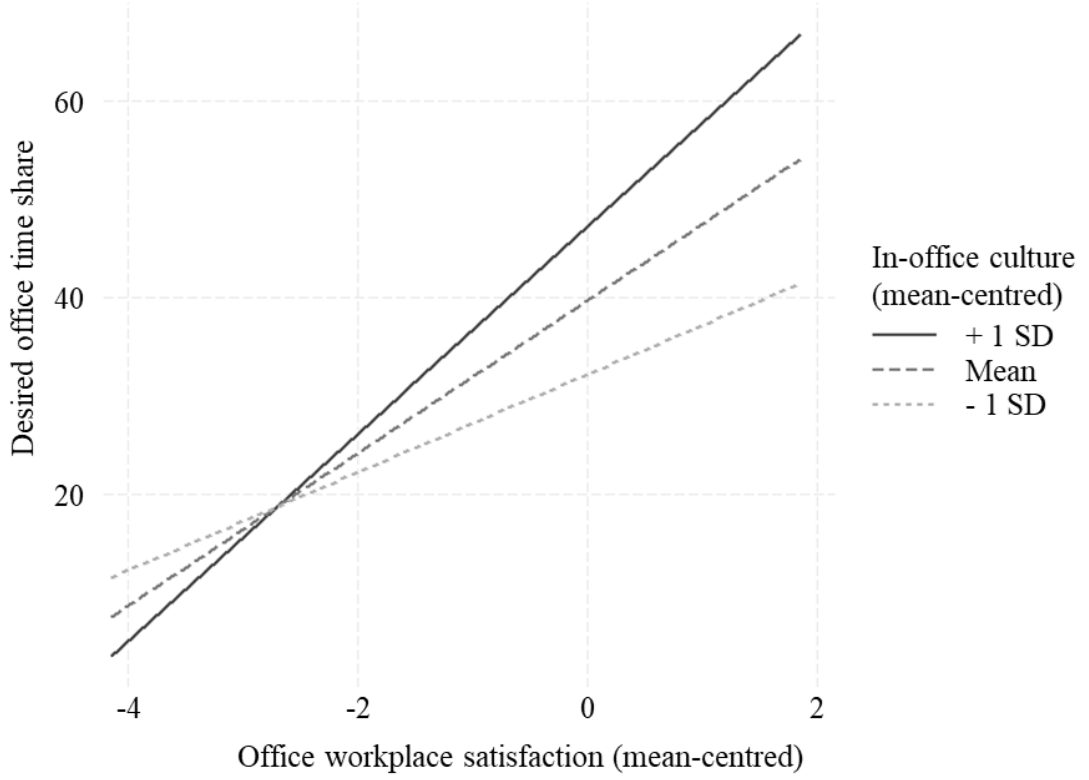
For better interpretability, the significant moderation effect is plotted according to the recommendations of Aiken and West (1991), as shown in Figure 2.

Table 2. Results of hierarchical regression

	Desired office time share						
	Model 1			Model 2			
	B	SE	p-Value	B	SE	p-Value	B
Constant	22.463***	6.840	0.001	22.590***	6.142	0.000	22.458***
Control variables							
Age	0.206*	0.119	0.083	0.318***	0.107	0.003	0.322***
Gender (1 = female)	4.081	2.628	0.121	2.827	2.335	0.227	2.592
Household Size	1.191	1.074	0.268	0.183	0.955	0.848	0.263
Main effects							
Office workplace satisfaction				7.903***	0.917	0.000	7.760***
In-office culture				4.823***	0.711	0.000	4.591***
Interaction effect							
Office workplace satisfaction × In-office culture							1.699***
R^2	0.015			0.231			0.249
Adjusted R^2	0.008			0.222			0.238
F Statistic	2.22*			26.83***			24.58***
ΔR^2				0.216***			0.018***

Notes: N = 453, B: Unstandardised regression coefficients; SE: standard errors; ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$

Figure 2. Plot of the moderating effect of in-office culture on the relationship between office workplace satisfaction and desired office time share



5 Discussion And Conclusion

This study aims to answer two research questions: (RQ1): *What influence does the perceived attractiveness of the office workplace have on employees' desired office time share?* and (RQ2): *Does in-office culture moderate the relationship between office workplace satisfaction and desired office time share?* Two hypotheses were formulated and empirically tested.

The results support the assumption that office workplace satisfaction positively influences the desired office time share (H1). Providing a better office workplace could, therefore, indeed attract employees back to the office. This confirms the conclusion reached in various studies that office properties must undergo a qualitative adjustment due to competition from other workplaces in the hybrid working world (Babapour Chafi et al., 2022; Sailer et al., 2022; Yang et al., 2023).

In addition, the results also support the assumption that in-office culture moderates the relationship between office workplace satisfaction and desired office time share (H2). With a higher in-office culture, the effect of office workplace satisfaction on the desired office time share increases. The graphical analysis of the interaction effect reveals further details. Suppose office workplace satisfaction is particularly low (left side of the intersection). In that case, a high in-office culture even hurts desired office time share compared to a lower in-office culture. With higher office workplace satisfaction, on the other hand, the effect of a high in-office culture on desired office time share is even stronger compared to a low level of the moderator. This indicates that with a suitable culture, there is potential for higher attendance in the office. These observations underline that the maximum effect of desired working practices can be achieved through improved office workplace satisfaction and a harmonised corresponding culture (Nanayakkara and Wilkinson, 2021).

The study's results provide vital information for research and practice. The study contributes to the ongoing development of literature on organisational culture in the real estate context. While past studies have primarily dealt with real estate's influence on organisational culture, this study examines whether organisational culture can be used as an employee management tool in the workplace.

The results offer various practical recommendations for organisations. They show that office workplace satisfaction positively influences the desired office time share. This suggests that high-quality spaces could be suitable for attracting employees back to the office voluntarily. If organisations want their employees to spend more time in the office, they should, therefore, upgrade their office space in line with users' requirements. The criteria for office space quality in a hybrid working environment could be different due to the re-evaluation of the workplace or the shift in activities carried out in the office (Appel-Meulenbroek et al., 2022; Tagliaro and Migliore, 2022; Babapour Chafi et al., 2022). Nevertheless, the assumption that good office space is essential for utilising the workplace seems to be confirmed.

From the perspective of corporate organisation and leadership as important initiators of organisational culture (Schein, 1985; Hooijberg and Petrock, 1993), the study offers a new perspective on the return to office debate. The results underline the importance of organisational culture for the desire to work in the office. An organisational culture focusing on presence in the office can increase employees' desire to work there. Accordingly, organisations that want to have their employees back in the office more regularly in future should implement and maintain such an organisational culture. However, ensuring that the organisational culture is not a step backwards into an old world is essential. Various studies show that a hybrid working world needs an organisational culture that is different from the hierarchical, presence-based monitoring of pre-hybrid times (Laker and Roulet, 2021; Babapour Chafi et al., 2022; Sailer et al., 2022). In order to awaken employees' desire to work in the office, the added value of working in the office must be emphasised rather than a perceived compulsion to be present.

Finally, the results call for a coordinated approach between the organisation's different departments. The results indicate that only the combined efforts of corporate real estate management, organisation, and leadership can deliver maximum success. Neither in-office culture alone nor upgrading the space without adapting employee behaviour accordingly through an organisational culture geared towards office presence can achieve the desired effect. If organisations want their employees back in the office, this can only be achieved through the joint efforts of the various departments.

The study also has some limitations that offer the potential for further research. First, the study of in-office culture is based on three items that still need to be validated. The measurement instrument used could be validated for even greater reliability of the results. The instrument used to measure office workplace satisfaction does not address individual property aspects that ensure satisfaction with the workplace. Further studies should thus analyse the requirements for physical workplaces in hybrid work settings. Similarly, the study does not provide information on an in-office culture suitable for a hybrid working environment. In addition, the study is based solely on employee survey data. To increase the reliability of the results, second-source data or experiments could be used to verify them. Furthermore, the study does not consider any country- or sector-specific differences. Therefore, generalisation of the results is only possible to a limited extent. Further studies could focus on these differences.

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Session 6

Session 6A: Indoor Environmental Quality 2, IEQ 2

Influence of Room Color Tone and Brightness on Interpersonal Dynamics in Virtual Workplace Environments

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ABSTRACT

In virtual workplace environments, individuals interact through avatars, each possessing an inherent Interpersonal Space (IPS). Interactions begin as these spaces intersect, a process critical in shaping and defining the dynamics of interactions and potentially influencing perceptions of privacy and collaboration. Despite its importance, virtual workplace platforms lack a standard for IPS, which is essential for preventing virtual overlap and ensuring seamless, natural interactions. Moving beyond the existing research focused on situational factors, like the influence of a virtual avatar's appearance or facial expressions, we explore how environmental factors like room color tone (warm vs. cool) and brightness (bright vs. dark) influence IPS in VR. We employed the 'stop-distance task' to assess the comfort space between participants and the virtual avatar across eight approach directions (0°, 45°, 90°, 135°, 180°, 225°, 270°, 315°) in four distinct virtual rooms. Our findings indicate a significant effect

of tone and brightness on IPS, with cool tone and bright rooms significantly reducing IPS, promoting closer interaction. Directionality also played a substantial role, with the largest IPS observed when participants faced the avatar directly (0°) and the shortest IPS when the avatar approached from the rear (180°), highlighting the non-circular nature of IPS in virtual settings. These results provide empirical insights into the intricate relationship between spatial design and IPS in VR, presenting insights to virtual workplace designers and engineers on designing virtual spaces for effective remote collaboration.

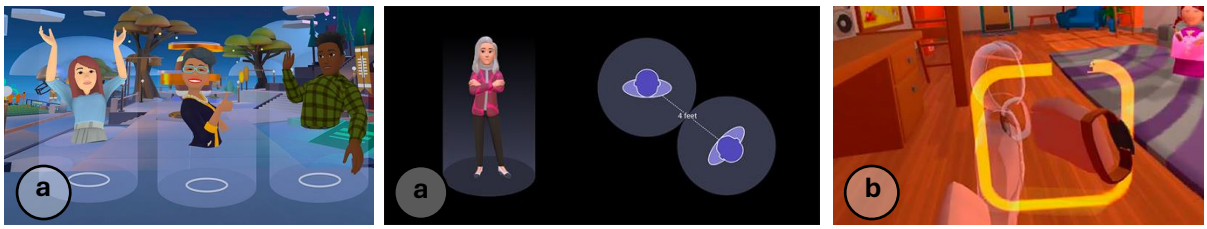
Keywords

Virtual Workplace Environment, Virtual Reality, Virtual Space Design, Interpersonal Interaction, Interpersonal Space

1 INTRODUCTION

Virtual Environments (VEs) are increasingly used for tasks such as remote work and education, enabling an era where people can engage from any corner of the world in a shared virtual space. These virtual workplaces are central to redefining the nature of collaboration and interaction, as they provide a rich platform for content creation and real-time collaborative efforts (Saffo et al., 2021). Communication transcends verbal exchanges in these spaces, incorporating non-verbal cues, notably Interpersonal Space (IPS), significantly affecting interaction dynamics. In both physical and virtual interactions, individuals naturally adjust their distance to communicate social meanings and maintain comfort (Sharma, 2022). This spatial negotiation is a subtle but critical aspect of interpersonal interactions and is particularly pronounced in structured settings like business meetings (Amaoka et al., 2009). When IPS norms are disrupted, it can lead to discomfort (Candini et al., 2021; Hayduk, 1983), underscoring the importance of well-defined spatial boundaries within virtual workplaces. Unlike the physical world, however, where IPS violations merely cause discomfort, the overlap of IPS between avatars marks the beginning of an interaction, thus bearing a more profound implication in VEs (LaRubbio et al., 2023; Neo et al., 2021). Understanding IPS behavior, therefore, is essential for designing virtual workplaces that support natural interactions and enhance user experience, especially when VR platforms provide inconsistent mechanisms for establishing and protecting IPS (see *Figure 1.1*).

Figure 1.1 Representation of IPS in VR platforms. (a)Horizon Worlds[14]*. (b)RecRoom*[15]*.*



[14] https://www.meta.com/ko-kr/experiences/2532035600194083/
[15] https://recroom.com/

The primary objective of this paper is to advance our understanding of how spatial design within VEs affects IPS, an area that remains notably underexplored. This study fills a crucial gap in the existing body of knowledge, extending the investigation of spatial perception to the intricacies of user interaction within VEs. Specifically, we explore how spatial arrangements, such as room color tone and brightness, influence an individual's interpersonal boundaries with those nearby. It is suggested that a virtual space's ambiance influences how individuals perceive and react to breaches into their IPS (Williamson et al., 2021). For instance, an adverse environment characterized by harsh lighting or jarring color schemes might make an individual resist such invasion, while a pleasant environment with soothing colors and comfortable lighting could render such an invasion neutral or even welcome. By examining these dynamics, this study sheds light on the psychological and behavioral impacts of spatial design in VEs.

Our exploration begins with a literature review encompassing virtual workplace and remote collaboration, interpersonal space in VR, and finally, spatial design in VR. Progressing from this foundational understanding, we investigate how participants react to virtual avatars in four distinct virtual rooms, each different in color tone and brightness, to assess IPS as the distance at which participants felt uncomfortable from a virtual avatar during the stop-distance paradigm. In this setup, the avatar approached the participant at a constant speed, echoing Hayduk's 'stop-distance' procedure (Hayduk, 1983). We analyzed eight different approach directions (0°, 45°, 90°, 135°, 180°, 225°, 270°, 315°), using interpersonal distance as a quantifiable element within the interactive experimental context, thus making the terms "interpersonal distance" and "interpersonal space" synonymous in our study. By acknowledging and integrating the principles that govern IPS, we aim to provide actionable insights to designers and engineers, facilitating the creation of virtual workplaces that enhance user experience, foster effective collaboration, and optimize interaction in the burgeoning landscape of remote work.

2 Related Work

In the current landscape of virtual transformation, virtual workplaces are not just emergent technologies but instrumental in redefining collaborative and interactive processes in professional environments (Vartiainen, 2015). Driven by advancements in computational hardware and network capabilities, research has progressively focused on integrating multi-user functionality to mirror real-world collaboration in VEs (Tea et al., 2021). This trend positions the virtual workplace as a multidimensional research area, ripe with applications that cater to various interaction and operational needs within an immersive virtual space facilitated by customized avatars. Each virtual workplace is a unique ecosystem, with the design differing significantly based on the platform's intent and the creative vision of its designers. These variations manifest in the virtual environments' scale, texture, and complexity, as seen in platforms like Horizon Workrooms[16], Microsoft Mesh[17], and Meeting VR[18] (see *Figure 2.1)*. Such distinctions are crucial as they directly influence user experience, shaping how participants perceive and interact within these spaces.

[16] https://forwork.meta.com/kr/horizon-workrooms/
[17] https://www.microsoft.com/en-us/microsoft-teams/microsoft-mesh
[18] https://www.meetinvr.com

Figure 2.1 Virtual workplace platforms (a)Horizon Workrooms. (b)Microsoft Mesh. (c) Meeting VR.

At the core of these virtual spaces is the concept of IPS, which dictates the onset of interactions when avatars' IPS overlaps, thus forming an interaction space. This interaction space is not merely a spatial division but a social mechanic, integral to maintaining interpersonal boundaries and ensuring user protection within a VE. Pohl et al. (2019) and McVeigh-Schultz et al. (2019) have explored how IPS can enforce safeguarded spaces by upholding social norms and preventing harassment, suggesting wider implications for this concept. Understanding IPS is crucial for virtual workplaces, especially given the variability in how VR platforms handle the establishment and maintenance of IPS. Current research endeavors are primarily directed toward refining the facilitation of remote collaboration within these workplaces. Concurrently, there is a recognized need for further inquiry into IPS's integral role in these virtual realms. Investigating IPS, especially its interaction with social mechanisms, is essential. Virtual workplaces must integrate measures that not only foster constructive user interactions but also safeguard IPS, thereby significantly augmenting the virtual office experience.

2.2 Interpersonal Space in VR

In VR, non-verbal cues are becoming just as important as verbal ones, particularly concerning IPS. Grounded in research, studies like Burgoon et al. (1996) highlight the impact of non-verbal communication, such as gestures and expressions in VR, where IPS is a quantifiable factor influencing user experience. In VEs, IPS adaptation is influenced by various factors, including gender, age, and environmental elements like room dimensions (Asún-Dieste et al., 2020). Translating IPS into VR introduces challenges, as avatars need to convey human interaction traits. VR platforms demonstrate the need for standardized IPS to enhance comfort and prevent user discomfort (Freeman et al., 2022). While significant as a technical concern, standardizing IPS in VR also upholds social communication nuances in digital environments (Williamson et al., 2022)

Research has enriched our understanding of IPS in VR, yet it often centers on avatar characteristics such as gaze or appearance and their effects on user comfort. Empirical studies by researchers like Wilcox et al. (2004) and Llobera et al. (2010) have measured physiological responses to virtual IPS breaches. Other works, like those of Bailenson et al. (2003) and Iachini et al. (2006), investigate IPS variations due to avatar realism and personal attributes. Buck et al. (2022) explored how avatar size and embodiment levels affect IPS, finding that IPS isn't uniformly distributed but rather larger in the front, as suggested by earlier studies like Hayduk (1983). On the contrary, Hecht et al. (2019) proposed a circular model, indicating no significant IPS variation from different directions. Research into avatars' expressions and movements by Cartaud et al. (2018) and Bönsch et al. (2020) demonstrated that emotional expression affects IPS, with Sammer et al. (2022) noting increased IPS in response to negative movements. Studies by Han et al. (2022) and Williamson et al. (2022) found that social density impacts the desired IPS.

Despite the progress, there's a gap in the literature regarding the spatial design factors, such as room color tone and brightness, on IPS within VEs. Our research aims to bridge this gap by focusing on how these spatial design elements influence IPS, thereby informing the development of VEs that support realistic interactions. By integrating the influence of spatial design, we aim to build upon the foundations laid by IPS research to offer a more comprehensive understanding that facilitates the creation of more comfortable virtual workplaces. For instance, understanding how different lighting conditions or color schemes affect users' perceptions of space and their comfort levels can help designers create environments that are not only visually appealing but also psychologically supportive. This holistic approach ensures that virtual workplaces are tailored to meet the nuanced needs of users, promoting better interaction and collaboration.

2.3 Spatial Design in VR

The design of virtual spaces critically affects how users perceive and interact with VEs, influencing their emotional, cognitive, and behavioral responses (Ma et al., 2022; Cha et al., 2020; Cha et al., 2019; Naz et al., 2017). These environments offer unparalleled control over spatial design elements, making understanding their effect on IPS essential (Williamson et al., 2022). Nonetheless, there's a research gap in how these elements affect IPS and, consequently, interpersonal interaction. This oversight can lead to well-intentioned virtual designs that fail to foster effective remote collaboration (Moore et al., 2009).

Color tone and brightness in VEs are two such modifiable elements that have the potential to influence IPS, shaping how users engage with each other (Naz et al., 2017). Warm color tones like reds, oranges, and yellows are known for stimulating excitement and activity, often symbolizing alertness or aggression, and cool color tones like blues, greens, and purples are known for inducing calmness and tranquility with their soothing effects (Cha et al., 2020). Such emotional responses elicited by these tones can play a significant role in the formation of IPS. For instance, in VEs, participants may adjust their IPS as a protective measure against perceived aggression in spaces colored with warm tones. In contrast, cool colors may enhance concentration and reduce stress, potentially leading to a contraction of IPS as psychological pressures are alleviated (Wilms and Daniel, 2017). This can result in individuals feeling more at ease during interactions, even when in closer proximity to each other.

Meanwhile, brightness is known to affect emotional valence, with lighter environments seen as more inviting, correlating with positive spatial experiences (Franz et al., 2005). Such environments provide a sense of security and openness, encouraging users to set closer spaces to other avatars. Conversely, dimly lit environments may induce feelings of anxiety or spatial confinement, leading users to prefer larger IPS. For instance, Li et al. (2020) found that virtual environments with varying levels of natural light impacted stress recovery, with brighter settings more effectively alleviating stress than darker ones. This suggests that lower stress levels associated with higher brightness may lead to a decrease in IPS.

In summary, both color tone and brightness have the potential to influence IPS behaviors. Particularly in VEs, where elements like color and illumination can be manipulated with greater ease than in real-world settings, the precise impact of these elements on interactions that mirror real-world IPS dynamics is not yet fully understood. Thus, our research explores how color tone and brightness adjustments can alter users' IPS. By analyzing these factors, we aim to provide a deeper understanding of how to create virtual environments that not only support realistic interactions but also enhance overall user experience. This knowledge can inform the development of virtual workplaces that are

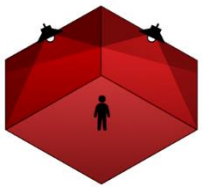
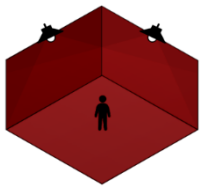
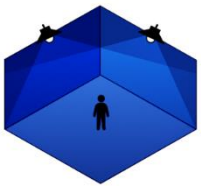
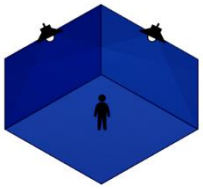
more conducive to effective collaboration, ultimately leading to more successful and satisfying user engagements.

3 METHODS

3.1 Research Design

Our study was structured around a balanced within-subject design to investigate how spatial design influences IPS within VEs, controlling for participant variance. Our experimental framework manipulated two key variables: the room's color tone (warm vs. cool) and the level of brightness (bright vs. dark). This design yielded four unique experimental conditions (see *Table 3.1*). Participants were randomly assigned to one of the four conditions and experienced all four conditions in a random order.

Table 3.1 2x2 Within-Subject Research Design

2x2 Within-Subject	Bright	Dark
Warm		
Cool		

3.2 Apparatus

The study environment was presented via a Head-Mounted Display (HMD, Meta Quest 2, resolution: 1832 x 1920 pixels, refresh rate: 120 Hz). Participants interacted with the VE using the Meta Quest 2 controller. The VEs were developed with Unity 3D software (Version 2022.2.20, by Unity Technologies).

3.3 Participants

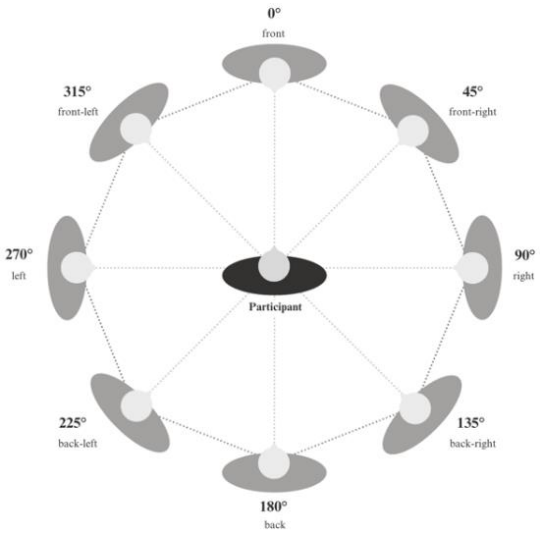
Our research involved 10 healthy Korean adults (mean age = 26.5, SD = 2.95, 5 males), ranging from 19 to 35 years old, from a university participant pool. Criteria for inclusion required participants to have normal or corrected vision without color blindness, full dexterity, no history of motion sickness or mental/neurological disorders, and no knowledge of the study's aims. All were right-handed and had previous VR experience. Sessions for each condition lasted about 8 minutes, with optional breaks totaling roughly 60 minutes. The study was conducted following the Institutional Review Board (IRB) guidelines at the Korean Advanced Institute of Science and Technology.

3.4 Measures

Questionnaires. We employed a tailored questionnaire to assess how immersed participants felt within the VEs. This included a condensed version of the Igroup Presence Questionnaire (IPQ), featuring a series of five questions rated on a 5-point Likert scale. The IPQ evaluates four aspects of immersion—Involvement (INV), Experienced Realism (ER), Spatial Presence (SP), and a General Sense of Being in the Environment (G). This abridged IPQ is designed to effectively measure the participant's engagement and sense of presence in virtual spaces. Additionally, we collected demographic data to contextualize our findings.

Interpersonal Space. In our study, we used the stop-distance method to measure IPS. In this task, a virtual avatar moved towards the participant from eight preset directions (0°, 45°, 90°, 135°, 180°, 225°, 270°, 315°, as illustrated in *Figure 3.1*). When participants felt the avatar was too close, causing discomfort, they used the controller to signal this, thereby establishing the IPS limit. We recorded these distances from the participant's viewpoint to the avatar and calculated an average over three trials for each directional approach to determine the IPS.

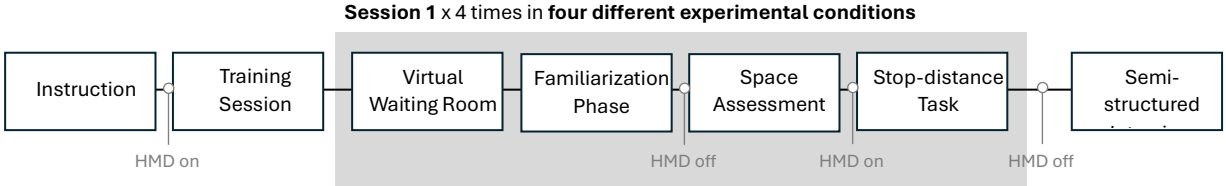
Figure 3.1 Direction of the virtual avatar's approach (0°, 45°, 90°, 135°, 180°, 225°, 270°, 315°)



3.5 Procedure

Before the VR experience began, participants were briefed on the experiment's structure and the tasks they would be performing (see *Figure 3.2*). Equipped with the Oculus headset and earphones, they first completed a training session to become accustomed to the stop-distance task, ensuring their readiness for the main part of the study.

Figure 3.2 Experimental procedure



The experiment began with participants in a VE designed to establish a baseline state (Deits-Lebehn et al., 2023). They spent the first minute in this virtual waiting room, allowing them to acclimate to the VR setting. Following this period, participants proceeded to the experimental space, where they provided verbal feedback on their experience for 90 seconds, reflecting on aspects of the environment (Küller et al., 2009). Next, participants briefly removed the VR headset to evaluate the environment and their sense of presence via digital questionnaires on an iPad. Once assessments were complete, participants resumed the VR experience, facing a virtual avatar positioned across the room. The core of the experiment involved the avatar approaching the participant from eight different directions at a constant speed of 0.5 m/s. Participants were instructed to signal when the proximity of the avatar became uncomfortable, effectively marking their interpersonal space threshold (Han et al., 2022; Hecht et al., 2019). During the stop-distance task, participants maintained a fixed lower-body position and rotated their upper body to face the virtual human as it approached, ensuring a consistent orientation throughout the task. After each trial, there was a short pause of 4 seconds before the next began, totaling 96 trials across all conditions (Han et al., 2022).

4 RESULTS AND DISCUSSION

Participant responses regarding each virtual environment, avatar approach direction, and IPS were recorded in a CSV format. Utilizing SPSS 27.0, we conducted a significance analysis at the 0.05 level. IPS served as our dependent variable in a repeated-measures ANOVA, with room color tone, brightness, and approach orientation as within-subjects factors. Subsequent to the ANOVA, we employed Duncan's multiple range test for post hoc multiple comparisons, ensuring a comprehensive understanding of the influence of spatial design on user experience in virtual environments.

4.1 Interpersonal Space

Statistical analysis revealed that a room's color tone and brightness substantially influence individuals' IPS in VEs. Rooms with warm tones led to larger IPS measurements across all eight directions, suggesting a preference for increased IPS in these settings. Brightness levels also impacted IPS, with participants requiring less space in brighter rooms. This trend was most notable when avatars approached participants at 0° and 180°, emphasizing the importance of visual factors in IPS comfort within virtual spaces. These results highlight the critical role of environmental design in enhancing the user experience in virtual workplaces.

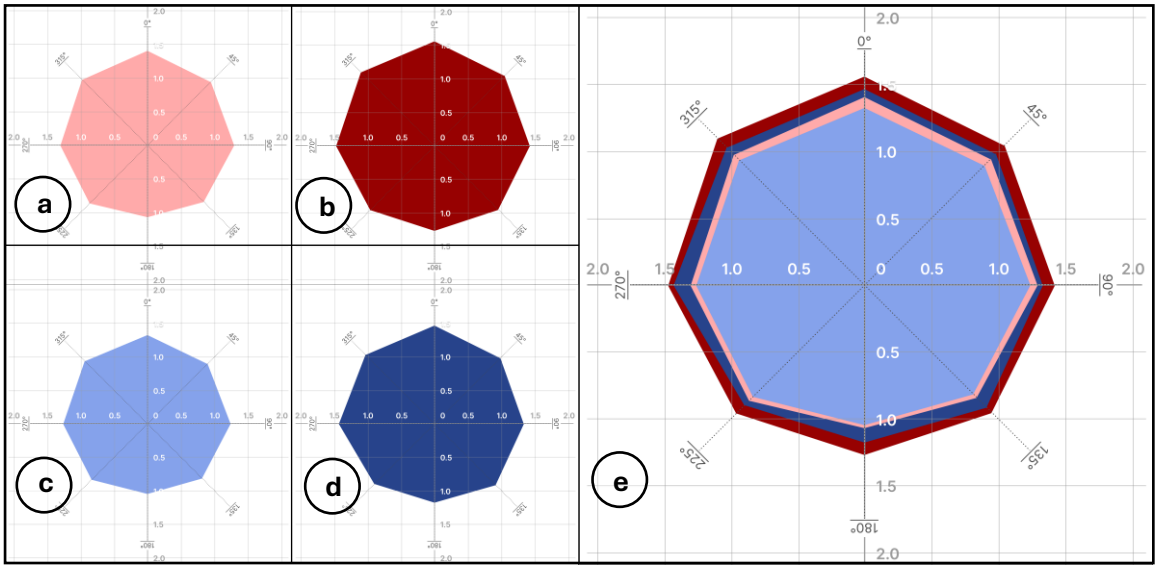
Table 4.1 IPS(m) around the participants when they were approached from eight directions

		0°	45°	90°	135°	180°	225°	270°	315°
Bright Warm	Mean (SD)	1.41 (0.20)	1.35 (0.22)	1.27 (0.21)	1.19 (0.24)	1.07 (0.19)	1.22 (0.25)	1.30 (0.23)	1.39 (0.23)
Dark Warm	Mean (SD)	1.55 (0.36)	1.48 (0.32)	1.42 (0.26)	1.35 (0.33)	1.28 (0.23)	1.37 (0.35)	1.47 (0.32)	1.55 (0.33)
Bright Cool	Mean (SD)	1.32 (0.23)	1.29 (0.23)	1.23 (0.21)	1.15 (0.27)	1.04 (0.18)	1.19 (0.22)	1.26 (0.19)	1.34 (0.26)
Dark Cool	Mean (SD)	1.47 (0.33)	1.39 (0.29)	1.33 (0.29)	1.29 (0.31)	1.18 (0.22)	1.28 (0.28)	1.43 (0.33)	1.47 (0.29)

Table 4.1 shows the means (standard deviations) of IPS of all the participants in the eight directions. The results suggest that the perceived IPS varies significantly with environmental factors. Participants clearly preferred larger IPS in warm-colored settings, irrespective of their position relative to the virtual avatar. This indicates a tendency towards seeking more space in such environments. Contrastingly, bright conditions were associated with smaller IPS, particularly noticeable when avatars approached head-on or from behind. This highlights a psychological component, where individuals may feel less threatened by approaches from the rear, which echoes the findings by Bailenson et al. (2003) and Hayduk (1983). Frontal approaches prompted the need for larger IPS, reflecting inherent social and cognitive behaviors and the instinct to evaluate direct interactions (Buck et al., 2022; Hayduk, 1983). Moreover, the majority of participants' right-hand dominance appeared to affect IPS, with smaller spaces maintained for right-sided approaches. This suggests a link to faster reaction times and a heightened sense of security from the dominant side. This response could point to the evolution of social behaviors and the influence of non-verbal cues, such as gaze direction, on IPS (Bailenson et al., 2003; Bönsch et al., 2020).

Our findings indicate that the spatial design of virtual workplaces should consider these factors, as color tone and brightness affect user comfort and interaction dynamics. Effective VE design for remote collaboration should incorporate strategic color and lighting choices to create spaces that accommodate natural human tendencies regarding IPS, thereby improving the overall user experience in virtual settings.

Figure 5.1 Plot of the IPS. (a) bright warm. (b) dark warm. (c) bright cool. (d) dark cool. (e) combined.



4.2 Spatial Presence

Table 4.2 presents the means (standard deviations) of spatial presence answered by the participants. In our exploration of spatial presence within VEs, participants experienced a more pronounced sense of 'being there' in darker settings, with minimal variation in their sense of agency. Darker rooms fostered

a stronger sense of presence, while brighter rooms lessened the perception of merely observing images. Despite slight variations in Spatial Presence Scores favoring darker environments, these did not significantly influence IPS. Our findings suggest that IPS is primarily affected by spatial design elements like color tone and brightness, underscoring the need for carefully considered spatial design in virtual workplace platforms to enhance user experience and interaction.

*Table 4.2 IVE Group Presence Questionnaire results**

Questions on Spatial Presence	LR Mean (SD)	DR Mean (SD)	LB Mean (SD)	DB Mean (SD)
1. In the VR-generated world, I had a sense of "being there"	3.82 (0.83)	4.02 (0.75)	3.84 (0.97)	3.98 (0.92)
2. Somehow, I felt that the virtual world surrounded me	4.03 (0.71)	4.28 (0.77)	4.11 (0.84)	4.26 (0.69)
3. I had a sense of acting in the virtual space, rather than operating something from outside	3.77 (0.96)	3.95 (0.97)	3.91 (0.96)	3.99 (0.99)
4. I felt present in the virtual space	4.03 (0.82)	4.05 (0.8)	4.12 (0.84)	4.15 (0.83)
5. I felt like I was just perceiving pictures	3.08 (1.22)	2.73 (1.20)	3.33 (1.05)	2.72 (1.38)
Spatial Presence Score	3.71 (0.43)	3.91 (0.38)	3.73 (0.61)	3.92 (0.41)

* For the purpose of this study, only the questions pertaining to spatial presence were selected.

5 CONCLUSIONS

Our research advances the understanding of IPS within VEs by demonstrating the influence of spatial design elements, specifically room color tone and brightness, on IPS. Cooler color tones and brighter settings significantly minimize IPS, suggesting a more inclusive and collaborative virtual workplace, while warmer tones and darker settings increase IPS, potentially creating a sense of privacy and boundary. The directional sensitivity of IPS, with varying IPS depending on the avatar's approach direction, underscores the non-uniform nature of IPS in virtual settings. These results have direct implications for the spatial design of virtual workplaces, where understanding IPS can lead to more efficient space utilization and inform the development of algorithms for avatar movement and interaction, enhancing the sense of naturalness in virtual encounters. Furthermore, this study serves as a foundational step towards establishing a standard for IPS in virtual workplaces, addressing a current gap in the design of these environments. Such standards could improve virtual interactions by respecting IPS while encouraging collaboration. As the virtual workforce grows, refining the spatial design of VEs to optimize comfort and interaction becomes increasingly important. Incorporating these insights, designers and engineers can create virtual workplaces that are user-friendly and adaptive to the diverse needs of the virtual workforce. This research paves the way for a new paradigm in virtual workplace design, where spatial dynamics are not an afterthought but a primary consideration, promoting a more empathetic and effective virtual workplace.

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Sounds of silence: Rhythmanalysis of noise in flexible workspaces

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ABSTRACT

Silence and noise have become an important theme that emerges in studies of collective workspaces. Drawing on an ethnographic field study of a major bank in Paris, this study offers a rhythmanalysis of noise in the context of flexible offices. Findings center noise rhythms as an unfolding in time-space that involves an interlaced relationship between order, and alternations of harmony and conflict. These findings reflect the relational ontological nature of noise and add to a multiplicity perspective on space in organization studies.

Keywords

noise, rhythm, organizational space, silence, sound

1 INTRODUCTION

Silence and noise have become an important theme that emerges in studies of collective workspaces (de Vaujany & Aroles, 2019; van Marrewijk, 2011; van Marrewijk & van den Ende, 2018; Wijngaarden, 2023). Here, collaborative workspaces refer to collective forms of offices such as coworking spaces, maker spaces, and other forms of creative spaces, corporate open-plan offices and open non-assigned offices that are often called hot-desking (Hirst, 2011), activity-based offices (Sivunen & Putnam, 2020), flexible offices, etc. Flexible offices refer to working from activity-based offices and partly teleworking (Taskin et al., 2023). Workers are expected to remain silent in collaborative workspaces (Appel-Meulenbroek et al., 2021), and paradoxically to be 'alone together' (Spinuzzi, 2012). To manage this paradox, workers in coworking spaces developed temporal and spatial patterns for noisy practices, such as socializing (Wijngaarden, 2023). Furthermore, McCormack (2008) suggested undertaking a rhythmanalysis (Lefebvre, 2003) to understand the affective relations and patterns of order that might emerge between the multiple bodies that produce and hear the sound in a particular space.

Hainge (2013) considered noise from a relational standpoint to have an immersive quality, despite being often regarded 'a by-product of an event or process, which is to say that it is produced by certain actions that are affected to achieve an outcome unrelated to the production of noise from the point of view of intentionality'(p. 9), therefore connoted as disagreeable in contrast to silence as the 'perfect state of rest'(p. 15). This connotation was stressed in research on open-plan offices (e.g. Appel-Meulenbroek et al., 2021; Ayoko et al., 2023; Danielsson et al., 2015) as they have been shown noise perceptions to be associated with impaired concentration, loss of control over the workspace and negative effects on job satisfaction. This relational view was highlighted only in a few studies such as in Sivunen and Putnam (2020) study of an activity-based office as perceptions regarding noise and silence were related to expectations regarding movement and to fluctuations between those who regard interruptions as normal and those who do not.

Based upon the discussion above and to disentangle the complex noise process inherent to collaborative workspaces, we turn to Lefebvre's (2003) rhythmanalysis, as he foregrounded rhythm in close association to noise: ' For there to be rhythm, there must be repetition in a movement, but not just any repetition. The monotonous return of the same self-identical, noise no more forms a rhythm than does some moving object in its trajectory' (p. 86). This study examines the following question: *What rhythm emerge from noise in flexible office?* To answer this question, we conducted an ethnographic field study between 2016 and 2019 of Digibank, a major banking organization in Paris, that had introduced a flexible office concept, with quiet areas and regulated and normed noise in collaborative and individual areas.

2 key aspects of lefebvre's rhythmanalysis

"Everywhere there is interaction between a place, a time and an expenditure of energy, there is **rhythm**" (Lefebvre, 2003, p. 25). This definition implies that rhythm is linked to a place or, more precisely, to a "temporalized space" (Lefebvre & Regulier, 2003a, p. 96). Moreover, rhythm refers to a differentiated repetition in time and space, as Lefebvre explains: "rhythms imply repetitions and can be defined as movements and differences within repetition (Lefebvre & Regulier, 2003a, p. 96). Therefore, Lefebvre's rhythmanalysis provides a framework for the analysis of sequences of actions and processes of "real and concrete cases that feature the lives of individuals and groups" (Lefebvre, 2003, p. 25).This framework is constituted by complementary rhythmic registers, including polyrhythmia, eurythmia, arrhythmia.

Polyrhythmia is understood as the interweaving of multiple rhythms that produce a time-space (Beyes & Steyaert, 2012; Edensor, 2010). When diverse rhythms coordinate, they produce a state of eurhythmia, which, in terms of the body, designates a 'healthy' living body. On the contrary, when there is discordance between rhythms, a state of arrhythmia emerges. This discordance of rhythms brings the eurythmic body towards a pathological state: a state of illness.

Central to rhythmanalysis is a concern with the body. Lefebvre stresses that "the theory of rhythms is founded on the experience and knowledge of the body"(Lefebvre, 2003, p. 77). To Lefebvre, a body in a "normal state" is "polyrhythmic and eurythmic" (p. 77). This normal body serves as a research tool for the rhythmanalyst, much the same as a metronome (Elden, 2013). The rhythmanalyst "listens – and first to his body; he learns rhythm from it, in order consequently to appreciate external

rhythms"(Lefebvre, 2003, p. 29). They draw on their whole bodies and all their senses to perceive surrounding rhythms.

3 methodological approach

Insights emerged from an open-ended and inductive research design (Schwartz-Shea & Yanow, 2012), wherein the initial focus was the everyday working life in Digibank following its spatial-temporal transformation at the beginning of 2016. This transformation included introducing working from home one to two days a week and implementing new flexible offices. In these offices, individual desks were no longer allocated to specific employees. Instead, workers moved around the workspace to find the required facilities for three needs: individual work, support activities, and collaboration. Support activities referred to areas housing lockers and printing areas. Spaces for collaboration included meeting rooms, creative and project areas, and conviviality spaces. Spaces for individual work included: workstations in open-plan layouts with 80 unassigned desks for 100 employees, closed phone pods, and one silent closed space per floor than can house up to 10 workstations. Employees were required to clear individual desks from personal belongings if they expect to be absent for more than two hours.

During the fieldwork (2016–2018), the first author role as a researcher was that of participant-as-observer—that is, she was immersed in the community but was known to be conducting research after having sought explicit permission (Ybema et al., 2009). The empirical investigation adopted various qualitative tools with ethnography being the main method (Ybema et al., 2009). We utilized thick descriptions (Geertz, 1973) based on participant observations, interviews, visuals, and autoethnographic accounts using the first author body as a metronome. The data collection comprised three phases. The first phase started in June 2016, just before the implementation of the change at Digibank, and lasted about four months. We collected architectural plans, spatial and temporal guidelines, design notes, and change planning to obtain a clear picture of the institutional rhythms. We also conducted 11 semi-structured interviews with organizational planners, including three facility managers, two architects, and four top managers.

The second phase, from October 2016 to July 2017, corresponded with the initial period after the transformation in which the research perspective shifted towards observing emerging practices, social interactions, and noise routines. Moreover, 27 unstructured interviews were conducted with employees, including facility managers, to glean their initial interpretations of the noise ordering. The last period was one year after the change implementation, from September 2017 to December 2018. Observations were made through habitual interaction with regular silence and noise spaces, nodes, and paths (Edensor, 2010). These were interlaced with the first author personal accounts of silence experience at Digibank, while listening first to her body and mobilizing all her senses (Lefebvre, 2003). We then listened to Digibank's employees' rhythms. Participants from the three research sites, reflecting the polyrhythmic nature of the organization, were given a digital camera and asked to photograph meaningful spaces and objects representing their daily silence experience. The photographs were subsequently discussed in the interviews, which 'offered closer look at what participants consider important [...] open space for the emergence of unexpected topics and themes' (Slutskaya et al., 2012, p. 29).

4 Findings

4.1 Rhythmically ordering noise

The introduction of the flexible office at Digibank gave rise to a particular regime ordering individual and collaborative work and regulating the use of different spaces. Specifically, noise turned out to be one relevant element in organizing everyday life in the flexible office: 'After few weeks post-move to the flex office, we realized that in order to allow our employees to work efficiently, we should deal with the issue of noise' (Jack #C2, September 2016). To do so, the steering committee responsible for the implementation of the flexible office, issued guidelines for the use of spaces. In these guidelines, spaces were designated following the intensity of noise into noisy, silent, and moderately silent areas. Noisy areas were centrally located and comprised closed meeting rooms, open conviviality space, and closed phone pods. Silent spaces were designed as transparent closed spaces and located at the back-front of each floor. The strategic intent of this design was to 'signal that these spaces are only for concentration and confidentiality far from nods of circulation. They are transparent because we aim with the new office to ensure openness and visibility so that employees dare to enter into this space even though it is close' (Victoire #W1, September 2016). However, employees were not supposed to stay in a silent space for more than one hour as 'silent spaces are pre-programmed to not be used more than one hour as afterward they get heated, after all, concentrated work is not supposed to last forever. Besides this permits a good number of employees to benefit from these spaces', added Victoire. In the same vein, phone pods were designed to be used for no more than one hour. Moderately noisy areas primarily referred to open-plan layouts where employees were supposed to conduct individual work and interact with each other briefly while keeping a moderate voice as: 'we aim that employee from different departments, teams know and be open to each other in the open space, but in a moderate way, as we implemented collaborative pods nearby so if they want to work together, they have to leave the open space and move into collaborative pods. The same rule should apply to phone calls. If employees get a call, they should not answer it from their desks but instead from the phone pod nearby' (Jack #C2, September 2016).

To tend towards the rhythmic order of noise, Digibank's management also introduced the rhythmic convention that shapes the intensity of sound in the flexible office: 'Be thoughtful to others and respect their need for silence', 'Be at the appropriate space to your activity at hand', ' At the open space, reduce the sound volume of your mobile, don't speak too loudly or call a colleague sitting far from you', and ' Don't sit more than one hour in silence spaces and calling pods.'

4.3 Eurhythmia and Arrythmia

Our observations show that approximately and during each first hour and last half-hour of the working day, arrhythmic disturbances to the rhythmic order happen at the Digibank flexible office. In this specific period of time, most silent spaces, calling pods, and non-programable collaborative spaces are empty. In the morning, a high volume of noise takes the entire open-plan space as sedentary workers (Hasbi & van Marrewijk, 2024) move around to select a preferred desk for the day, salute each other, and shout a loud 'bonjour' to colleagues on the other side of the open-plan office. Similarly at the last half-hour in the afternoon, in noise, employees disconnect their laptops pack their belongings, and walk to their lockers; while there is always a loud voice shouting '*bonne soiree, a demain'* to the whole

open-plan office. These disturbances were considered by some employees as time-consuming and hindering to their productivity: 'I easily lose two hours to noise in the flex office, from 9 to 10 it is very loud in the open space, it's unbearable even though I put on my headphone. Still, I cannot concentrate as there is a lot of movement at this hour, it's like working in a corridor' (Adele, #M30, February 2018). Arrhythmia reaches a peak of intensity on Tuesday, the day when employees are not allowed to telework and should be present onsite. In this day and particularly when buildings approached maximum capacity, silent spaces transformed into open-plan noisy spaces as employees kept the door open to trick the heating sensor. Moreover, non-programmable collaborative spaces were used to perform individual work and thus in some corners of the flexible office and far from passageways, these collaborative spaces were experienced as silent spaces especially when employees put on their headphones. Conversely, open-plan offices were used to perform collaborative work and become spaces of continual loud noise as 'when an employee has a question for a colleague, they ask the question from their desk, other colleagues joined the conversation' (first author field notes, March 2018). Although the rhythmic order of noise was conceived by Digibank planners and management, employees managed to establish rhythms for noise, that is for instance transforming their domestic workspace into a silent space to perform concentration work. This was emphasized by most of our respondents in different nuances: 'My two days of telework are quiet days allowing me to escape the noises here. It is very calm at my home, and it allows me to concentrate. So, I keep all work that needs concentration for these days' (Nathalie #P24, June 2018). Moreover, to some employees' silence didn't mean complete quietness but listening to chosen sound while working. This was emphasized in varied nuances: 'I only concentrate on telework as I put loud music being alone. What irritates me here is the sound of walking' (Pierre #M20, December 2018).

5 Conclusion

Through a rhythmanalysis (Lefebvre, 2003) of noise in the French Digibank, we found that the introduction of flexible offices in everyday organizational life shapes a multiplicity of noise rhythms into three states: polyrithmia, eurhythmia, and arrythmia. The interplay of these states indicates that noise rhythms are an unfolding in time-space that involves an interlaced relationship between order, and alternations of harmony and conflict. This reflects the relational ontological nature of noise (Hainge, 2013; Sivunen & Putnam, 2020) and adds to a multiplicity perspective on space in organization studies (Beyes & Holt, 2020; Beyes & Steyaert, 2012)

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Lights, Noise, Temperature… Socialise! A Psychological Investigation into Employees' Workspace Environment Satisfaction and their Motivation to Socialise

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ABSTRACT

Workers are motivated to commute to physical workspaces for a variety of personal, spatial, and task-related reasons. However, it remains unclear if and how workers' motivation to socialise with their coworkers interacts with their satisfaction with various physical aspects of the workspace (i.e., lighting, temperatures, noise) and overall workspace satisfaction. Drawing from Cohen and Wills' (1985) stress buffering hypothesis, we propose and test a model wherein satisfaction with physical space attributes correlates with general workspace satisfaction and is moderated by motivation to come into the office to socialise with coworkers. Specifically, we hypothesise that the relationship between physical space attribute satisfaction and general workspace satisfaction will be significant and positive when the desire to socialise is low but will be unrelated when desire to socialise is high. Confirmation of this hypothesis would suggest that the desire to socialise buffers employee's workspace (dis)satisfaction. Using survey data from 542 finance professionals, we found that physical space satisfaction is significantly related to general workspace satisfaction. However, desire to socialise did not moderate the relationship between physical attribute satisfaction and overall workspace satisfaction. Interestingly, correlations suggested that physical workspace attribute satisfaction was significantly correlated with desire to socialise. These findings suggest that although our initial hypothesis was not supported, satisfaction with specific ergonomic workspace characteristics is related to a workers' desire to come into the office to socialise with coworkers. Future research should continue to explore the psychological processes underlying this relationship and to further our understanding of how the built environment aids in satisfying work relational needs.

Keywords

Workspace, Ergonomics, Stress-buffering hypothesis, Workplace socialisation, Workspace design

1. INTRODUCTION

During the COVID-19 lockdown periods, it became clear to many workers that tasks once thought to necessitate in-person attendance could, in fact, be efficiently managed remotely (Diab-Bahman & Al-Enzi, 2020; Hopkins & Bardoel, 2023; Vyas, 2022). This insight prompted a surge in workers' demands for increased work flexibility (Spurk & Straub, 2020). Notably, half of all full-time workers in the U.S. believe their jobs can be performed remotely, and among this group 60% express a preference for a permanent hybrid work model (Gallup, 2024). In the wake of the pandemic, as workers gradually return to their physical workspaces, they are met with unprecedented flexibility (Gallup, 2024). This evolution in work preferences and attitudes has led employers to pay closer attention to the elements that might encourage the use of their corporate real estates (Gupta et al., 2022).

A pivotal distinction between conventional office setups and home office configurations lies in the ability to personalise ergonomic aspects of the workspace. At home, individuals typically enjoy relatively increased autonomy over their environment, allowing them to adjust temperature, lighting, and noise levels to their preference. In contrast, office settings often impose restrictions on such adjustments. For example, employees may not have the liberty to alter the office temperature or use personal heating devices at their desks (Facilities Management Daily, 2020). The disparity in ergonomic control has become more pronounced during the COVID-19 lockdowns, with many workers recognising this as a significant drawback of traditional office environments compared to the comforts of working from home (Diab-Bahman & Al-Enzi, 2020).

Despite these ergonomic limitations, some individuals may be willing to endure less-than-ideal office conditions for the sake of interpersonal interactions. Yang and colleagues (2022) found that knowledge workers particularly value in-person encounters for activities like meetings and informal socialising. Fayard and colleagues (2021) discussed the ever-growing problem of workplace loneliness for remote workers, pointing out that workers often look forward to “human moments” in the office where emotions and empathy may be shared in a face-to-face fashion between employees. These findings suggest that, from the perspective of the employee, the trade-offs between ergonomic comfort and social engagement are crucial considerations in workplace preferences.

The objective of this study is to understand if workers’ motivation to socialise with their coworkers in-person will buffer the potential negative effects of the ergonomic conditions of their physical office on their overall workspace satisfaction. We call upon Cohen and Wills’ (1985) stress buffering hypothesis in testing a model wherein satisfaction with physical space attributes is related to general workspace satisfaction and is moderated by motivation to come into the office to socialise with coworkers.

2. LITERATURE REVIEW

2.1. Workplace Ergonomics

Until recently, workspace design largely followed a "19th Century Model of Work" as described by Duffy (1997), prioritising uniformity, close supervision of workers, and a clear demarcation between work and leisure activities. The dawn of the 21st century, however, has ushered in significant changes in how work is conceptualised and executed. Advances in tools and technology, alongside evolving employer expectations for skill adaptation and the increasing complexity of tasks, have redefined the workplace. Today's work environments are characterised by their non-territorial, mobile nature, challenging the traditional confines of workspace design (Harris, 2015). This evolution has led ergonomic researchers

to explore how the physical attributes of a workplace influence workers as they navigate the flexible working world. Broadly, ambient factors such as temperature, lighting, and noise levels are recognised as critical to supporting this flexibility (Cuerdo-Vilches et al., 2021). Well before the onset of the COVID-19 pandemic lockdowns, corporate real estate professionals have recognised the value of ergonomic considerations in workspace design on employee morale and productivity (de Croon et al, 2005; Vischer, 2007).

Vischer (2007) suggested that worker's satisfaction with their workspace's lighting, noise level, and thermal comfort, were key factors in leading to psychological comfort within workspaces. These three ergonomic variables have been tied to workers' attitudes, well-being, and productivity. Lan et al. (2011) found that exposure to temperatures warmer than usual elicited more negative moods among workers and reduced their willingness to exert effort. Similarly, Rupp et al. (2015) observed that complaints about temperature were directly associated with diminished productivity. Furthermore, Kaarlela-Tuomaala et al. (2009) reported that elevated noise levels could lead to increased distractions, concentration difficulties, and a greater reliance on coping mechanisms. The issue of noise has been extensively explored in workspace design research, particularly in how open-plan offices exacerbate workplace dissatisfaction and negative attitudes through increased ambient noise (Bernstein & Turban, 2018; Makhbul et al., 2022). Makhbul and colleagues (2022), through a dimension reduction analysis, pinpointed acoustics as the foremost stressor in the workplace, with lighting emerging as the second most critical factor. This emphasis on lighting as a pivotal element of workplace satisfaction is echoed in the findings of Hiyasat et al. (2023). These broad studies' findings align with earlier research by Schneider (2002), which underscored the significance of proper lighting in enhancing K-12 students' learning environments.

Hypothesis 1: Physical space satisfaction (a combination of noise, temperature, and lighting satisfaction) will be significantly and positively related to general workplace satisfaction.

2.2. Workplace socialising and the stress buffering hypothesis

The office environment often presents limitations in tailoring key ergonomic features—temperature, noise, and lighting—to individual preferences (Ng., 2010; Awada et al., 2021; Kawakubo & Arata, 2022; Montreuil & Lippel, 2003). Structural and design elements of the workspace itself may impede achieving ideal ergonomic conditions for all workers. For instance, the placement of cubicles can result in unequal access to air conditioning, affecting temperature uniformity across the workspace. While some employers attempt to alleviate these disparities by permitting the use of personal devices such as desk heaters or personal fans (Liu et al., 2020), organisational policies frequently ban such devices due to safety concerns (Facilities Management Daily, 2020), as observed within our study's context. The COVID-19 lockdowns highlighted limitations in controlling environmental noise at home (Puglisi et al., 2021); yet, post-lockdown, the shift to remote work has broadly granted employees greater control over their work environment's ergonomic settings. This autonomy is an important factor driving many employees to favour remote work or seek alternative workspaces outside the traditional office setting (Yang et al., 2022).

However, another force may push workers to work at a traditional office location: workers' desire to socialise with their coworkers. From a career perspective, professional isolation has been identified as an important concern for remote workers (Charalampous et al., 2019). A decrease in informal learning

and opportunities for interpersonal and developmental networking activities were cited as reasons why remote employees may feel professionally isolated (Charalampous et al., 2019). Time away from coworkers and managers during the pandemic lockdowns may exacerbate these worries (Gao & Sai, 2020). Though there are plenty of ways to stay connected with work teams, coworkers, and managers virtually (Briggs et al., 1998; Hertel et al., 2005), some research has found that manager-employee and employer-employee relationships may be strengthened more effortlessly in physically collocated contexts (Hinds & Cramton, 2014). Regardless, cultivating relationships with coworkers and leaders is crucial to feelings of social support for workers (Lakey & Orehek, 2011). Additionally, coworker interaction is associated with numerous positive organisational outcomes. In 2019, Singh and colleagues found that coworker exchange was positively associated with psychological flourishing, which in turn was positively associated with employee performance. In their 2008 review on coworker effects on organisational and worker outcomes, Chiaburu and Harrison found that coworker support (defined as instrumental or affective support through task-directed helping, mentoring, and friendliness) was positively related to task performance, job satisfaction, job involvement, and organisational commitment.

Interacting with coworkers in person can provide social support, potentially mitigating the stressful effects of an unsatisfactory ergonomic environment. The social support provided may be emotional, informational, or instrumental in nature (Viswesvaran et al., 1999). Cohen and Wills' 1985 stress buffering hypothesis describes a model wherein higher levels of social support act as a protective factor which moderates the impact of stress on an individual's well-being (Cohen & Wills, 1985). This suggests that fostering socially supportive relationships in the workplace could be crucial for mitigating the adverse effects of stressful work environments, namely the potential deleterious effects of work environments which are not ergonomically ideal. The stress buffering hypothesis suggest that this may occur as social support provides additional resources to individuals as they expend resources to manage the effects of non-ideal ergonomics. In our study, we leverage the stress-buffering hypothesis to posit that individuals who desire to engage in social interactions with coworkers at the office experience a buffering effect such that the relationship between ergonomic satisfaction and general workplace satisfaction will be not significant when socialisation desire is higher and thus, presumably, buffers potential effects of poor ergonomics on general satisfaction. To note, hypotheses are tested cross-sectionally, and directional effects are not tested.

Hypothesis 2: The relationship between physical space satisfaction and general workspace satisfaction will be significant and positive when the desire to socialise is low but will be unrelated when desire to socialise is high.

3. METHOD

3.1. Procedure

This study was conducted in the context of a workspace redesign project in a large financial organisation from January to July in 2023. The primary objective of the project was to gather insights into desired changes to office space, motivations behind these preferences, as well as scheduling and job task details. In the initial data collection phase of the redesign initiative, workers throughout each department in the organisation were engaged in focus group participation and survey responding. The data for this study comes exclusively from this preparatory and initial data collection phase of the redesign project. Furthermore, all data were collected cross-sectionally.

3.2. Participants

Participants were employees of a large financial organisation who were asked to participate in a workplace redesign initiative survey. Out of an initial 754 participants, 212 were filtered out to retain only office workers, resulting in a sample of n = 542. The survey was distributed by an organisation executive and was followed by three follow-up reminders. Respondents were distributed across seven major cities in the Southeast US. Participants had an average tenure of 14.1 years (*SD* = 9.77). Participants were employed at a wide variety of job levels (individual contributor = 68.8%, manger = 9.3%, section manager = 2.3%, director = 11.5%, assistant vice president = 3.8%, vice president or higher = 3.8%). Finally, participants were employed across a wide range of business operations (business technology & security = 8.22%, engagement = 9.02%, bank services = 8.36%, financial services = 11.14%, other financial services = 2.65%, internal compliance= 2.52%, legal = 1.33%, research= 6.9%, supervision and regulation = 23.47%, executive = 0.27%, strategy and risk = 1.19%). Employee demographic information was not able to be collected.

3.3. Measures

The content of the survey was developed partly from responses from 58 focus groups which were conducted across all organisation departments to find out the greatest issues in the current workplace and greatest future workplace needs. All survey item responses were indicated on a 1-5 Likert scale (1 “Strongly Disagree” - 5 “Strongly Agree”). For the socialisation variable, respondents were told “For the following questions, indicate your agreement about why you come into the office”, and were then prompted to respond to, “I physically come into the office to socialise with others”. For the satisfaction measures, respondents were first asked “Indicate your satisfaction with the [organisation’s] workspaces in general”, and then … “for noise level at my work area”, “temperature at my work area”, and “lighting at my work area”.

3.4. Analytical Approach

We used linear regression in R (R Core Team, 2020) to determine the beta-coefficient between physical workspace attributes and workplace satisfaction. Furthermore, we moderated that regression to determine the influence of employee desire to socialise on the relationship between physical workspace attributes and workplace satisfaction. Additionally, we calculated between-persons correlation coefficients between all variables. We used null hypothesis testing to determine whether results were statistically significant ($\alpha = .05$).

4. RESULTS

Between-persons correlations between all variables were calculated (Table 1). Within the correlation matrix, we observe that unique, as well as the sum of, physical space variables are significantly related to both desire to social and workspace satisfaction. The singular exception to this is the not significant relationship between light satisfaction and desire to socialise.

Table 1. Between-persons correlations between physical workspace variables, desire to socialise, and workspace satisfaction.

Variables	*M(SD)*	1	2	3	4	5
1. Noise satisfaction	3.31(1.12)	-				
2. Temperature satisfaction	3.26(1.05)	.38***	-			
3. Light satisfaction	3.45(1.08)	.32***	.39***	-		
4. Sum physical space attribute satisfaction	10.02(2.46)	.76***	.77***	.75***	(.63)	
5. Desire to socialise	3.49(1.14)	.17***	.11***	-.03	.11*	-
6. Workspace satisfaction	3.61(0.87)	.44***	.39**	.39***	.51***	.09*

Note. *** = $p < .001$, ** = $p < .01$, * = $p < .05$. Sum physical space attribute satisfaction is the sum of noise satisfaction, temperature satisfaction, and light satisfaction. Reliabilities as Cronbach's alpha are presented along the diagonal.

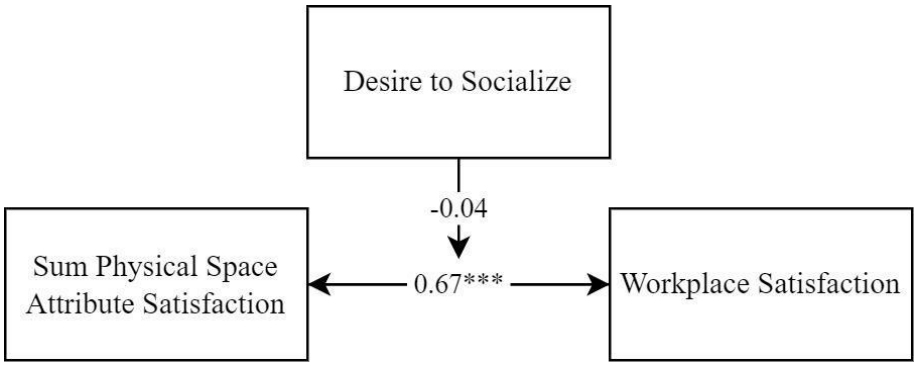
A moderation regression model was calculated (Table 2; Figure 1). Results indicated that physical space satisfaction was significantly related to general workspace satisfaction (β = 0.67, *SE* = 0.13, $t(538) = 5.088$, 95% CI [.41 .92], $p < .001$). However, desire to socialise did not moderate the relationship between physical attribute satisfaction and overall workspace satisfaction (β = -0.04, *SE* = 0.03, $t(538) = -1.07$, $p = .28$). Interestingly, exploratory analyses suggested that sum physical workspace attribute satisfaction was significantly correlated with desire to socialise ($r = 0.11$, $t(540) = 2.59$, 95% CI [.03 .19], $p = .01$). The exclusion of light satisfaction, the singular physical workspace variable not related to desire to socialise, did not change the significance of the results of the moderation analysis.

Table 2: Regression of correlations between physical workspace variables and workspace satisfaction, moderated by desire to socialise.

Variable	β	*SE*	t-value	p-value
Intercept	1.3	0.44	2.99	< .01
Desire to socialise	0.15	0.12	1.25	.21
Sum physical space attribute satisfaction	0.67	0.13	5.09	< .001
Sum physical space attribute satisfaction: desire to socialise	-0.04	0.03	-1.07	.28

Note. Sum physical space attribute satisfaction is the sum of noise satisfaction, temperature satisfaction, and light satisfaction.

Figure 1. Final moderation model.



5. DISCUSSION

The purpose of the present study was to propose and test a model wherein worker satisfaction with ergonomic features of an office relates to general workspace satisfaction and is moderated by motivation to come into the office to socialise with coworkers. We found that ergonomic satisfaction is significantly related to general workspace satisfaction. Contrary to our hypothesising, the desire to socialise did not moderate the relationship between ergonomic satisfaction and overall workspace satisfaction.

While our second hypothesis was not confirmed by our findings, a noteworthy correlation was discovered: ergonomic satisfaction (i.e., temperature and noise) is significantly correlated to employee's intent to come into the office to socialise with their coworkers. This observation coordinates with the resource perspective widely discussed in psychological literature, particularly within the framework of the Conservation of Resources (COR) theory (Hobfoll, 1989). Broadly, in psychological literature, the COR framework describes how individuals acquire, maintain, and deploy tangible and intangible resources to achieve personal or organisational outcomes. By addressing ergonomic concerns, organisations may then free up cognitive and emotional resources that employees can then allocate toward socialising with colleagues. Thus, increasing satisfaction with ergonomic conditions could potentially facilitate social interaction by eliminating a perceived barrier and creating a more comfortable environment for interactions. These findings suggest that although our initial hypothesis was not supported, satisfaction with specific ergonomic workspace characteristics (i.e., temperature and noise) is an important factor related to workers' desire to come into the office to socialise with coworkers.

5.1. Implications

We did not find evidence supporting that socialisation intention mediated the relationship between ergonomic satisfaction and workplace satisfaction as expected per the stress buffering hypothesis. This may be due to several factors, including the use of an indirect measure of social support and a possible restriction of range in the ergonomic conditions. However, the findings of this study stress the importance of addressing ergonomic workspace factors in improving workplace satisfaction. First, ergonomic aspects such as lighting, temperature, and noise levels not only are related to employees' satisfaction with their workspace but, in the case of temperature and noise, might also serve as pull factors, prompting workers to feel more inclined to come into the office to socialise. By increasing satisfaction with ergonomic characteristics, organisations can potentially remove barriers to socialise.

This may lead to the fostering of greater opportunities for in-person interactions among team members. Conversely, it is also possible that individuals who are more inclined to socialise perceive the ergonomic conditions of their office more favourably. One important step organisations can take is to collect data on their employee's attitudes on their workspace's ergonomic conditions. It is especially crucial to collect data from a variety of workspace locations within the office and across all job levels, as the conditions across workstations and areas in one building can vary considerably.

Finally, organisational socialisation is a wider process by which workers learn the content and processes associated with their role in an organisation as well as social norms associated with the organisation in general (Chao et al., 1994). Promoting socialisation within the office environment may lead to numerous organisational benefits, including improved worker retention, enhanced knowledge-sharing, and increased organisational commitment (Bauer & Erdogan, 1998). One key aspect of this process includes informal interactions between coworkers. It is therefore crucial for organisational leaders to prioritise ergonomic satisfaction in their workspaces. Organisational decision makers should also recognise that fostering interpersonal interactions and socialising within a workspace requires intentional effort. Setting aside time for social hours or creating dedicated areas for informal gatherings can significantly enhance these interactions. This responsibility extends to immediate managers, as this group of workers may advocate for the implementation of workspace improvements and foster a supportive work environment conducive to social interaction. By recognising and addressing the importance of ergonomic workspace factors, organisations can cultivate a more engaged workforce, possibly contributing to their long-term success.

5.2. Limitations & Future Directions

In our study, we did not measure trait differences among employees. Future research should examine individual differences in personality and motivation, as these aspects could influence responses to workspace redesign initiatives. Additionally, given the cross-sectional nature of our study, future research should aim to explore these variables more thoroughly. Employing longitudinal designs, such as measuring employees' feedback before and after workspace redesigns with ergonomic changes, could offer a clearer understanding of how these interventions impact employee behaviour over time. Finally, future research should continue to explore the psychological processes underlying the relationship between ergonomic satisfaction and the intent to come into the office to socialise. Doing so may further our understanding of how the built environment aids in satisfying work relational needs.

6. CONCLUSION

The increasing flexibility of work environments ushers in new questions related to how the traditional office workspaces need to be designed. Workers are, now more than ever, actively comparing their at-home setups with that of their traditional offices'. For many, the home provides an ideal work environment where productive work and work-related socialising may occur. However, for those who wish to come into the office for in-person socialising, the ergonomic qualities of the office might be associated with that wish. Ensuring satisfactory temperature, noise, and lighting within the office could be related to workers perceiving the office as a more supportive environment for social interactions.

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Transforming acoustic environments: A comparative pre-post analysis of acoustic comfort and noise disturbance in three renovated offices based on the ISO 22955:2021.

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ABSTRACT

The prevalence of open-plan offices is on the rise, eliciting concerns among users primarily due to noise and the challenge of balancing two seemingly conflicting acoustic activities: oral communication and concentrated individual work. Within such environments, disruptions arising from speech can lead to tensions between individuals seeking focus and those obligated to engage in verbal communication as part of their tasks.

This research investigates the intricate relationship between acoustic comfort, noise disturbance, and their consequential effects on human health and wellbeing, with a specific focus on the guidelines outlined in ISO 22955:2021. The International Organization for Standardization (ISO) introduced this standard as a comprehensive framework to assess and manage acoustic comfort in various environments inked to the obligations of the activity.

The study examines the impact of transforming three diverse office environments into open office spaces on acoustic comfort, referencing ISO 22955:2021 guidelines. Evidence-based data was gathered through pre- and post-renovation surveys, coupled with acoustic measurements in the newly transformed spaces.

Results indicate a notable improvement in subjective experiences post-renovation, with occupants reporting enhanced health and wellbeing alongside reduced noise disturbances. However, challenges emerged in aligning the open-offices with the sometimes stringent requirements of ISO 22955:2021. Balancing the need for spaces with speech privacy (concentration) or speech intelligibility (collaboration) posed difficulties, highlighting the nuanced nature of open-office design.

The research provides valuable insights for architects, interior designers and other stakeholders involved in designing open office spaces, emphasizing the positive impact of a good balanced indoor acoustic environment on subjective occupant experiences. By integrating ISO 22955:2021 guidelines, the research contributes to a nuanced understanding of optimizing acoustic comfort in contemporary office environments. The findings underscore the importance of adopting evidence-based strategies to

create workspaces that not only comply with standards but also enhance the health, wellbeing and satisfaction of occupants.

Keywords

Acoustic comfort, open-plan offices, noise disturbance, ISO 22955:2021

1 INTRODUCTION

The rise of open-plan offices presents challenges related to noise management and the conflicting acoustic needs of occupants. This paper explores the intricate relationship between acoustic comfort, noise disturbance and their impacts on human health and wellbeing within open-plan office (OPO) environments, with a specific focus on ISO 22955:2021 guidelines.

1.1. The increasing prevalence of open-plan office designs

The rise of OPO has been a global trend in recent years, driven by numerous factors such as the desire to increase collaboration, communication and cost-effectiveness in the workplace [1,2]. These offices offer benefits such as increased usable space, higher occupant density and improved interaction among employees due to the removal of internal walls [3,4]. However, this layout has raised concerns about privacy, noise levels and interruptions, impacting wellbeing, job satisfaction, and performance [5-7]. Noise distractions in OPO can lead to productivity loss, particularly for tasks requiring complex verbal processes and are linked to higher annoyance and mental health issues [8]. Additionally, the lack of privacy and control over noise and interruptions has been associated with higher sick leave rates, especially in large OPO settings [9]. Research indicates that even low noise levels can cause disturbances, affecting cognitive performance and causing extended physical and psychological effects like fatigue and anxiety [10]. The impact of noise on workplace satisfaction in OPO has been identified as a significant factor influencing overall employee satisfaction [11]. Studies have shown that minor deteriorations in acoustical room properties can adversely affect self-rated health and overall disturbances among employees [12]. Providing a satisfactory indoor acoustic environment in OPO is crucial for promoting employee performance and satisfaction, despite various challenges related to noise perception and workplace distractions [13,14].

1.2. The concept of acoustic comfort and its importance in such environments

The acoustic comfort at the workspace is determined by the individuals' subjective perception of the sound environment and its influence on their comfort and performance. In OPO, where balancing oral communication and focused work is vital, managing acoustic comfort is key [15]. This trade-off between privacy and communication in activity-based workspaces can limit opportunities for confidential discussions and concentrated work, impacting workspace satisfaction [16,17]. Previous research points out that the room acoustic improvement of OPO can usually be achieved by introducing a sound absorbing suspended ceiling and dividing floor- or desk screens between working positions, but there are different solutions required depending on spatial geometries of the office [18]. Establishing behavior protocols for sound privacy and implementing acoustical treatments like sound-absorbing ceilings and walls can significantly enhance acoustic comfort in workspaces [19]. These

findings emphasize the importance of creating office environments with enhanced room acoustic conditions to promote employees' wellbeing and productivity. Following guidelines such as ISO 22955:2021 [20] make it easier to assess and control acoustic comfort and design workspaces that maximize the comfort and the balance between speech privacy and speech intelligibility. The objective of this study is to investigate how the ISO 22955 works in practice, what influence it has on the interior design and how it influences the experience and the acoustic comfort of the users. Additionally, it offers insights on how to enhance acoustic comfort, reduce noise disturbances and improve employee wellbeing in OPO settings. It also highlights the benefits of using sound-absorbing materials, provide data-driven guidance for future office designs and emphasize the link between improved acoustics and employee satisfaction.

2 ISO 22955:2021: A Comprehensive Framework

ISO 22955:2021 is an international standard released by the International Organization for Standardization (ISO) that provides a comprehensive framework for assessing and managing acoustic comfort specifically for open office spaces. The standard was introduced to address the growing concerns and challenges related to acoustic comfort in OPO environments, where noise disturbances and the need to balance different acoustic activities, such as oral communication and concentrated individual work, have become increasingly prevalent. ISO 22955:2021 emphasizes the importance of balancing the acoustic needs of different activities within a space, while considering the preferences and comfort of occupants. By incorporating evidence-based strategies and measurements, the standard aims to create environments that not only comply with acoustic regulations but also promote a positive user experience.

2.1 Overview of ISO 22955:2021 activities and the acoustic parameters

The standard is applicable to all OPO in which the following activities are performed and divided in Space type 1 to 6;

1) activity not known yet – vacant floor plate
2) activity mainly focusing on outside of the room communication
3) activity mainly based on collaboration between people at the nearest workstations
4) activity based on a small amount of collaborative work
5) activity that can involve receiving public
6) combining activities within the same space

The standard describes specifies acoustic indicators and values tailored to accommodate these activities individually. In reference to paragraph 1.3 of this paper, speech is the most distracting sound source in open offices. For that reason, the standard is focused on containing speech propagation between workstations, between work clusters and on the entire floor. In this study we investigate the different space types, focused on Space type 3 and 4. For a better understanding we summarized the acoustic parameters underneath in relation to the interactivity (Table 1.). The ISO 22955:2021 guidelines can serve as a valuable tool for evaluating the acoustic performance of a space and

implementing measures to enhance comfort and wellbeing. For that reason we investigated if this standard could be applied to the renovation of three different offices.

- $L_{Aeq,T}$ = the A weighted sound pressure level in occupied setting in dB (target value, no design criterium)
- $D_{A,S}$ = the decay of A weighted sound pressure level of speech at the opposite desk in dB; (relative to one meter distance)
- T_r = the reverberation time in seconds
- $D_{2,S}$ = the decay of A weighted sound pressure level of speech per doubling of the distance over a line of workstations
- $L_{p,A,S,4m}$ = the A weighted sound pressure level of speech at 4 meters distance (derived from a line)

2.2 Challenges of implementing ISO 22955:2021 in open-plan office environments

Research has shown that meeting the acoustic requirements outlined in ISO 22955:2021 can be challenging in OPO particularly when dividers/screens between workstations and fundamental room acoustic features are absent [21]. Given the limited research on challenges associated with the ISO standard's application, this study also sought to explore these potential obstacles.

Table 1. Acoustic parameters in relation to the interactivity

Space type	interactivity	acoustic challenges	LAeq,T (dB)	DA,S (dB)	Tr (S)	D2,S (dB)	Lp,A,S,4m (dB)
2)	communication	Limit aural exposure to the ambient noise	< 55	≥ 6	≤ 0.5	≥ 7	≤ 47
3)	collaboration	Creating a high level of intelligibility between workstations	< 52	≤ 4	≤ 0.5	≥ 8	≤ 48
4)	concentration	Reduce intelligibility between workstations	< 48	≥ 6	≤ 0.5	≥ 7	≤ 47

3 METHODOLOGY

This study involved the renovation and transformation of three office buildings, situated in Belgium (BE), Denmark (DK) and the Netherlands (NL), into OPO. The primary objective behind this transformation was to enhance the energy efficiency of the buildings. However, the renovation was also driven by the evolving needs of the workforce towards hybrid working arrangements, the desire to enrich employee experiences, foster collaboration and innovation, mirror the respective companies' cultures and brand

identities and integrate the latest advancements in workplace design, technology and sustainability practices.

3.1 General information about the investigated office buildings

The office renovation timeline in Denmark spanned from May 2021 to end of 2022, for the office in Belgium from July 2021 to June 2022 and for the office in the Netherlands from October 2022 to April 2023. Prior to the renovation, the office environments of the three buildings comprised a mix of enclosed offices (individual), small group offices (collective) and smaller OPO accommodating 4-8 workstations. The new office layouts are summarised in Table 2, while the updated floor plans and some reference pictures are illustrated in Figures 1 to 3.

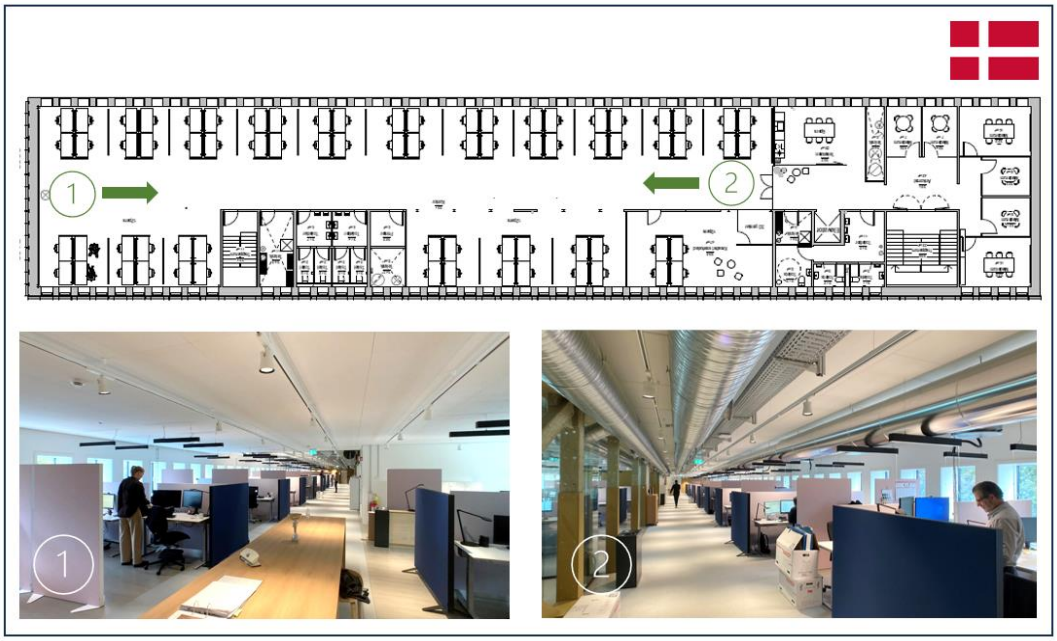
Table 2. General information about the investigated office buildings

office location	Belgium	Denmark	Netherlands
floor area (m2)	465	698	567
break-out space (m2)	57	47	75
enclosed office (m2)	18	0	18
rooms for (online) meetings and concentration (m2)	59	60	110
open-plan office (m2)	332	506	273
no. of workstations (desk+chair) in the open-plan office	30	72	22
available m2 per workstation	11,07	7,03	12,41

Figure 1. Transformed NL office

Figure 2. Transformed DK office

Figure 3. Transformed BE office



3.2 Data collection: pre- and post-renovation user surveys

Pre- and post-renovation surveys were conducted to gather feedback from occupants regarding their subjective experiences in the office environments. The online tool 'SurveyMonkey' was used for the pre-survey and 'Typeform' for the post-survey. The surveys followed the GABO Questionnaire as mentioned in Annex D of the ISO 22955:2021. It focuses on aspects such as the noise environment, distractions, speech intelligibility, health and overall comfort. For the pre-renovation survey (May 2022) we approached the employees (n = 175) by sending an email to all eligible employees who were not on parental/sick leave, with information about the study and a link to the questionnaire, and 70% responded. The second survey (Sept. 2023) was sent to the employees (n = 164) with a response rate of 57%. This was approximately 6-10 months after the renovation completion, depending on the location of the office. The participants sample size and population characteristics are shown in Table 3 and 4.

Table 3. Participants gender

gender	before		after	
	n	%	n	%
female	53	43	39	42
male	68	55	52	56
other	1	1	1	1
rather not say	1	1	-	-
total	123		93	

Table 4. Participants age range

age	generational labels	before		after	
		n	%	n	%
18 - 24	Generation Z	3	2	1	1
25 - 40	Millennials	37	30	27	29
41 - 56	Generation X	64	52	47	51
57 - 66	Baby Boomer	18	15	18	19
66 +	Baby Boomer	1	1	0	0
	total	123		93	

3.3 Data collection: room acoustic calculations and measurements

In addition to the surveys, acoustic consultants conducted room acoustic calculations to assess compliance with the room acoustic parameters as shown in Table 1. However, this evaluation was limited to the offices in BE and NL, as the ISO 22955:2021 was not published yet during the design phase of the office in DK. The post-room acoustic measurements are conducted in all three offices and performed as described in the ISO 22955:2021 with following the procedure as described in ISO 3382-2:2010 [22] and ISO 3382-3:2022 [23] using an omnidirectional sound source and omnidirectional microphone. Pre-room acoustic measurements were only conducted in the NL office. For the calculations, the acoustic consultants used the 'CATT Acoustics' software tool.

4 RESULTS

The surveys conducted among employees provided valuable insights into their subjective experiences and perceptions of the office environments, offering a complementary perspective to the objective room acoustic measurements. Analysis of survey responses revealed a correlation between occupants' reported levels of satisfaction and the observed improvements in acoustic parameters following the renovations. Specifically employees in the post-renovation phase reported enhanced comfort, reduced noise disturbances and improved communication compared to their pre-renovation counterparts. Furthermore, the survey responses highlighted specific areas of concern, such as speech privacy and speech intelligibility, which were corroborated by corresponding acoustic measurements.

4.1 Room acoustic measurements in transformed spaces

To assess compliance with the room acoustic indicators and values outlined in ISO 22955:2021, it is crucial to determine the 'Space type'. The BE office adopted 'Space type 4', characterized by limited collaborative work, as its starting point, as decided by the building owner and facility manager. Similarly, the NL office opted for 'Space type 3', emphasizing collaboration among nearby workstations. In the absence of a predefined Space type during the design phase for the DK office due to the unavailability

of ISO 22955:2021, 'Space type 4' was adopted during construction. Tables 5 and 6 summarize the recommended, calculated and measured values for the BE and NL offices, while Table 7 presents those for the DK office. Overall, the measurements indicate compliance with the standard, although the most significant deviation was observed in the reduction of noise to "the opposite desk" (DA,S), where the attenuation does not meet ISO 22955:2021 requirements. The crux of the matter is that in collaborative spaces (NL office), the desk or floor screens are too high, whereas in areas designated for concentration (BE office), they are too low. This also accounts for the discrepancy between the calculated DA,S value (8dB) in the BE office, which is higher than the measured value (4dB). The acoustic consultant recommended a desk screen height of 65 cm (above desktop), whereas a height of 46 cm was implemented. Conversely, in the NL office, the calculated DA,S was lower (4dB) than the measured value (7dB). This could be attributed to the computer screens being positioned higher (50cm) than the desk screens' (35cm), obstructing the sound waves (see illustration in Figure 1).

Table 5. Average room acoustic values BE office

space type 4. Individual work	target LAeq,T (dB)	DA,S (dB)	Tr (S)	Tr 125Hz (S)	D2,S (dB)	Lp,A,S,4m (dB)
recommended	< 55	≥ 6	≤ 0,5	≤ 0,8	≥ 7	≤ 47
calculated	-	8	0,4	0,8	5	47
measured	-	4	0,4	0,8	7	49

Table 6. Average room acoustic values NL office

space type 3. Collaborative work	target LAeq,T (dB)	DA,S (dB)	Tr (S)	Tr 125Hz (S)	D2,S (dB)	Lp,A,S,4m (dB)
measured before ren.	-	7	0,3	0,5	12	53
recommended	< 52	≤ 5	≤ 0,5	≤ 0,8	≥ 9	≤ 49
calculated	-	4	0,5	0,7	8	48
measured after ren.	-	7	0,3	0,4	9	46

Table 7. Average room acoustic values DK office

space type 4. Individual work	target LAeq,T (dB)	DA,S (dB)	Tr (S)	Tr 125Hz (S)	D2,S (dB)	Lp,A,S,4m (dB)
recommended	< 55	≥ 6	≤ 0,5	≤ 0,8	≥ 7	≤ 47
measured	-	10	0,3	0,3	9	44

Tables 5 and 6 summarize the recommended, calculated and measured values for the BE and NL offices, while Table 7 presents those for the DK office. Overall, the measurements indicate compliance with the standard, although the most significant deviation was observed in the reduction of noise to "the opposite desk" (DA,S), where the attenuation does not meet ISO 22955:2021 requirements. The crux of the matter is that in collaborative spaces (NL office), the desk or floor screens are too high, whereas in areas designated for concentration (BE office), they are too low. This also accounts for the discrepancy between the calculated DA,S value (8dB) in the BE office, which is higher than the measured value (4dB). The acoustic consultant recommended a desk screen height of 65 cm (above desktop), whereas a height of 46 cm was implemented. Conversely, in the NL office, the calculated DA,S was lower (4dB) than the measured value (7dB). This could be attributed to the computer screens being positioned higher (50cm) than the desk screens' (35cm), obstructing the sound waves (see illustration in Figure 3).

4.2 Subjective experiences via pre- and post-renovation surveys

Pre- and post-renovation surveys were conducted to gather feedback from occupants regarding their subjective experiences in the office environments. In total 98 questions were asked, divided in three chapters; 1. "*You and your workplace*" (n=54), 2. "*Your relation to noise in general*" (n=31) and 3. "*You and your health*" (n=12). In this study we prioritize analyzing the key findings of the survey. This focused approach helps us gain valuable insights into our research questions. One of the first questions was in what kind of office space the employees are working and what kind of office space they would desire. Figure 4a. and figure 4b. illustrates the options provided, along with corresponding responses. The findings indicate a shift from varied office setups to OPO and semi-open office configurations (93%). Notably, despite 42% currently working in fully open offices, a significant majority express a preference for semi-open setups (57%), with no one opting for full open offices. Some employees responded with a preference for a combination of home office and semi-open office (3%) after the renovation

Figure 4a. In what kind of workspace in the office are you working?

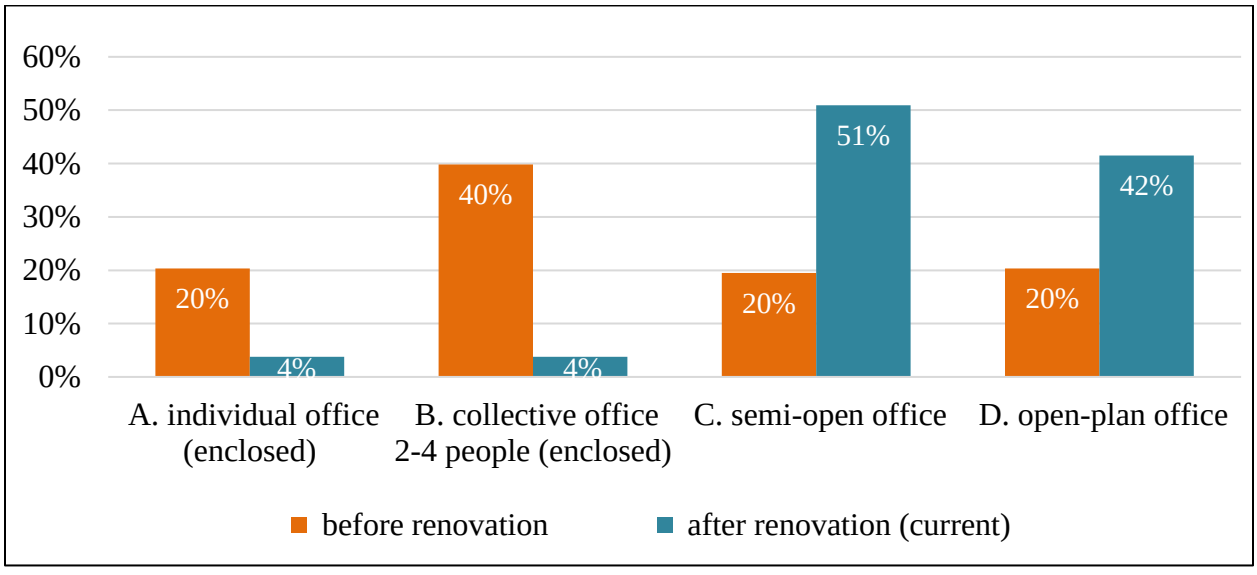
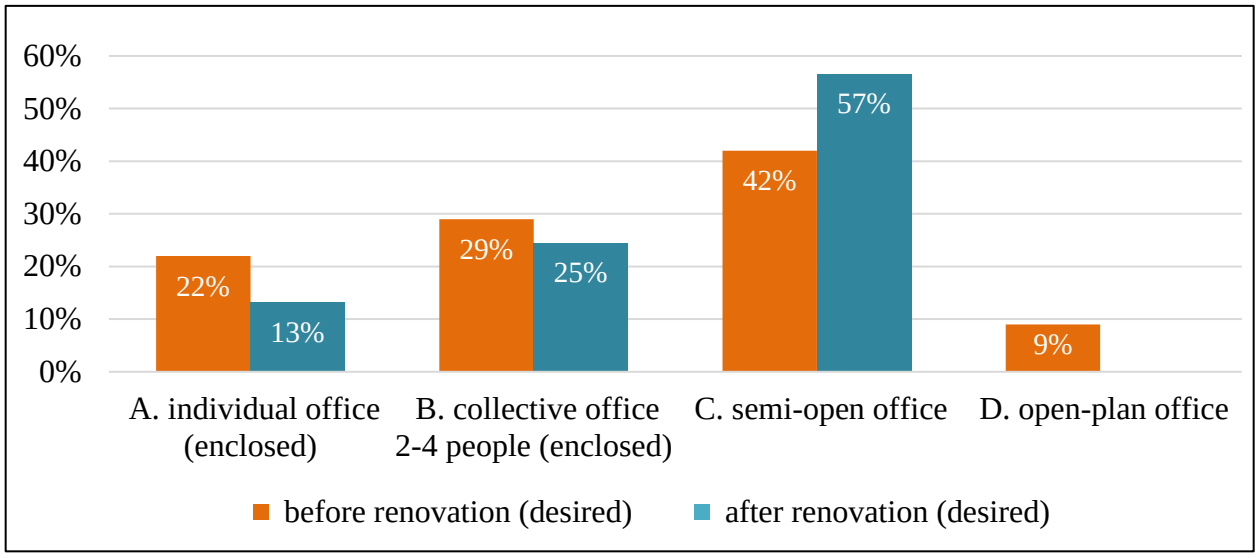


Figure 4b. In what kind of workspace in the office do you desire to work?



The employees working in the newly renovated offices reported a decrease in noise levels and with that a quieter work environment (Figure 5). Consequently, they report a reduction in noise disruptions, as illustrated in Figure 6.

Figure 5. Degree of noise

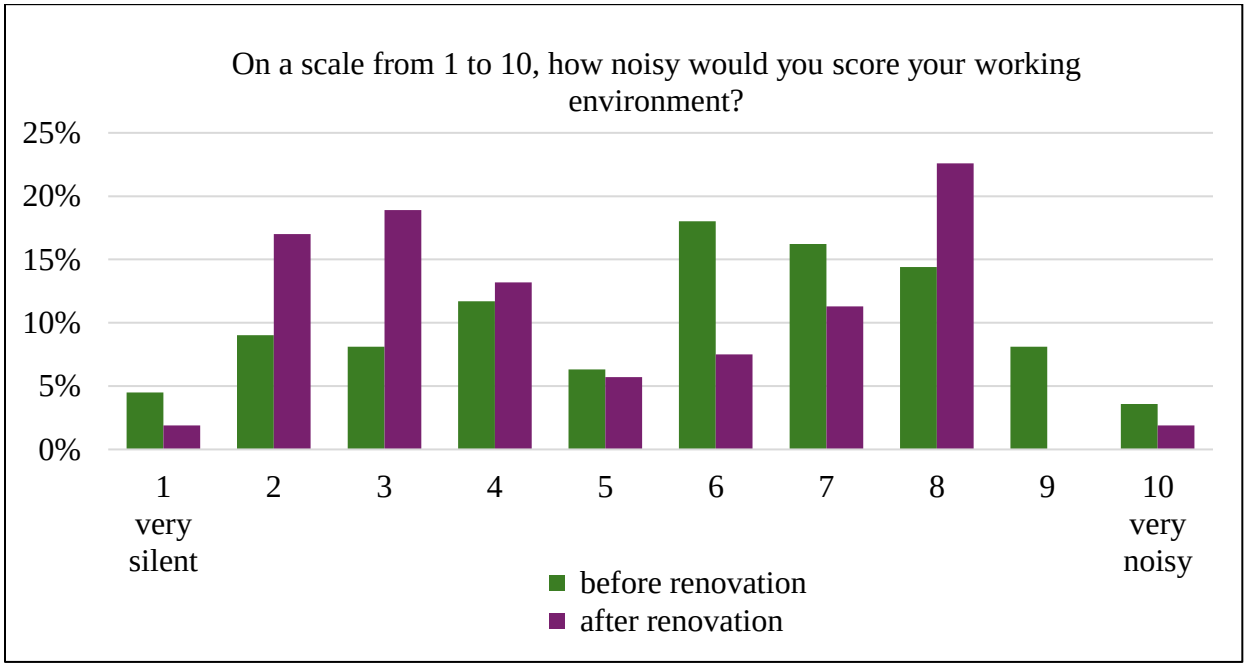
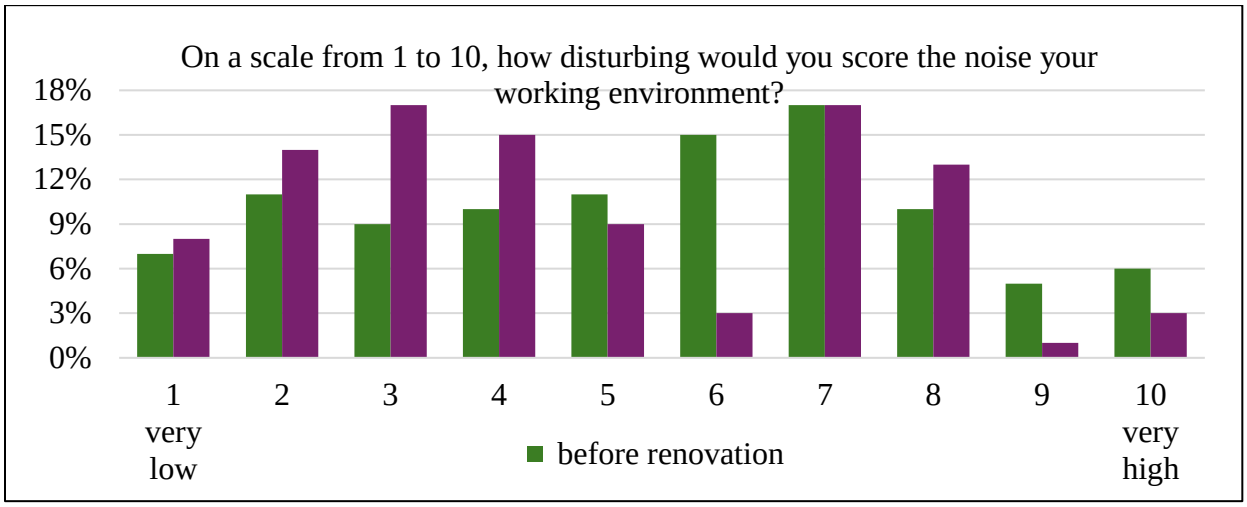
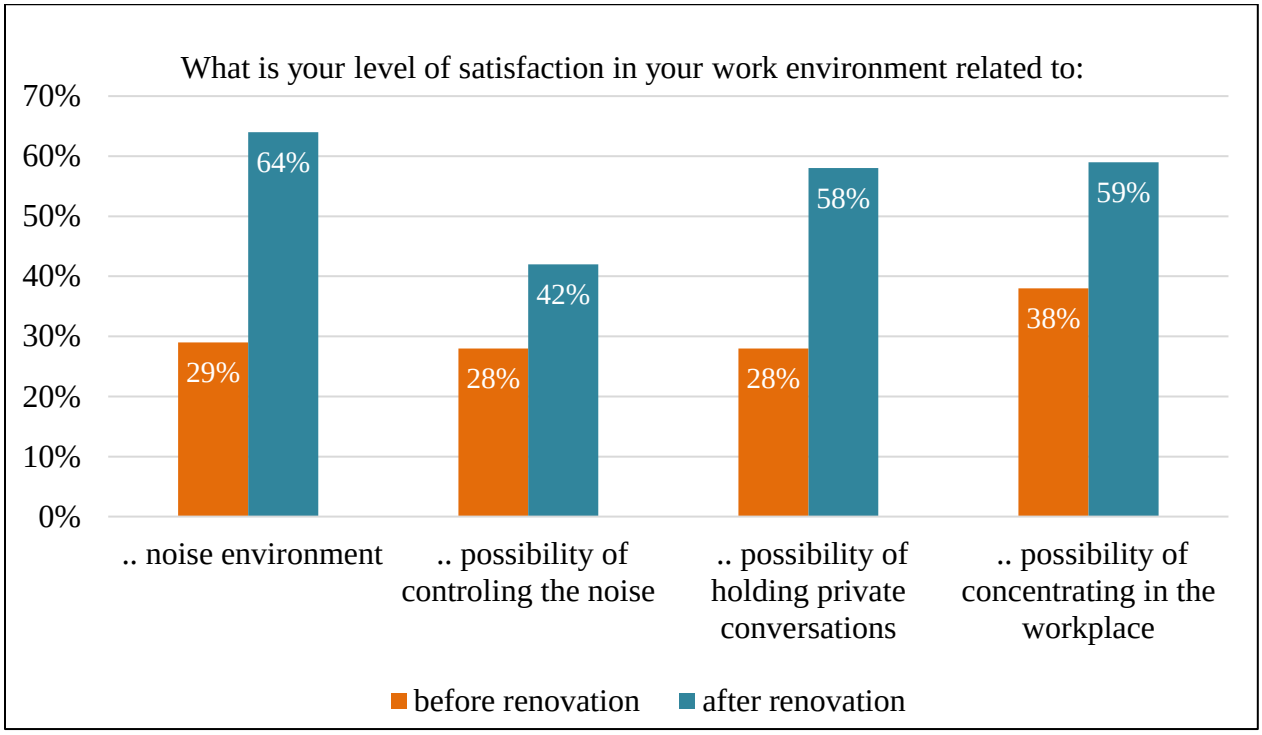


Figure 6. Degree of disturbance



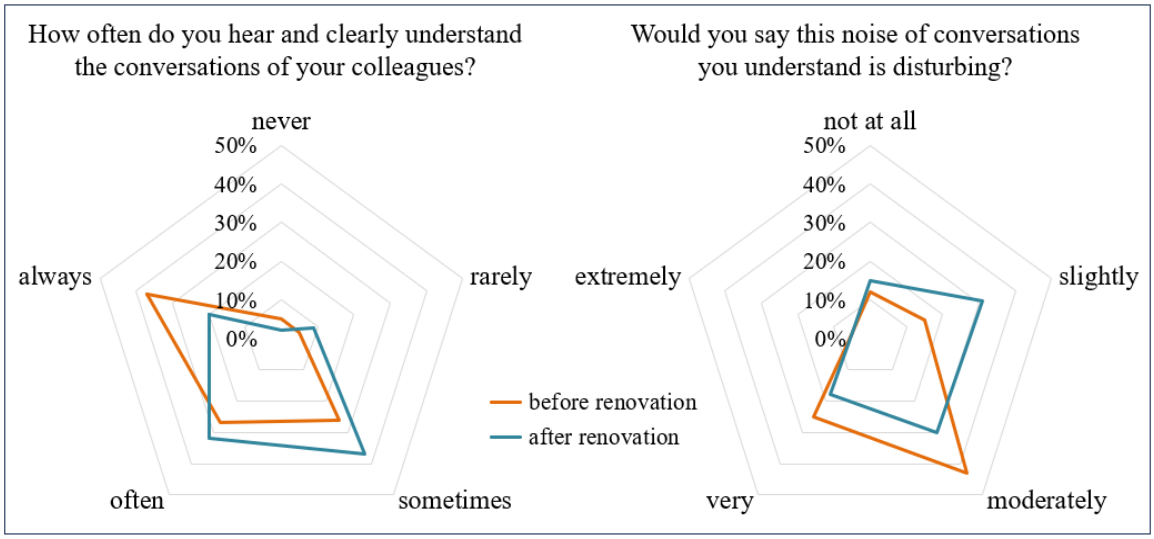
The survey participants were asked about their workplace satisfaction across various aspects, using a 'Likert' scale ranging from *'very unsatisfied'* to *'very satisfied'*. Figure 7 displays the combined percentage of responses indicating *'satisfied'* and *'very satisfied'*.

Figure 7. Percentage of responses: satisfied / very satisfied



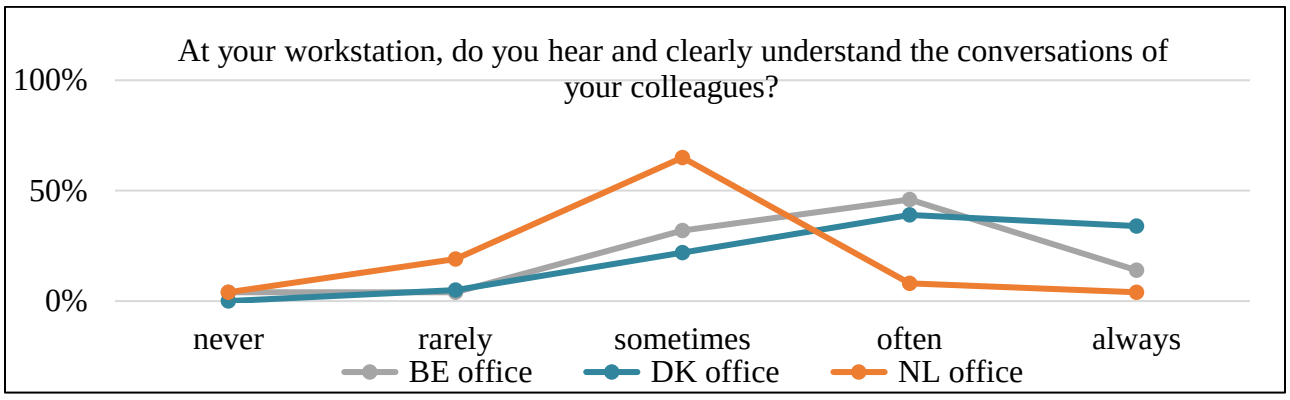
Given that conversational noise is a primary source of dissatisfaction in open offices [24], employees were surveyed regarding the frequency and disturbance level of overhearing their colleagues' conversations (Figure 8).

Figure 8. Frequency and disturbance level of conversations



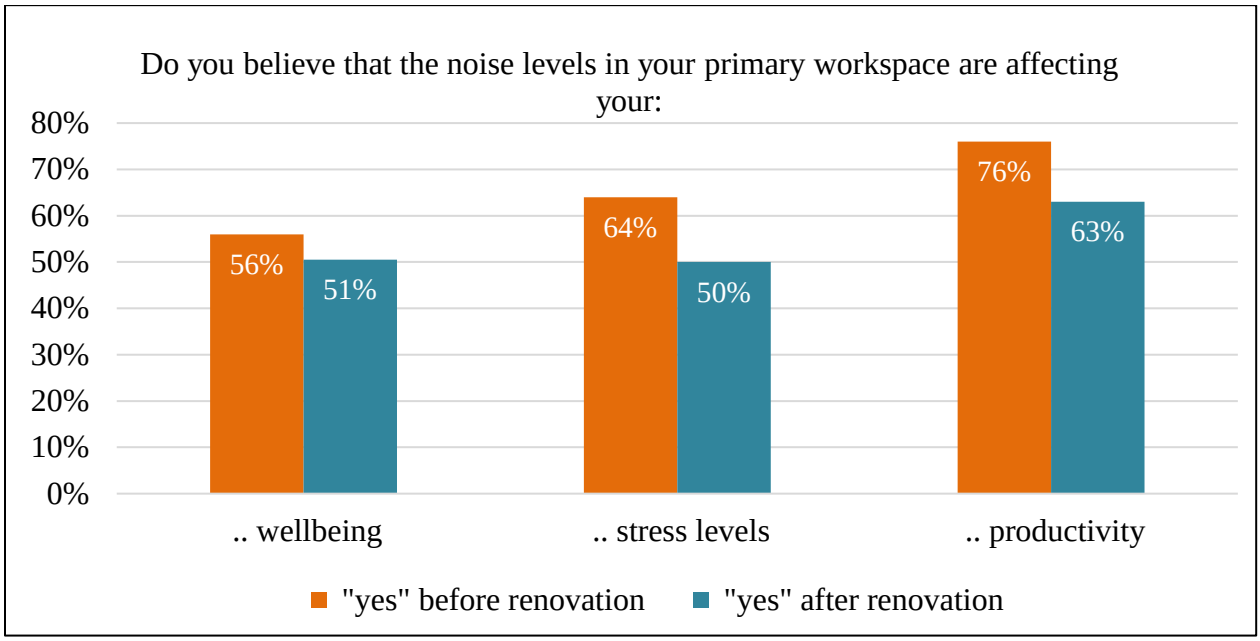
When analyzing conversations among colleagues, the highest prevalence is observed in the offices in BE and DK (Figure 9). Specifically, when considering 'often' and 'always', this primarily occurs at the office in DK (73%) and BE (60%), while only 12% is reported for the office in NL.

Figure 9. Frequency of conversations per location



When looking at the employee's relationship to noise in general we asked about their subjective experiences of wellbeing, stress levels and productivity. The results indicate an improvement in all three areas for individuals working in the newly renovated offices (Figure 10).

Figure 10. Perceived impact of noise levels on wellbeing, stress and productivity



5 CONCLUSION

The results of our study shed light on the subjective experiences and objective measurements regarding acoustic comfort in OPO environments. We found that noise in these environments can negatively affect productivity, satisfaction and overall wellbeing. By surveying employees before and after office renovations, we found that there was a noticeable improvement in acoustic comfort and a reduction in noise disturbances after the changes. Specifically, employees reported less noise and disruptions and better ability to concentrate, leading to higher satisfaction with the office environment. Our analysis of room acoustic measurements, following ISO 22955:2021 guidelines, revealed significant improvements in acoustic conditions and it showed that overall, the offices met the standard. However, some concerns remained, especially regarding speech privacy and intelligibility. Even though there was a clear improvement in speech privacy (21%), some employees still found their colleagues' conversations distracting, especially in offices where desk screens were too low. This was confirmed by the acoustic measurements, particularly in the reduction of noise to "the opposite desk" (DA,S). In conclusion, our study highlights the importance of addressing noise issues in OPO for better acoustic comfort. Following ISO 22955:2021 can help create a good indoor acoustic environment, but it is crucial to coordinate different 'space types' with users' needs beforehand. Among the various office layouts analysed, the semi-open office layout proved to be the best performer, offering the highest acoustic comfort and the least noise disturbances. Our overall findings underline the importance of considering both subjective experiences and objective room acoustic parameters when designing office environments to ensure they meet users' needs and preferences.

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Session 6B: Hybrid Working 1

The hybrid-work office: Exploring the changing knowledge-work office in a living lab

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ABSTRACT

Post-corona hybrid working in many knowledge-based organizations resulted in hyper-flexibility for individuals in their work situation decisions. This caused organizations to consider the facilities offered in the traditional office in a new light. The Dutch government set up a living lab to explore how hybrid working changes the physical and social needs that should be facilitated in the workplace. Living labs can be considered 'real-life' experiments, where monitoring, evaluation and interventions in the work environment are cyclically implemented, in close collaboration with the end-users of the office and the professionals who manage the work environment. However, moving beyond actionable micro-level learnings toward strategic input remains a challenge in living labs.

Design/Methodology/Approach: During 2023, researchers cyclically monitored and evaluated office users' experiences in a new hybrid work environment in a living lab in Amsterdam. Lessons from end-

users were placed into a framework in collaboration with facility managers and strategic managers of hybrid working.

Findings: We present a framework developed by facility and strategic managers, the micro-learnings from the end-users in the living lab, and the value of the outcomes of the living lab. Findings highlight the impact of hybrid working on social behaviour and agreements in the workplace and the changing needs in both the facilities and services in the building. The factors that enable flexibility in a hybrid work environment in organizations are discussed.

Limitations: There are numerous methodological challenges of a living lab monitoring and evaluation approach because of the constantly changing environment. However, the internal validity of the findings is very high, for precisely the same reason. Findings inform policy recommendations for the social and physical implementation of hybrid office environments; ultimately enriching the discussion on the factors impacting the balance between user' experience of hybrid workplaces and organizational support for healthy workplaces.

Keywords

living labs, hybrid working, office, micro-level learnings, outcomes.

INTRODUCTION

Hybrid working has quickly become an accepted way of working in the past two years, with adoption of this practices soaring worldwide (Marzban et al., 2023). Hybrid working emerged as a direct result of mandatory working from home during the COVID-19 pandemic. The pandemic served as a learning experience for workers and organisations, demonstrating that many tasks can be effectively carried out from the home office. It represents the newest iteration of teleworking, enabling workers to conduct a portion of their work outside the traditional office setting and collaborate with others through digital tooling, and activity-based working (Allen et al., 2015).

Two key aspects characterize hybrid working. First, an emphasis on individual choice and flexibility in work decisions of office workers, especially knowledge workers (Nenonen & Sankari, 2022). Second, there is a notable increase in the number of office workers who prefer to work at home and not in the office. This has also become generally more acceptable in society (Babapour Chafi et al., 2020)

Hybrid working presents a potential economic benefit for organisations in that it may lead to a more efficient use of office space (Mosteiro-Romero et al., 2023). The societal acceptance of hybrid working and the personal flexibility in decisions about when and where to work, may lead to different activities in the office. This shift in behavioural patterns raises new questions in organisations. Organisations need to reconsider the flex-work policies, the facilities provided and social agreements in the workplace. For instance, reconsidering the balance between quiet workspaces for concentrated work and spaces for collaboration and socialization (Colenberg et al., 2022), or identifying patterns in behavioural choices of knowledge workers to estimate the facilities needed in the office (Appel-Meulenbroek et al., 2022).

To explore hybrid office-workers' behaviour, and the implications thereof for facility- and strategic managers of hybrid working, a living lab was set up in Amsterdam by the Dutch Government. In this paper we will discuss the user-experiences, the manager's interpretation thereof and the value of the outcomes from the living lab in Amsterdam (LLA). The research questions are:

a) *What are the end-user experiences in a new work environment designed to support hybrid working?*

b) *How can end-user experiences be translated into a framework to adequately support hybrid working?*

What are living labs?

Living labs refer to a cyclical process of information collection and feedback focused on the development of innovative solutions over a period of time in a real life context. The aim is to support learning, innovation and growth in an organisation, as the organisation deals with the problems encountered by the participants in the organisation (Schuurman & Tõnurist, 2016). Living labs have two main characteristics, a) they are "real-life test and experimentation environments" and b) users of the environment are "co-involved in the innovation process" (Dell'Era & Landoni, 2014, p. 139).

'Users' in the LLA are the employees making use of this new hybrid office environment. These end-users are considered the main information sources for unique insights into the work environment. These insights can be uncovered by research leading to a deeper understanding of users' needs and behaviour (Dell'Era & Landoni, 2014, p. 137). The value of end-users' unique insights help tailor design solutions

and lead to better adoption of the proposed solutions (Chayutsahakij & Poggenpohl, 2002; Veryzer & de Mozota, 2005). In the hybrid work context, this means that the employee (end-user) working in a specifically designed hybrid-work office (living lab) may have unique insights in the use of products and services implemented to support his or her work.

However, living labs tend to be practice-driven, wherein the "theoretical underpinnings and foundations are mostly established 'post-hoc'" (Schuurman & Tõnurist, 2016, p. 78). Dekker et al., (2021) note that living lab experimentation tends to be generative, which produces actionable learning; however, they recommend that evaluation should be explicit and aim to stimulate democratic and robust academic learning. 'Results' from living labs are an elusive concept and in some cases "implementing an open innovation perspective is considered more important than obtaining specific innovation results" (Gascó, 2017, p. 90). Because of the focus on end-user experience in a real-life environment, the outcomes from the living lab are rich and diverse, but also very often fiercely individual. Fuglsang et al. (2021, p. 13) call them "micro-level" learnings. It is a known challenge, and also experienced in this project, to translate micro-level learnings from living labs into valuable general outcomes for of the larger organisation and eventually become of value in society. Moore (1995) terms these beneficial outcomes public values. In the following section, we explore the value of living lab outcomes.

The value of living lab outcomes

Haug and Mergel (2021) indicate outcomes from living labs as either tangible or intangible. However, Fuglsang et al. (2021) provide a more elaborate description through a thorough systematic literature review of research outcomes from living labs. They identify four types of public value outcomes from living labs: a) administrative value, b) citizen value, c) societal value and d) economic value (Fuglsang et al., 2021, p. 11). First, outcomes from living labs enhance administrative processes and drive organizational change by providing a safe environment for experimentation. Second, living labs prioritize citizen-(or in our case user)-centric approaches, fostering partnerships between government and citizens while promoting inclusiveness. Third, they facilitate public sector innovation and collaborative problem-solving, contributing to societal advancement and the democratization of innovation. Finally, while not often documented, living labs have the potential to create economic value through the development of new products, process improvements, and addressing complex societal issues via open innovation strategies.

Research context and goal

In this paper, we have three goals: 1) to indicate the micro-level learnings from end-users in the hybrid work environment, 2) to indicate the practical framework developed in collaboration with facility managers (FM) and hybrid working strategic managers (SM) to categorise the micro-level learnings in the living lab and 3) to illustrate the contribution of living labs to innovation in the hybrid work environments using the designation of public value of living labs identified by Fuglsang et al. (2021).

By doing so, we provide an example of how micro-level learnings from living labs can effectively contribute to the development of guidelines from hybrid work environments that are responsive to the needs of end-users and helpful for managers of the hybrid work environment. In the next section, we describe the research approach.

Method

Two researchers were involved in assessing this new LLA hybrid work environment and collected data between February and December 2023.

Two types of participants were involved in the LLA. The first type was office workers (end-users) using the new hybrid work environment as their main place of work. The second types of participants consisted of facility managers and hybrid working strategic managers who were responsible for setting up and managing the office. It is important to note that input from the two types of participants occurred iteratively. This means that micro-level learnings were collected from end-users, and a draft framework was developed by facility and strategic managers, followed by more micro-level learnings collected from end-users etc. The data collection processes are described separately in the following section.

To collect insights from end-users about their experiences in the hybrid work environment, four data collection methods were used: (1) observations; (2) semi-structured interviews; (3) survey data and (4) focus groups. Using triangulation of methods enhanced the validity and credibility of the findings by utilizing these multiple data sources for the outcome of the experiments (Creswell & Plano Clark, 2011). Data collected from end-users resulted in micro-level learnings about the satisfaction and preferences of office workers in this hybrid work environment.

To develop a practical framework for categorization of the identified micro-level learnings, workshops were organised with facility managers and hybrid working strategic managers. In the living lab, the role of facility managers were to address the concerns voiced by end users, while the strategic managers helped to develop the framework needed to interpret the lessons learned from end-users and to communicate the lessons outside the organisation. Workshops were held with both facility and strategic managers at three moments during the year: a workshop was held in May 2023, an intermediate feedback and discussion session in July 2023 and a final evaluation session in November 2023. During these sessions, the micro-level learnings gathered in the hybrid offices from end-users were discussed.

In the results section, we first present the framework developed and thereafter the micro-level learnings from the living labs in the newly developed framework. In the discussion section, we indicate the value of the living lab outcomes using the four public value elements identified by Fuglsang et al. (2021).

Results

First, we present the practical framework developed in collaboration with facility and strategic managers of the hybrid work environment. Even though micro-learnings were used to develop the framework, it is necessary to present the framework first and the organised micro-level learnings thereafter. Through collaborative categorization and sense-making during the workshops, micro-level learnings were grouped into five perspectives. These perspectives centre around organisational aspects, social aspects, facilities and services, building related aspects and aspects dealing with the monitoring and evaluation of the living labs itself. This co-created framework helped facility and strategic managers to structure feedback from end-users, enabling strategic response to the micro-level learnings from end-users. The framework is presented below, showing the five perspectives and a description of the impact of this perspective on the hybrid work environment.

Table 10 Framework for categorising outcomes from living lab experiments into five perspectives

Perspectives	**Description of the perspective**
Social	Behavioural norms and agreements about the use of the work environment. For example, at team level, assigning team zones in a flex work environment or agreements about noise management through quiet zones.
Facilities, facility management and services	Physical elements, furniture, and equipment in the work environment, and serviceand service packages impacting the use of the work environment. For example, security services, building opening times, and cleaning services.
Building related aspects	Construction and infrastructure of a building. For instance, climate installations, temperature management, way finding and parking facilities.
Organizational	Policy and guiding principles for the use of the work environment. For example, implementation of clean-desk policies, flex-work policies or implementing a living lab with co-creation in a work environment.
Monitoring and evaluation	Procedures, methods, and communication associated with the research process in the living lab. For example, ensuring end-user participation through timeous and adequate communication.

Subsequently, we plot the micro-level learnings collected from end-users into these five perspectives in the framework above. These are presented in the following section.

Hybrid work micro-level learnings from the LLA in the framework

We use the framework to present the micro-level learnings about end-users' hybrid work environment requirements. In the left column is the perspective, then the micro learning from the LLA and on the right, the implication of the micro-level learnings for the facilitation and development of the hybrid work strategy.

Table 11 Implications of micro-level learnings on the hybrid work strategy and facilities

Perspective	**Mico-learnings from the LLA**	**Implications for hybrid work strategy and facilities**
Social	The primary purpose of coming to the office is the work.	The primary activities necessary to complete work, i.e. the work process, has not changed due to hybrid working and all work related activities should still be facilitated in the office.
	The secondary purpose for coming to the office is to *work near colleagues* and *to meet informally*.	Facilities to support collegiality and team work are preferable.
	"Informal meeting" occurs in a diverse range of physical workspaces. At the coffee station In the corridors At the desks while working	Facilities and collective agreements on behavioural norms to support informal meetings are preferable.
	When meeting informally at desks, teams areas emerge.	Hybrid working accentuates the need for team areas.
	Teams tend to use the same workspaces every day.	Team areas to some extent constrain the flexible use of the office environment.
	Social agreements (with the help of team leaders) are made about: 'claiming' behaviour 'informally meeting' at desks (due to the distraction it creates)	Collective agreements on behavioural norms should be developed and supported by leadership.
	End-users prefer not to verbally communicate social agreements (i.e. reprimanding colleagues) to address behavioural problems in the work environment.	Communicating social norms for addressing problematic behaviour in the work environment should be communicated visually or in writing.
Facilities, facility management and services	Diverse facilities in the office are used during a normal workday (desks, phone booths, formal meeting rooms and informal areas).	The primary work process has not changed due to hybrid working, and all work related activities should still be facilitated.
	Activities like "concentrated work" and "informal meeting at the desk" cause friction when near each other.	Hybrid work accentuates the difference between concentrated work (in a quiet area) and interaction with others (also online).
	Phone booths are frequently used for online meetings	Facilities to support hybrid work are often used in the workplace.
	Phone booths are not soundproof	For safety reasons, phone booths should still allow the occupant to hear a fire alarm.
	Phone booths are not soundproof	Phone booths should therefore not be placed in 'concentration zones' but rather bordering zones where noise and interaction is encouraged.
	Phone booth designs are cramped, without 'desk space' and too transparent	Improvements to phone booths designs were advised (larger desk space, opaque glass and clever placement in the office environment).
	Meeting room for stand-up meetings are not used because it is not reflected in the work process.	Facilities to support hybrid work should match the work process.

	Custom options on some desks (such as in-desk wireless chargers / docking stations / screens) create preference patterns in desk-selection.	Diverse desk configurations with custom options constrain flexible use of the office environment.
	Small lockers and lack of coat racks result in occupied workplaces, even when not in use.	Limited personal storage space (such as small lockers or absence of coat racks) increase 'claiming' behaviour in the office environment.
	Limited view on others' desks is pleasant.	Visual privacy in the work environment is preferable.
	View on plants/greenery in the office is pleasant.	Visual view on plants/greenery is preferable.
Building aspects	Users have limited knowledge of facilities available for their use in the building (beyond their floor).	Lack of awareness of available spaces constrains flexible use of the office building.
	Strict building opening hours (7:00 a.m. — 6:00 p.m.) prevent an early start or working late.	Strict opening and closing times constrain flexible use of the building.
	Colleagues from different departments (of the same organisation) have limited access to the building.	Limited (or ad hoc) access hinders interdepartmental colleagues to meet.
	Lack of parking facilities impact the decision to come to the office.	Limited (or ad hoc) access hinder office attendance.
Organizational	When a large proportion of the work floor is dedicated to a specific work activity (for instance informal meeting) which does not align with the work process, it leads to end-user dissatisfaction.	Hybrid working may lead to lower occupancy, enabling a lower flex factor. Be aware, that the flex-factor is not something users comment on. However, all work related activities should be facilitated in appropriate proportions.
	Setting up a living lab for safe experimentation helps FM to better empathize with the end-user.	Hybrid working requires some adjustments to facilities, services and social agreements in the office. Living lab is an appropriate method to identify and develop these adjustments
Monitoring and evaluation	Co-creation contributes to an engaged end-users.	The method can help to develop support for the behaviour changes in hybrid working.
	Interactive and more visible forms of data collection yield more rich results than passive research.	Development with end-users also requires active participation and regular feedback.

Discussion and conclusion

The aim of the LLA was to learn about hybrid working and to grow as an organisation in facilitating hybrid working effectively (Dell'Era & Landoni, 2014). From the micro-level learnings and framework, the following lessons can be formulated. First, the exploration of hybrid working using a living lab promoted participation, conversation, and trust between the end-users and the facility and strategic managers team in the LLA. Small adjustments in the workplace made by FM as a result of the input from end-users earned their trust and created a better work environment with minimal effort.

Second, the work activities completed in the workplace (i.e. the work processes) did not significantly change as a result of hybrid working. End-users still expect to be able to complete all work-related

activities at work, not only social activities (Colenberg et al., 2022). Although the activities did not change, the difference between concentrated work (in silence) and working together (not in silence) is more accentuated in the hybrid work office. Therefore, additional areas /facilities or additional behavioural agreements are needed to support effective work in the hybrid office.

Third, in terms of efficiency, a hybrid work environment should support flexible use of the provided facilities because of the lower occupancy rates (Mosteiro-Romero et al., 2023). From the micro-level learnings, it is clear that the following measures could encourage flexible use of the work environment:

- Offer standardized workspaces (including standard desks, screens, docking stations, chairs, and access to a view on greenery).
- Offer diverse typologies of facilities that support hybrid working (phone booths, discussion nooks, desks (for concentrated work in quiet areas and for discussion while working in noisy areas).
- Offer personal storage space to prevent 'claiming' a specific workplace.
- Broaden access and knowledge of the available spaces to ensure optimal use of the building (awareness of possible workplaces, building opening times and authorisation to enter the building).
- Offer support to facilitate the discussion about behavioural agreements about the use of the office environment.

It is important to note two conflicting impacts of hybrid working. Hybrid working causes lower occupancy in the office and therefore require more flexibility to ensure offices are optimally used. At the same time, hybrid working cause end-users to primarily come to the office to work near their colleagues, resulting in a need for team areas which is in opposition with the idea of flexible use of the office, in which anyone can sit anywhere at any time.

We have highlighted the micro-level learnings from end-users in the hybrid work environment and placed them in the framework developed in collaboration with facility and strategic managers. The outcomes of the living lab can broadly be categorized as tangible outcomes and intangible outcomes, as described by Haug and Mergel (2021). Organisational norms for hybrid working, facility managers' co-creation practices with end-users and social agreements in the hybrid workplace are examples of intangible outcomes of this living lab. Tangible outcomes deal with the suggestions for improvement of products and office furniture and layout that could enable a more pleasant hybrid work environment.

The values of the LLA can also be described using the classification of living lab outcomes by Fuglsang et al., (2021). The LLA process improved the administrative processes within the organization and contributed to a safe environment for experimentation in which both types of participants (end-users, facility and strategic managers) in this study felt taken seriously in their different perspectives. This is an example of the administrative value of a living lab. By setting up a living lab in the organisation, the employees of the organisation were included in the decision-making process, leading to a user-centric

hybrid work environment. An environment with which both end-users, facility and strategic managers were satisfied with, which can be classified as a citizen value. By spreading the lessons learned, this paper highlights the societal value of the LLA.

Through collaborative problem-solving, the lessons learned in the living labs are not only beneficial to the host organisation and their employees, but are communicated to other organisations contributing to a societal advancement of solutions for hybrid working – another societal value. The economic value of the LLA, lies in first identifying and then solving the unique challenges of office workers in a new hybrid work environment created. Improvements in terms of the necessary social agreements, facilities, and services to support flexible and hybrid working, and the policies for the vision of the future of work were improved. While, in the process, learning and growing as an organisation (Schuurman & Tõnurist, 2016)

Living labs, of which the LLA is an example, often have difficulties translating the micro-level learnings to a broader strategy or academic knowledge. The LLA illustrates how the researchers approached the conceptualisation of the micro-learnings by including FM and SM in the development of a framework. Future research could include a somewhat broader range of decision-makers and professionals in the process. Testing this framework, or developing a framework in collaboration with decision-makers, may be a valuable approach in other living labs. This may assist in moving beyond generative experimentation (Dekker et al., 2021) toward formulation of strategy, explicit evaluation of outcomes and development of academic knowledge.

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Are perceptions of the office environment and teleworking related to team climate at hybrid workplaces? A cross-sectional study

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ABSTRACT

Purpose. The increase of teleworking has drawn attention to the role of office design in hybrid work. The questions of how to support interaction and teamwork are relevant to both office design and telework arrangements but studies investigating office design and teleworking together are still rare. The aim of this study is to investigate how the perceived office environment and the amount of teleworking are associated with team climate in hybrid work.

Theory. General frameworks of socio-technical systems thinking and salutogenic user-centred approach to workplace design were applied.

Design/methodology/approach. Cross-sectional survey data was collected from employees working in the activity-based offices of five Finnish organisations in Autumn 2022 (n=923). Team climate was measured with the short version of the Team Climate Inventory (Kivimäki & Elovainio, 1999), measuring four dimensions (Vision, Participatory safety, Support for innovation, Task orientation). Other questions covered perceived office conditions, perceived availability of different workspaces, and the amount of telework. Data was analysed using linear regression adjusting for age, gender and managerial position.

Findings. All perceptions of the office environment were related to team climate, although the associations were weak. The relation between perceived office conditions and team climate was stronger among workers who did not telework regularly, whereas the sufficient availability of different workspaces was more important for team climate among workers who mainly worked away from the office. The amount of telework was not related to team climate, suggesting it is less important for such outcomes than office design.

Originality/value. The study provides new information on the role of office design in post-pandemic workplaces and bridges research on office design and telework. The study is rare in using a validated multi-dimensional measure of teamwork which strengthens the results.

Keywords

Workplace management, User satisfaction, Office design, Remote work, Post-pandemic workplace.

Following the Covid-19 pandemic, the increase in teleworking has raised new questions on organizational productivity in hybrid workplaces. Telework refers to work that could be performed at the office but is regularly done at another location based on an agreement with the employer (2002 EU Social Partners' Framework Agreement on Telework). The increase in employee autonomy over off-site and on-site working has led to lower presence rates at offices. With decreased face-to-face encounters, one concern is how to maintain efficient collaboration and teamwork. Thus, organisations need to re-think the role of office (Gensler, 2023; Leesman, 2023), and solve questions of how to adjust workspaces to support hybrid working while also meeting sustainability and saving targets.

Both organisations and the real estate sector are trying to identify, which work activities the future office should support and how to attract employees to the office (CBRE, 2023; Castellum, 2023). Multiple consulting and real estate firms have addressed the information gap by reporting user experience trends from their own surveys (e.g., Castellum, 2023; Gensler, 2023; Steelcase, 2023; Leesman, 2023). Some reports highlight social and collaborative activities, as well as learning and information sharing, as crucial factors (Castellum, 2023), while others stress the importance of supporting a variety of activities (Gensler, 2023; Leesman, 2023) or considering individual workplace needs (Steelcase, 2023). However, few scientific studies have yet addressed the role of office in post-pandemic workplaces. They have mainly focused on task-related workspace preferences, observing that the workplace is generally perceived to support particularly interactive and collaborative activities (Appel-Meulenbroek *et al.,* 2022, Yang *et al.,* 2023, Rücker *et al.,* 2024).

Previous research suggests that both office design (Engelen *et al*., 2019) and teleworking (Beauregard *et al*., 2019) may affect interaction and collaboration. Yet, studies investigating office design and teleworking together are still rare as these topics have been largely investigated in separate lines of research. There is, thus, a new need to investigate how teleworking and the conditions at the workplace together support collaboration and teamwork. Such information is needed to support workplace design but also to help organisations in developing the leadership and organisation of hybrid working.

Theoretically, the relationships between perceived office environment, teleworking and teamwork can be approached from the socio-technical systems perspective. Workplace design can be seen as an integral component of the organisation which affects organisation's performance in dynamic interplay with other system components (Davis, 2019), such as telework. Furthermore, salutogenic and user-centric approaches to workplace design (Ruohomäki *et al.,* 2015) are timely, to ensure that the potential of workplaces in supporting the well-being and productivity of users is supported when re-designing workspaces to meet new user needs.

The activity-based office (ABO) concept provides a useful context for investigating office conditions and telework in hybrid work. The concept is based on users working partly elsewhere which enables high space-efficiency through shared use of workspaces. Another key feature is the idea of specifically supporting not only individual work but also various forms of collaboration and interaction with workspace planning (e.g., zones for informal and formal interaction). This kind of design likely continues in hybrid work to support flexible and efficient use of space. Activity-based offices are typically rated positively in terms of collaborative tasks (Engelen *et al*., 2019; Ruohomäki *et al*., 2021) but they also include aspects that may be negative for social relations. Non-territorial offices can decrease social encounters and cohesion within teams, with potentially negative consequences for the quality of interaction and sense of community (Haapakangas *et al*., 2019; Wohlers and Hertel, 2017).

Regarding measures of collaboration, studies on office design have seldom used validated surveys. Another common limitation has been the investigation of single aspects of interaction or collaboration and focusing on communication without considering its goals, such as teamwork productivity. Thus, we measured the quality of collaboration with the Team Climate Inventory (Anderson & West, 1994; Kivimaki & Elovainio, 1999) which captures four dimensions of teamwork relevant to creativity and innovation in the workplace (Anderson *et al*., 2014; Hülsheger *et al*., 2009).

To address the gaps outlined above, the aim of this study is to investigate how the perceived office environment and the amount of teleworking are associated with team climate in hybrid work. Due to the exploratory nature of the study, no specific hypotheses are tested but the general assumption was that both the perceived office environment and the amount of teleworking would be associated with team climate.

2 METHODS

2.1 Study design, participants and context

Cross-sectional survey data was used from "Relations between different office types, telework, and sickness absence before and after the coronavirus pandemic – HERO project". The data originated from employees working in the activity-based offices of five organisations located in Southern and Southwest Finland. Data was collected electronically through personal links sent by the researchers to each employee in Autumn 2022 (n=998, response rates 31-73%). For this study, we included respondents with information on age, gender, and managerial position (n= 923). The average age of the participants was 50.0 years (*SD*=10.1), 74.8% were women and 12.3% worked as managers.

All sites were visited and evaluated by researchers, including photographs and documentary material (e.g., layouts, office etiquette). The ABOs represented mainly modern, good quality design. In addition

to workstations, most of them also included typical ABO elements such as working cafés, support spaces, bookable and non-bookable meeting rooms, and areas for concentrated work. The spaces were distributed across several floors or even buildings in all the sites.

Teleworking was common in all organisations. Regarding on-site working policies, two of the organisations had a guideline of at least two days per week on average at the office but with some flexibility. One recommended at least one on-site day per week for all personnel and two had no organisation-wide minimum for working at the office. Some organizations also encouraged partial on-site workdays, e.g., for attending meetings.

2.2 Survey

The questionnaire addressed several themes related to the larger research project that concerned relations between office design, telework and health from pre-pandemic to post-pandemic time. The following survey measures were used in this study.

Team climate was measured with the short version (Kivimäki & Elovainio, 1999) of the Team Climate Inventory (Anderson & West, 1994). It measures four dimensions including *participatory safety* (4 items, e.g., acceptance and sharing of information within the group), *support for innovation* (3 items, e.g., cooperating and taking time to develop ideas), *vision* (4 items, e.g., perception of team's objectives as clear, achievable and worthy, agreement with objectives), and *task orientation* (3 items, e.g., critical appraisal, building on each other's ideas). The perceived office conditions were measured with single statements concerning person-environment fit (i.e. suitability of environment to one's work), support for interaction, availability of colleagues in the premises, possibilities to detach from work in the break room, furniture ergonomics and comfort, sufficiency of work and storage space, and cleanliness (Ruohomäki *et al.*, 2013). These were rated on a scale from 1 (strongly disagree) to 5 (strongly agree). The ease of switching to a more suitable workspace was rated from 1 (very difficult) to 5 (very easy, Haapakangas *et al.*, 2024). A three-item measure of *task privacy* (Oldham, 1988), rated from 1 (strongly disagree) to 7 (strongly agree), was used as a measure of distractions and the ability to concentrate. Access to quiet space, spaces for spontaneous discussions and bookable meeting rooms were rated with three response options (1=yes, sufficiently, 2= varyingly, not well enough, 3= no, not at all), adapted from Bodin Danielsson and Theorell (2019). These variables were analysed as binary, combining categories 2 and 3. In addition, the respondents rated their normal amount of teleworking using a six-point scale (Daily, 3–4 days per week, 1–2 days per week, 2–3 days per month, Less frequently, I don't do any telework; adapted from Ruohomäki *et al.*, 2023). Teleworking was explained as referring to work done outside the main work premises as agreed with the employer. Gender (male/female), age (in years) and managerial position (yes/no) were also included.

2.3 Statistical methods

Data was analysed using linear regression (IBM SPSS Statistics, version 29) as preliminary analyses suggested linear, rather than non-linear, relations. Two models were run separately for each office environment variable. First, we examined how each office perception variable was associated with four team climate (TC) outcomes, adjusting for age, gender, and managerial position (Model 1). In the second model, we included the amount of teleworking as another independent variable to investigate

its relationship with the TC outcomes simultaneously with the perceptions of the office environment. As additional analyses, we run Model 1 separately for subgroups based on the amount of telework (4 groups) to explore whether they differed in the strength of the relationship between office perceptions and TC. Due to the high number of analyses, these differences are demonstrated by reporting the results for two categories of telework amount (*hybrid workers* who teleworked 3-4 days per week, n=494) and *office-based workers* who teleworked less than weekly or not at all, n=94) and for two outcomes (Participatory safety and Task orientation). Unstandardised estimates with 95% confidence intervals are reported. Due to the very high number of statistical tests, we adjusted the *p*-values using the Benjamini-Hochberg procedure to control the false discovery rate.

3 RESULTS

Full descriptive statistics for the variables can be found in other publications of the project (Haapakangas *et al.*, 2024; Tulenheimo-Eklund *et al.*, 2024). The workspaces were rated positively on average. The ease of switching workspace received the lowest (*M*=3.4, *SD*=1.1) and cleanliness the highest ratings (*M*=4.4, *SD*=0.8) among items rated from 1 to 5. Task privacy was moderate (*M*=4.2, *SD*=1.5, scale 1-7). The availability of workspaces for quiet work, spontaneous discussions and booked meetings was perceived as sufficient by 40%, 50% and 67% of respondents, respectively. Team climate was also positively assessed (Vision: *M*=4.0, *SD*=0.6; Participatory safety: *M*=3.7, *SD*=0.8; Task orientation: *M*= 3.4, *SD*=0.7; Support for innovation: *M*=3.3, *SD*=0.8). Teleworking was very common as appr. 54% of respondents teleworked 3-4 days per week and appr. 24% teleworked daily.

The analyses showed only negligible differences between Model 1 and Model 2. Against expectations, there was no association or even a tendency between the amount of teleworking and the TC outcomes. Due to this result and the high number of tests, we only report the estimates of workplace perceptions for Model 2.

Of the covariates, age and gender were not associated with TC. Managers rated all TC dimensions slightly more positively than ordinary employees (*B*=0.19–0.23, all *p*'s <0.05).

The results for Participatory safety and Support for innovation are shown in Table 1 and for Vision and Task orientation in Table 2. All workplace perceptions had a statistically significant association with all TC dimensions. However, the R^2 values showed that the models only explained 2-9% of the variation in TC outcomes. All associations are small, suggesting that a one-unit difference in workplace perceptions is unlikely meaningful for the perceptions of TC while a greater change in workplace perceptions might be.

Table 1. The associations between office perceptions and Participatory safety and Support for innovation. Unstandardised estimates with 95% confidence intervals are shown. Adjusted p-values are reported

	Participatory safety	Support for innovation
Sufficient access to quiet space[a]	0.04 (0.03, 0.25)*	0.15 (0.03, 0.27)*
Sufficient access to spaces for spontaneous discussions[a]	0.20 (0.10, 0.31)***	0.21 (0.09, 0.32)**
Sufficient access to bookable meeting rooms[a]	0.21 (0.10, 0.32)**	0.27 (0.14, 0.38)***
Ease of workspace switching	0.10 (0.05, 0.15)***	0.11 (0.06, 0.16)***
Person-environment fit	0.13 (0.08, 0.18)***	0.14 (0.08, 0.19)***
Support for interaction	0.16 (0.11, 0.21)***	0.15 (0.09, 0.20)***
Availability of colleagues	0.17 (0.13, 0.22)***	0.15 (0.10, 0.20)***
Detachment from work in the break room	0.17 (0.13, 0.21)***	0.13 (0.09, 0.18)***
Furniture ergonomics and comfort	0.15 (0.10, 0.20)***	0.15 (0.10, 0.21)***
Sufficient work space	0.14 (0.08, 0.19)***	0.12 (0.06, 0.18)***
Sufficient storage space	0.10 ((0.06, 0.15)***	0.10 (0.05, 0.14)***
Cleanliness	0.18 (0.11, 0.24)***	0.17 (0.10, 0.24)***
Task privacy	0.09 (0.06, 0.13)***	0.08 (0.05, 0.12)***

* *p<0.05, **p<0.01, ***p<0.001.* [a]Reference category: varying or no access

The estimates of the workplace perceptions that have the same scale are comparable with each other. Regarding the availability of different workspaces, the access to bookable meeting rooms and to spaces for spontaneous discussions are quite equally related to all TC dimensions, whereas access to quiet spaces appears more related to Task Orientation than other dimensions. Task privacy has a low although consistently highly significant (p<0.001) association with all dimensions and cannot be compared with other predictors due to different scales. Among the other workplace perceptions, the overlap across all 95% confidence intervals suggests that there are no robust differences in how perceptions of different environmental factors are associated with the TC dimensions. However, there is a tendency for the ease of workspace switching and the amount of storage space to have a weaker

relation to TC than perceived environmental support for interaction, the availability of colleagues, detachment in break rooms and cleanliness.

Table 2. The associations between office perceptions and Vision and Task orientation. Unstandardised estimates with 95% confidence intervals are shown. Adjusted p-values are reported.

	Vision	Task orientation
Sufficient access to quiet space[a]	0.14 (0.06, 0.22)**	0.25 (0.14, 0.35)***
Sufficient access to spaces for spontaneous discussions[a]	0.19 (0.11, 0.27)***	0.19 (0.09, 0.29)**
Sufficient access to bookable meeting rooms[a]	0.24 (0.15, 0.32)***	0.16 (0.06, 0.27)**
Ease of workspace switching	0.08 (0.05, 0.12)***	0.10 (0.05, 0.14)***
Person-environment fit	0.10 (0.06, 0.13)***	0.15 (0.11, 0.19)***
Support for interaction	0.14 (0.11, 0.18)***	0.18 (0.14, 0.22)***
Availability of colleagues	0.10 (0.07, 0.14)***	0.14 (0.09, 0.18)***
Detachment from work in the break room	0.13 (0.10, 0.16)***	0.14 (0.10, 0.18)***
Furniture ergonomics and comfort	0.15 (0.11, 0.19)***	0.12 (0.07, 0.16)***
Sufficient work space	0.15 (0.11, 0.19)***	0.11 (0.06, 0.16)***
Sufficient storage space	0.07 (0.04, 0.10)***	0.10 (0.06, 0.14)***
Cleanliness	0.15 (0.10, 0.20)***	0.17 (0.11, 0.23)***
Task privacy	0.07 (0.04, 0.09)***	0.06 (0.03, 0.10)***

** p<0.05, **p<0.01, ***p<0.001.* [a]Reference category: varying or no access

The results of additional analyses for two subgroups (office-based vs hybrid workers) for Participatory safety and Task orientation are shown in Table 3. The sufficient availability of different types of workspaces is related to TC among hybrid workers but not among office-based workers. Task privacy appears more important for the TC of office-based workers, although there is overlap in the 95% confidence intervals of the subgroups. The P-E fit, perception that workspaces support interaction, availability of colleagues and detachment in break rooms have a stronger relationship with TC among office-based than hybrid workers. There are also some differences between the TC dimensions among office-based workers: Detachment in break rooms and furniture ergonomics appear to be more strongly

related to Participatory safety than to Task orientation, while the size of work and storage space is associated with Task orientation but not with Participatory safety.

The R^2 values of the models concerning office-based workers were higher than those observed in other analyses. In particular, the perceptions of the P-E fit and support for interaction explained 18% and 21% of variation in Task Orientation, respectively, for this group.

Table 3. The associations between office perceptions and Participatory safety and Task orientation for those who telework 3-4 days per week ('Hybrid work') and those who do not telework or telework less than weekly ('Office-based work'). Adjusted p-values are reported.

	Sub-group	Participatory safety	Task orientation
Sufficient access to quiet space[a]	Office-based work	0.37 (-0.10, 0.84) ns	0.27 (-0.15, 0.70) ns
	Hybrid work	0.04 (-0.11, 0.19) ns	0.22 (0.09, 0.35)**
Sufficient access to spaces for spontaneous discussions[a]	Office-based work	0.34 (-0.12, 0.80) ns	0.22 (-0.21, 0.64) ns
	Hybrid work	0.16 (0.02, 0.30)*	0.21 (0.08, 0.34)**
Sufficient access to bookable meeting rooms[a]	Office-based work	-0.1 (-0.52, 0.51) ns	0.08 (-0.38, 0.55) ns
	Hybrid work	0.23 (0.08, 0.39)**	0.20 (0.06, 0.34)**
Ease of workspace switching	Office-based work	0.13 (-0.06, 0.31) ns	0.14 (-0.03, 0.31) ns
	Hybrid work	0.10 (0.03, 0.17)**	0.11 (0.05, 0.18)**
Person-environment fit	Office-based work	0.27 (0.07, 0.48)*	0.31 (0.13, 0.49)**
	Hybrid work	0.09 (0.03, 0.16)**	0.11 (0.05, 0.17)**
Support for interaction	Office-based work	0.34 (0.16, 0.52)***	0.33 (0.18, 0.49)***
	Hybrid work	0.15 (0.08, 0.21)***	0.16 (0.11, 0.22)***
Availability of colleagues	Office-based work	0.22 (0.03, 0.40)*	0.24 (0.08, 0.40)**
	Hybrid work	0.18 (0.12, 0.24)***	0.11 (0.06, 0.17)***
Detachment from work in the break room	Office-based work	0.27 (0.13, 0.41)**	0.17 (0.04, 0.31)*

	Hybrid work	0.15 (0.10, 0.21)***	0.11 (0.06, 0.16)***
Furniture ergonomics and comfort	Office-based work	0.30 (0.11, 0.48)**	0.13 (-0.04, 0.30) ns
	Hybrid work	0.10 (0.04, 0.17)**	0.08 (0.03, 0.14)**
Sufficient work space	Office-based work	0.14 (-0.08, 0.37) ns	0.22 (0.03, 0.41)*
	Hybrid work	0.15 (0.08, 0.22)***	0.10 (0.04, 0.17)**
Sufficient storage space	Office-based work	0.12 (-0.06, 0.30) ns	0.19 (0.02, 0.35)*
	Hybrid work	0.10 (0.04, 0.16) **	0.11 (0.06, 0.16)***
Cleanliness	Office-based work	0.12 (-0.18, 0.41) ns	0.21 (-0.05, 0.48) ns
	Hybrid work	0.18 (0.08, 0.26)***	0.12 (0.04, 0.20)**
Task privacy	Office-based work	0.14 (0.01, 0.26) *	0.13 (0.02, 0.24) *
	Hybrid work	0.08 (0.03, 0.12) **	0.05 (0.01, 0.09) *

**p<0.05, **p<0.01, ***p<0.001*. [a]Reference category: varying or no access

4 Discussion

This study provided new information on the relations between perceived office conditions and team climate in hybrid work. Previous research has, particularly before the pandemic, largely overlooked interrelations between office conditions and teleworking. Our study bridges these research topics by analysing the amount of telework and perceived office conditions together. Another strength of this study was the measurement of collaborative work with a validated multi-dimensional measure that predicts teamwork outcomes, such as innovation and productivity.

As the main result, the study shows that perceived office conditions are more related to team climate than the amount of telework. This highlights the necessity to consider the role and design of the workplace as a central component in the organisational system in hybrid work (*cf*. Davis, 2019). In fact, the amount of telework was, surprisingly, not associated with team climate at all despite high levels of teleworking in our sample. This result mitigates concerns over negative effects of the lack of face-to-face on communication and suggests that employees are adaptive in finding ways to maintain a good team climate despite working remotely from each other.

On the other hand, the absence of an association between teleworking and team climate can be interpreted conversely as indicating that the amount of time spent at the workplace is not significant for team climate. Thus, the role of office design in hybrid work may be more related to supporting different tasks at the workplace, while developing design to generally attract workers to work more on-site may be less important, at least for team climate.

The observed relation between perceived office environment and team climate is in line with earlier studies on activity-based design (Engelen *et al*., 2019) and users' workspace preferences in hybrid work (Castellum, 2023, Appel-Meulenbroek *et al.,* 2022, Yang *et al.,* 2023, Rücker *et al.,* 2024). The perceptions that workspaces support interaction, the availability of colleagues, break rooms that enable detaching from work and cleanliness appeared most related to team climate. However, the associations were weak. This is expected as team climate is likely mainly determined by factors other than the physical workplace, such as task characteristics, team size and composition (Curral *et al.*, 2001), and work experience (Goh *et al.,* 2009). The weak associations mean that minor changes in office design are unlikely to be meaningful in practice, but more substantial differences in design may be relevant to team climate.

The differences between office-based workers and hybrid workers (teleworking 3-4 days per week) are expected as the employees who spend more time at the office are more dependent on the quality of office spaces in doing their job. On the other hand, having easy access to different types of workspaces appears more important for employees who work mostly away from the office. Such workers appear to experience more difficulties in finding suitable workspaces at the office, possibly due to a lack of routine (Haapakangas *et al*., 2023). It is also possible that negative user experiences at the office lead employees to increase teleworking (Haapakangas *et al.*, 2024). Furthermore, the results of the office-based workers suggest that office attributes may be differently related to different dimensions of teamwork, warranting further research with larger samples.

As limitations, our sample was characterised by, on average, very high levels of telework. This meant that the offices were in low use at the time of the survey, limiting possibilities to interact face-to-face with colleagues, which may have underestimated the relation between perceived office conditions and team climate. Thus, further research in other contexts is needed. Future studies with an experimental design would also be useful for showing whether specific improvements in office design can facilitate teamwork. Finally, this study focused only on team climate. The role of office design and user experience might be different for other outcomes, such as productivity or well-being.

5 Conclusion

The aim of this study was to investigate how the perceived office environment and the amount of teleworking are associated with team climate in hybrid work. The results support the view that office design is relevant to supporting teamwork in hybrid work. This association is, however, rather weak meaning that only major differences in office quality may be meaningful in practice. Yet, office design is more relevant to team climate than the amount of teleworking. This supports the role of office design as an important system component of organisations in hybrid work.

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What determines the differences between Dutch hybrid workers' location choice clusters?

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Abstract

Purpose

This explorative study examines location preferences of knowledge workers in the context of hybrid working. Despite the popularity of hybrid working in popular and academic discourse, it remains unclear who wants to work from home, the office, or other locations and in what proportion.

Approach

Drawing on survey data collected among 9,799 knowledge workers from Dutch public organisations during 2023, this study explores hybrid workers' location choices, work activities, workplace satisfaction, demographics, and work-related aspects.

Using Ward's Agglomerative hierarchical cluster analyse, six distinct location of work clusters were identified. Differences between the clusters were uncovered with a Chi-Square test and ANOVA.

Results

This study underscores a significant shift towards flexible working, with 64% of employees working outside the office. It identifies six distinct location choice clusters. The results indicate that individual flexibility enables workers to align their location choices better with task demands. Known challenges such as privacy concerns and insufficient support for focused work are being addressed by the mainly home and regular workers clusters. However, the results also highlight that all activities are performed by workers in all clusters, emphasizing the ongoing need to provide workplaces that facilitate both focused work and social interaction.

Value

This study provides insights in the decision patterns of knowledge workers in the context of hybrid working. This helps organisations balance individual preferences of workers and organisational goals. The clusters facilitate meaningful discussion surrounding collective (team)agreements and the design of the office space. Future research implications for strategic staffing decisions and workplace optimisation are discussed.

Keywords

Location of work, Cluster analysis, Work activities, Workplace satisfaction, Work-related aspects

1 INTRODUCTION

Teleworking is defined as a way of working in which the knowledge worker spends parts of the working time away from their office (e.g. at home or elsewhere) and uses ICT tools to collaborate with others (Allen et al., 2015). What distinguishes hybrid working from earlier ways of teleworking, is that the choices individual workers make has been given more weight (Nenonen & Sankari, 2022). Another characteristic is the scale at which workers can now perform their work outside the office. Digitization in response to COVID-19 have accelerated the shift to remote working (Babapour Chafi et al., 2022). Nonetheless, many of the previously identified advantages and disadvantages of teleworking remain relevant. Benefits include an improved work-life balance, flexibility and an increased (perceived) productivity. Professional isolation and spontaneous knowledge sharing are often posed as disadvantages (Allen et al., 2015; Brijn et al., 2022; Babapour Chafi et al., 2022; Nenonen & Sankari, 2022; Van Breukelen, 2021).

In both popular discourse and academic literature, hybrid working has gained considerable attention. Previous efforts have aimed to align workers with their work environment (Hoendervanger, 2021). Yet it remains unclear to organisations which workers prefer to work from home and in which proportions, and which activities should then mainly be facilitated in the office (Appel-Meulenbroek et al., 2022; Colenberg & Keyson, 2021). This is further complicated by the fact that knowledge workers may not be seen as a homogeneous group, with the same activities and work patterns (Greene & Myerson, 2011). Recent studies also suggest that hybrid working experiences vary among workers (Miglioretti et al., 2023; Peñarroja, 2024). With an increased emphasis on individual preferences, a one-size-fits-all environment seems less relevant (Babapour Chafi et al., 2022).

It is expected that some workers will be more office-based, while others will work more location independent. To effectively meet the needs of hybrid workers, workplaces should provide both quiet spaces for privacy and social areas for interaction (Colenberg et al., 2022). While accommodating to individual worker's needs may be challenging, clustering workers based on similar location choice patterns can be beneficial. These insights help organisations strike a balance between meeting individual needs and achieving collective goals. Therefore, in this paper, the choices made on the location of work for hybrid working are used to create clusters and check whether distinguishing characteristics between these clusters are visible.

Research questions are:

RQ1: *What location choices do hybrid knowledge workers make?*

RQ2: *Are there any distinguishing characteristics between clusters of knowledge workers with similar location choices?*

2 Hybrid work

Hybrid workers have the flexibility to choose their location of work. Thus, clustering workers based on their location choices seems insightful. Greene and Myerson (2011) offer a solid framework in this regard, identifying four distinct groups based on their interaction with the physical work environment: two clusters of office-based workers (*anchor* and *connector*) and two clusters primarily operating outside the office (*gatherer* and *navigator*). Building upon these insights, hybrid workers interaction with diverse locations are incorporated in this paper, with the expectation to discover distinct choice patterns, related to distinguishing worker and work characteristics. In their recent study, Appel-Meulenbroek et al. (2022) outlined various characteristics of knowledge workers that may influence their location choice. To differentiate between the identified patterns, relevant characteristics of workers are examined across four categories: work activities, workplace satisfaction, demographics, and work-related aspects. Below is argued which variables can be expected to matter and why.

2.1 Work activities & Workplace satisfaction

Knowledge workers are frequently clustered based on their activities. This approach is related to the principles of activity-based working (ABW). ABW prescribes workers to choose a workspace that best aligns with their current tasks. The physical environment is designed to accommodate various activities (Duffy, 1997; van Meel, 2019).

User experiences with ABW vary, with some encountering challenges such as privacy issues and inadequate support for concentrated work. In the light of hybrid working, it is expected that experiences with ABW will overall improve (Hoendervanger, 2021). Workers now have the flexibility and autonomy to perform concentration tasks at home and use the office for collaborative work if they want (Colenberg et al., 2022). Hybrid working enables workers to consider which activities warrant office presence for them. The ABW perspective therefore remains relevant in identifying patterns of choice.

Hoendervanger (2021) demonstrates that the experience with the work environment depends not only on individual work patterns, but also on characteristics of the work environment. Dissatisfaction with aspects of the office work environment influence location preferences, also confirmed by Babapour Chafi et al. (2022). Furthermore, other studies (Nakrošienė et al., 2019; Peñarroja, 2024) indicate that having a suitable home workspace can increase the likelihood of working from home. Consequently, satisfaction levels with various aspects of both home and office work environments are examined.

2.2 Demographics & Work-related aspects

Research indicates that personal characteristics influence teleworking experiences (Allen et al., 2015) and location preferences (Appel-Meulenbroek et al., 2022). Ollo-López et al. (2020) discovered that individuals with higher education levels were more likely to work from home frequently. Gender is also a notable factor, as argued by Singh et al. (2013). They found that women are more inclined to telework than men. Furthermore, Nakrošienė et al. (2019) observed that younger workers tend to favour teleworking more compared to their older colleagues.

Differences based on age can offer valuable insights into work behaviour (Deprez et al., 2015) and preferred work location (Singh et al., 2013). However, it is crucial to consider these differences within the context of the organisation (Joshi et al., 2011). When grouping workers based on their personal characteristics, it is essential to not only consider age but also factors such as job function and years of service (Stassen et al., 2016). Variables like the amount of work hours per week (Singh et al., 2013) and commuting time (Ollo-López et al., 2020) should also be considered as they may influence work location preferences.

3 Method

3.1 Participants

With a specifically designed survey complete responses from 9,799 knowledge workers in Dutch public organizations were collected during the second half of 2023.

In this sample, gender was equally divided. The mean age was 48.23 years (*SD* = 11.27 ±), and 38% held a bachelor's degree, 38% a master's degree, and 18% an associate degree. On average, participants allocate their 34.8 (*SD* = 4.26) weekly working hours as follows: 36.8% at their primary office location, 51% from home, 4.7% while traveling, 4.8% at another organizational site, and 2.5% at various external locations, including client sites and public spaces.

3.2 Measurements

Locations of work. Participants were asked to distribute their weekly working hours as percentages (totalling 100%) across five distinct locations (see above).

Work activities. Participants were asked to distribute their weekly working hours as percentages (totalling 100%) across six activities (CfPB activity taxonomy, Niekel et al., 2022) to include the following items: general and routine work, focused individual work, active collaboration with colleagues,

scheduled meetings (including video meetings), unscheduled meetings (including video meetings), and telephone calls.

Workplace satisfaction. The levels of satisfaction were measured using a five-point Likert scale (5 = *very satisfied*) for both the office and the home environment. Five aspects were adopted from the WODI light questionnaire (Maarleveld et al., 2009) and measured: **"**psychosocial (6-items, α =.830)", "physical (5-items α =.800)", "architectural (2-items, α =.670)", "facilities (3-items, α =.700)" and "spatial (5-items, α =.850, solely for the office)".

Demographics. Gender (male/female/other), level of education (five categories), and age (five categories starting at 18-30).

Work-related aspects. Managerial role (yes/no), average commuting time (six categories from "0-15 min" to "more than 90 min"), years of service (interval), and working hours per week (interval).

3.3 Statistical analysis

For RQ1, Ward's Agglomerative hierarchical cluster analysis was utilized to explore workers location choices, benefiting from its capability to handle clusters of varying sizes effectively (Jaeger & Banks, 2023). The authors chose to start the clustering with seven clusters and limit the procedure to three clusters. In the interpretation of the dendrogram results, the Dunda-Hart stopping rule is combined with the Squared Euclidean Distances (d^2) (Jaeger & Banks, 2023). The last step of the procedure is comparing the stopping rule ratios with two criteria. Firstly, the number of clusters must be sufficiently recognisable to individual workers and teams in terms of location of work diversity. Secondly, the cluster sizes must be large enough to be relevant for policymaking.

For RQ2, Chi-Square tests examined the relationship between the location clusters and nominal variables, while ANOVA investigated the relationship with ratio variables. A stricter alpha value (.001) was applied due to the larger dataset. Cohen's (1988) effect sizes were employed for both analyses, with post hoc procedures conducted only when effect sizes (η_p^2 and Cramer's V) exceeded medium thresholds (Cramer's V: 0.13-0.22 for degrees of freedom > 5; η_p^2: >0.06). Small effect sizes that were almost in the medium effect range were also reported for exploratory purposes.

4 Results

4.1 Location of work clusters

The researchers interpreted the results derived from the dendrogram and identified six distinct clusters of work locations (C1-C6, see Table 1). The procedure showed that six clusters is both statistically and practically recognizable and relevant for policymaking. The Dunda-Hart stopping rule ratio is highest at six clusters. Using fewer profiles resulted in the disappearance of the 'travelling worker', which is both recurrent in previous literature (Greene & Myerson, 2011; Nenonen & Sankari, 2022) and highly relevant in the context of hybrid working.

Table 1. Location of work clusters

	C1 Mainly home worker	**C2 Regular home worker**	**C3 Traveling worker**	**C4 Home-office worker**	**C5 Regular office worker**	**C6 Mainly office worker**
n	*2747* (28%)	*2201* (22%)	*1352* (14%)	*1974* (20%)	*1129* (12%)	*396* (4%)
At the own office (base location)	17%	26%	31%	**49%**	**68%**	**91%**
On the way, traveling (non-commuting)	3%	6%	14%	2%	5%	2%
At home	**78%**	**57%**	31%	**47%**	22%	4%
At another location of the organization	2%	8%	15%	1%	4%	2%
At another location (including at clients or public places	1%	3%	9%	1%	2%	1%

Note: the bold percentages indicate the preferred locations per cluster.

Table 1 (RQ1) illustrates that most respondents fall into the clusters of mainly home worker (28%) or regular home worker (22%). 15% of the workers fall in the mainly or regular office worker clusters. These clusters highlight the diversity in preferences and tendencies regarding individual choices of work locations.

4.2 Differences in work related aspects between the location of work clusters

Tables 2 and 3 showed that work related aspects characteristics differ between the work location clusters (RQ2). The analyses showed that managerial role and average commuting time (see Table 2) vary between workers with different location choices.

Workers in the mainly office worker cluster, regular office worker cluster and traveling worker cluster are more likely to have a managerial role in the organization compared to workers in the mainly home worker, regular home worker and the home-office worker clusters, $p = .001$ (see Table 3).

Workers in the mainly and regular office worker clusters have a shorter commuting time to the office (0 - 30 minutes) compared to workers in all the other clusters, $p < .001$. On the contrary, workers in the mainly home worker, regular home worker and the traveling worker clusters were more likely to have a commuting time of 60 minutes or longer compared to the regular office worker and the mainly office worker, $p < .001$ (see Table 3).

Table 2: Location of work clusters Chi-square test statistics

Characteristics	χ^2	***df.***	***sig.***	***Cramer's V***
Demographics				
Gender	46.442	5	<.001	0.070
Age group	198.674	20	<.001	0.072
Household composition	91.619	25	<.001	0.044
Level of education	223.771	25	<.001	0.080
Work related aspects				
Managerial role in the organization	393.806	5	<.001	0.206**
Average commuting time	537.020	25	<.001	0.106*

Note: **the effect size exceeds the threshold, differences between clusters were reported in Table 4. * = are small effect sizes.

Table 3. Differences between the location of work clusters and the nominal variables

Characteristics	**Mainly home worker**	**Regular home worker**	**Traveling worker**	**Home-office worker**	**Regular office worker**	**Mainly office worker**
Role in the organization						
Manager	2%	6%	**15%**	8%	**18%**	**16%**
No manager	98%	94%	86%	92%	82%	84%
Average commuting time						
0-15 minutes	8%	9%	6%	11%	**16%**	**20%**
16-30 minutes	21%	18%	19%	24%	**29%**	**34%**
31-45 minutes	20%	19%	22%	23%	25%	19%
46-60 minutes	20%	20%	22%	20%	18%	18%
61-90 minutes	**20%**	**22%**	**23%**	17%	9%	7%
More than 90 minutes	**12%**	**12%**	9%	5%	2%	2%

Note: the bold percentages indicate clusters that significantly differ from the non-bold percentages.

4.3 Differences in work activities and satisfaction with the work environment between the location of work clusters

Tables 4 and 5 showed that work activities and work environment satisfaction levels differ between the work location clusters (RQ2) (see Table 4).

Workers in the mainly home worker cluster evaluate the psychosocial aspects and the facilities at home in a more positive manner compared to all the other clusters, p = < .001 (see Table 5). Mainly office workers and regular office workers perform more "actively collaborating with colleagues" activities compared to workers in the mainly home worker cluster and regular home worker cluster, p = <.001. Workers in the mainly home workers and regular home workers clusters perform significantly more individual focused work compared to workers in the other clusters, p = <.001 (see Table 5).

Table 4: Location of work clusters ANOVA test statistics

Characteristics	***F***	***df.***	***sig.***	η_p^2
Work related aspects				
Years in service	35.302	5	<.001	0.018
Hours of employment	22.676	5	<.001	0.011
Work environment satisfaction levels				
Psychosocial aspects at home	188.610	5	<.001	0.088**
Psychosocial aspects at the office	104.398	5	<.001	0.051*
Physical aspects at home	77.436	5	<.001	0.038
Physical aspects at the office	32.261	5	<.001	0.016
Architectural aspects at home	50.296	5	<.001	0.025
Architectural aspects at the office	29.846	5	<.001	0.015
Facilities at home	75.119	5	<.001	0.062**
Facilities at the office	29.846	5	<.001	0.015
Work activities				
General and routine work	48.430	5	<.001	0.024
Focused individual work	104.223	5	<.001	0.051*
Actively collaborating with colleagues	126.054	5	<.001	0.060**
Scheduled meetings	62.722	5	<.001	0.031
Unscheduled meetings	53.484	5	<.001	0.027
Telephone calls	4.054	5	<.001	0.002

Note:** = the effect size exceeds the threshold, differences between clusters were reported in Table 5.
* = are small effect sizes.

Table 5. Differences between the location of work clusters on the continuous variables

Characteristics	Mainly home worker	Regular home worker	Traveling worker	Home-office worker	Regular office worker	Mainly office worker
Work environment satisfaction levels						
Psychosocial aspects (home)	*M = 4.64, SD = 0.45*	*M = 4.55, SD = 0.52*	*M = 4.40, SD = 0.58*	*M= 4.43, SD = 0.56*	*M = 4.20, SD = 0.68*	*M = 3.98, SD = 0.79*
Psychosocial aspects (office)	*M = 2.81, SD = 0.70*	*M = 2.92, SD = 0.71*	*M = 3.09, SD = 0.73*	*M = 3.09, SD = 0.71*	*M = 3.24, SD = 0.73*	*M = 3.36, SD = 0.69*
Facilities (home)	*M = 4.33, SD = 0.68*	*M = 4.18, SD = 0.74*	*M = 4.01, SD = 0.80*	*M = 4.07, SD = 0.75*	*M = 3.83, SD = 0.83*	*M = 3.56, SD = 0.93*
Work activities						
Focused individual work	*M = 30.36, SD = 21.03*	*M = 27.60, SD = 16.95*	*M = 21.71, SD = 13.17*	*M = 24.04, SD = 15.31*	*M = 20.39, SD = 13.72*	*M = 17.88, SD = 13.74*
Actively collaborating with colleagues	*M = 11.22, SD = 8.57*	*M = 14.03, SD = 9.01*	*M = 17.38, SD = 10.72*	*M = 15.72, SD = 9.71*	*M = 17.60, SD = 11.48*	*M = 18.69, SD = 15.01*

Note: *M = mean, SD = standard deviation*

5 DISCUSSION AND CONCLUSION

5.1 Discussion

Based on the distribution of working hours across six different locations, six distinct clusters were identified from mainly home worker to mainly office worker, with varying grades in between.

Differences between early cluster findings of Greene & Myerson (2011) underscores the shift towards flexible, hybrid working, with 64% of workers predominantly working outside the office. With greater autonomy in choosing the work locations, the added nuance of six clusters proves to be advantageous. Furthermore, this study underlines the need for organisations to reassess internal knowledge sharing. While Greene & Myerson (2011) describe their office-based workers as the primary source of information within organisations for colleagues to go to, this study indicates that only 16% of workers currently fall into this cluster.

Focusing on the characteristics of the six clusters, this study revealed different distinguishing factors. Regarding *work activities*, this study found that workers engaged in focused tasks are predominantly clustered in the home-based clusters. This suggests that a significant portion of concentrated work is now more frequently carried out from home, in contrast to the findings of Greene & Myerson (2011). It indicates that individual flexibility enables workers to align their location choices better with task

demands. Known challenges such as privacy concerns and insufficient support for focused work are being addressed by workers through remote working. However, the results also highlight that all activities are performed by workers in all clusters, emphasizing the ongoing need to provide workplaces that facilitate both focused work and social interaction, as suggested by Colenberg et al. (2022).

It was found that *workplace satisfaction* is another important factor. Workers who primarily work from home, tend to perceive their home environment more positively in terms of psychosocial factors, physical aspects, and facilities compared to those who frequently work at the office. Thus, having a suitable home workspace increases the frequency of remote work (Nakrošienė et al., 2019; Peñarroja, 2024).

On the other hand, *personal characteristics* (gender, age, education level, and household) seem to have a limited impact on location preferences, contrary to previous findings (Appel-Meulenbroek et al., 2022; Delbosc & Kent, 2024; Moens et al., 2022; Nakrošienė et al., 2019; Nguyen, 2021). Although older workers show a greater inclination to work from home, no significant differences in gender, household, or educational levels were found.

Work-related aspects seem to have some impact, however. Those primarily working in the office typically have short commute times compared to remote-base workers, consistent with prior studies (Ollo-López et al., 2020).

5.2 Limitations

One limitation is that the dataset is exclusively composed of Dutch hybrid workers from Dutch public organisations. This may restrict the generalizability of findings to broader populations. While the sample size is substantial, it is necessary to exercise some caution when extrapolating the identified clusters to contexts beyond the Dutch public sector. Cultural and international differences potentially account for the observed absence of significant differences in gender, levels of education, and hours of employment.

Additionally, the Ward's hierarchical clustering is computationally intensive and sensitive to outliers. Other clustering methods – such as K-means – are more efficient and less affected by outliers. However, the pre-specified clusters in other methods would have limited flexibility in data exploration, which was the focus of this study (Jaeger & Banks, 2023).

5.3 Practical implication and future directions

This study considers hybrid working as a precondition for knowledge workers, who now possess the autonomy to choose their work location. By addressing the diverse range of location preferences, organisations can effectively manage this unprecedented flexibility.

A challenge highlighted in our study is determining which activities need to be supported in the office. Our results indicate that employees desire to continue performing portions of all their activities on-site. Practitioners should, therefore, focus on how to best support different types of employees when they are in the office. This involves creating a balanced mix of open and enclosed spaces to accommodate both remote and office-oriented employees. Future research is needed to explore the fit between work activities and office spaces within the six location of work clusters.

Another key challenge stressed in this study is the heterogeneity of knowledge workers. Managers and teams could benefit from understanding the different location of work clusters. They are not an absolute representation of reality but facilitate discussions on preferences within the context of hybrid working. These insights aid in making informed collective decisions about work arrangements and collaboration among team members.

Future research should further explore the underlying motives and mechanisms that influence individual choices of work locations. Additionally, it is valuable to validate the identified clusters through qualitative research methods. This will enhance the practical recognition of these clusters and ultimately provide a comprehensive understanding of the diverse patterns of individual location choices within the context of hybrid working.

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Topologies of workplaces?! What can we learn from spatial sociology about hybrid workspaces?

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1 INTRODUCTION

The reorganisation of work during the Corona pandemic has entailed a reduction in face-to-face contact with customers, the avoidance of business travel and mandatory working from home. In all countries where this was an option, the percentage of people working from home rose sharply. Before the pandemic, most European countries fluctuated around 3-6 per cent (working remotely on a regular basis), with the exception of Finland and the Netherlands at 13 or 14 per cent (Eurostat 2019). During the pandemic, rates rose to over 30 per cent. Even though the numbers decreased after the peak of the Corona pandemic (without vaccination), most studies suggest that the rate will remain higher than before in the long term. Other factors, such as high energy prices and environmental trade-offs, are also expected to play a role. Before the Corona pandemic, people were reluctant to work remotely, but suddenly things started to move: production machines were monitored remotely, midwives cared for pregnant women via telemedicine, and teaching was done remotely. As a result, many more people than before have realised that the world of work is undergoing a major digital transformation. At the heart of these current - but already developing - changes is the reconfiguration of place and space. This is further facilitated by the information space or spaces that are emerging on the basis of the Internet (Baukrowitz & Boes 1996; Will-Zocholl 2021; Will-Zocholl & Roth-Ebner 2021).

This paper deals with the reconfiguration of space in the context of knowledge work in 'information space'. It is based on theoretical explanations that emphasise the importance of the social construction of spaces and understand space from a relational perspective. Broadening the understanding of what constitutes space helps to provide workplaces that take into account a major challenge of today's office work: the simultaneity of physical and virtual workspaces. The aim of this paper is to introduce theoretical foundations of spatial sociology and information space in order to sharpen the analytical view of ongoing processes. It is assumed that the immediate environment of specific workplaces in the information space plays a role in one way or another. It is also assumed that the simultaneity of interwoven workspaces does not remain without consequences. These questions will be pursued using case studies from an exploratory study of spatial relationships in the world of work during the pandemic and two earlier studies, primarily based on mental maps and interviews.

2 Reconfiguring space as a relational and socially constructed phenomenon

In social and cultural sciences, the "spatial turn" (Craft & Thrift 2000) is under discussion for a while. It refers to refocused attention on spatial structures and gives voice to relational concepts of space. For a long time – and still predominantly in sciences of built environment and real estate management – space meant either a built environment or a geographical area that could be further described by specifying boundaries. In this perspective, “space” occurs as a “container” that exists even without people or in which certain facts of the physical-material world are included, such as surface forms and soils, climate and bodies of water, vegetation and fauna, as well as the works of man – or in case of work spaces: work furniture, work equipment, lighting, people working, types of rooms with different functions, e.g. meeting, silent work, video conferences, coffee zones, etc. Such perspectives which strongly rely on a scientific understanding of “space” that is inspired by the natural sciences, see “space” as entity, that can be objectively observed in "the" reality. According to the self-conception of traditional geography as well, "spaces" are then treated as realities. They are understood as the effect of natural and anthropogenic factors, interpreted as the result of processes that have shaped the landscape or built environment.

For social sciences this understanding isn’t very helpful. During the spatial turn, the notion of an absolute space has thus been replaced by an understanding of space in which the positions of people and things can only ever be determined in relation to others. A social construct, in other words, that is based on relationships between actors and things (Bourdieu 1983; Léfèbvre 2005; Löw 2013). Thus Martina Löw (2013) proposes to describe how, by whom and through what spaces are formed in order to make the production of spaces visible. The approach aims to overcome the rigidity of the container model and focus more on the processuality without negating the material level of these processes. This idea is based on Giddens' (2000) concept of the duality of action and structure. Following on from this, she speaks of a "duality of space" (Löw 2013). This does not mean - as in other contexts (e.g. Nappi/De Ribeiro 2021) - the divergence or merging of physical place and virtual space, but rather the reproduction of spatial structures through action and the action-structuring effect of spaces, in the sense of: enabling, restricting or limiting. "Space" is constituted on the one hand by the practice of arranging and on the other by an already existing order, i.e. by the duality of structure and action (ibid. 2013).

According to Löw (2013), the dimension of action comprises two analytically distinct processes: "spacing" and "synthesis" (158f.). Spacing is the process of placing goods and people; this includes setting up, constructing, measuring or placing goods, but one's own positioning is also part of the spacing process. Spacing always takes place in relation to other placements. Synthesis refers to the linking of goods and people through processes of perception, imagination and memory. The process of synthesis is thus immanent to the constitution of space (Löw 2001: 158f.). So, if spaces are constituted through people's actions, this means that the body is actively placed in relation to the space or is linked to it. In this understanding of space, social relations become independent of spatial proximity and a common nation-state "container", whereby the geographical and social spatial references of action can diverge greatly. This means working spaces only arise when people work together, regardless of where

exactly they are located (Lefebvre, 1991; Löw 2013). In the past, this promoted the idea of a dissolution of space and an increasing insignificance of places (Schröer 2006). Time is replacing space as the dominant structure because geographical distances can be overcome ever more quickly (see further Harvey 1989) and technological progress and the digitalisation of entities mean that geographical distances no longer have to be covered. The latter development is also linked to the emergence of network-like structures in which places no longer represent materialised nodes of an information network (Castells 1991). This leads us to questions about the influence of technological developments on the constitution of spaces.

3 The information space as space of work

The constitution of spaces is changing under the influence of technological developments. The emergence of the "information space" (Baukrowitz & Boes 1996) can also be seen as such a re-figuration of spaces under the conditions of "digital mediatisation" (Knoblauch & Löw 2022, 32) or "digitalised informatisation". This can be used to describe the consequences of new information and communication technologies and the internet for work and its organisation as well as for the organisations themselves. It is more than a technical infrastructure or "data highways", but rather "a social space for action that enables the storage, handling or exchange of information and information objects" (Boes et al. 2017: 153). Workspaces in the information space are created through social practices of communication and collaboration between people, regardless of where exactly they are located. The information space thesis is closely linked to the theory of the informatisation of labour (Schmiede 2006), which describes how, over the decades and centuries, an abstract information layer is formed parallel to the labour process, which is initially subjected to the increasing demands of capitalist management and control of labour processes. With technical progress, in this case the digitalisation of data and information, these also become accessible in the information space and raise the possibilities and options of control but above all also of the reorganisation of work to a new level. A global space of production unfolds (Boes & Kämpf, 2007), which forms the basis, to rethink work organisation, business models, cooperation and the international division of labour at a macro level.

At the micro level, the shift of work into the information space not only changes the work processes and organisation, but also the ways of working, the nature of work, with its required competences, skills and resources. (e.g., Roth-Ebner 2015, Ryser et al. 2016). The prerequisite for working in the information space is that more and more work objects and processes are available and can be mapped virtually in the information space. While this initially applied mainly to highly qualified knowledge work such as software engineering, there are increasingly more activities for which this applies - at least in part. It is closely linked to the expectation that ties to places and people will weaken, but do not become dispensable. This is because the information space is not conceivable independently of local conditions, i.e. although the bond to places is loosened because work can potentially be done from anywhere (at least in the case of knowledge work), the place does not become insignificant. Geographical locations influence incorporated knowledge, who we are, what qualifications we have acquired, how we communicate and deal with other people. The conceptual distinction between space and place becomes relevant here. Place can be described as current positioning and potentially refers to stability, in practice this means that the presence of certain objects can already establish a place (deCerteau 1980), i.e. in the case of office work, for example, a desk. But places are also characterised

by "identity, relation and history" (Augé 1994). In this contribution, place is defined as the concrete (work)place from which workers create their work spaces.

For today's knowledge workers in particular, this development goes hand in hand with the fact that they participate in more than one social action space at the same time, both virtually and physically. Under these conditions the assumption that location is unimportant or that geographical location is irrelevant (anyplace, anytime) is experiencing a revival. In the past, the possibility of overcoming geographical distances ever more quickly (cf. e.g. Harvey 1989) and the progress of information and communication technologies had promoted the idea of a dissolution of space and an increasing insignificance of places (Schröer 2006; Graham 1989). Today, digitalised (or digital) work is conceived as a prototype of trans local and mobile work that can take place detached from any temporal and local references. A look at the everyday life of digitalised and trans local work makes it clear that differentiation is necessary here. Digitalised work can be locally bound (e.g. parts of administrative processing that have to be offered locally as face-to-face service), and trans local work can be less digitalised (mobile service technicians, commuting care workers). Even in areas that appear to be "placeless" at first glance, empirical results point in a different direction, so that doubts about the assumption of "placelessness" (Flecker & Schönauer 2016) are justified, which does not simply occur, but must be actively prevented. Further, the shift to the information space has not yet been completed as parts of work remain that have to be negotiated in face-to-face meetings, as can be seen, for example, in the steady increase in business travel in parallel with global collaboration (until the COVID-19 pandemic). Instead of "placelessness", it is more about linking physically determined places and virtual spaces of action in the information space.

Based on the explanations outlined above, we will now ask how employees experience the increasing shift of work into the information space, what spatial references become visible? How do these interwoven workspaces emerge for them and what practices do they develop in dealing with them?

4 Office Work in the information space

The application of Martina Löw's "Duality of Space" to office spaces entails the production of these spaces through the actions of various actors, including office workers, management, and architects. These spatial structures become visible in the actions of these actors (Petendra 2015). However, this does not imply that the built world is entirely irrelevant. The container space is of relevance because it can be perceived as a "dimension of everyday synthesis that must be taken into account into the sociological concept of space" (Löw 2001, 66). This seems just as important in the context of increasingly virtualised working environments, in which the place where work is performed, the place (or space) of the working object and the place of the colleagues or the company are all different.

However, due to the virtualisation of work, it is questionable whether this container space model is still perceived in this way or whether space takes on a completely different meaning in the everyday imagination. It can be postulated that the immediate surroundings of the concrete workplaces in the information space will exert an influence, whether direct or indirect. This should also have an effect on the perception of space. Furthermore, working in the information space entails that we work simultaneously in physical places and in virtual spaces. This simultaneity of interwoven work spaces is

mediated through the use of different media. Implications are expected for the individuals who work in these environments and their perceptions of workplaces and collaboration with others.

In order to explore this question two earlier studies based on mental maps and interviews were taken into account. One was conducted in flexible offices and analyses how office workers shape office workspaces through their daily practices and what meanings are created in the process (Petendra 2015). The other examines how the use of digital media influences the perception of space and time and what challenges this poses for digitally working knowledge workers, who largely work remotely (Roth-Ebner 2015). Petendra (2015) notes a "body-centred workplace structure" evolving in flexible working environments, where the work desk gains importance. In the case of mainly remote working people in Roth-Ebner's study, less the place than a media generated space is experienced. Workspaces are defined by technical artefacts, such as smartphones, and can take on any number of forms, leading to a "multiplication of space" (Roth-Ebner 2015). Despite physical distance, employees experienced a strong media co-presence, especially in video conferences and when remotely controlling work processes.

Own research has been done based on Petendra's und Roth-Ebner's results, using the framework of 'spacing' and 'synthesis' to conduct an explorative study consisting of 12 mind maps and semi structured interviews with people standing prototypically for today's knowledge workers: a mixture of working from home, working in the office in stable or flexible arrangements. Aim was to investigate placement practices and the synthesis of workspaces.

The results can be structed among placement practices, work activities and working locations. Firstly, the study identified various placement practices that range from basic to specific ones. Basic placement practices include adjusting the desk height or swapping chairs if the workstations are located in private areas of the home. Specific placement practices include, firstly, the process of settling down: this process involves arranging work equipment such as laptop, work mobile phone, privately procured tablet, ring lamp and headset. Many of the gadgets used have a fixed place on the desk. Further tasks like "having a cup of coffee", "unpacking the water bottle" or others are used to mark the start of work. Secondly, the results show that there is no uniform tendency in the organisation of work activities: Some prefer to conduct staff meetings from the sofa because they feel more comfortable in a more convenient position, while others change workplaces due to external factors such as "needing to move" or "new inspiration". Thirdly, it shows that the change of specific work location is connected to specific tasks. Sometimes personal appointments are deliberately scheduled for days in the office to be more accessible, while more complex work that requires peace and quiet tends to be done in the home office. Those findings are highly connectable to others in the field of "activity-based working" ().

Contrary to Petendra's findings, no competitive strategies were discussed in relation to the choice of workplace in the office. Only the proximity to colleagues was an important aspect here. When asked about the influence of the environment on working, those with their own office explained that the design of the room is important to them and that a working environment should also be inspiring for them. Other interviewees, especially those without an office of their own focus more on the digital entities from which they synthesise their workspaces. For them, the focus is on functionality and access to

digital work tools. This also happens, when travelling. Overall, the results of the study show that workspaces are synthesised by linking work locations and digital entities. The increasing ubiquity of the workspace means that workspaces can also be synthesised outside of actual working hours. This often happens spontaneously, e.g. through associations during everyday activities such as going to the coffee machine. The separation of work and leisure is still a challenge and carries out attempts of various boundary setting practices, e.g. the use of different devices. Within the information space, the simultaneity of workspaces remains a challenge while the role of colleagues in the workspace varies depending on the activity of the interviewees. Despite the challenges of working virtually, participants are overwhelmingly positive about the possibilities.

5 Conclusion

For a sociological understanding of space it is important to emphasise the social component of space production. The "Duality of Space" (Löw 2001) describes the processes of spacing and synthesis as an interplay of action and structure: spaces are created through the social actions of people and these spaces are structured by actions that have previously become manifest. Furthermore, it becomes clear that virtual spaces are neither a pure simulation of the previously built space nor an exclusive extension of the built space through digitally generated (work) spaces. Different spatial scales overlap, on site and in virtual space, in close proximity and at a great spatial distance. Geographical characteristics such as time zones, political aspects or cultural practices of those involved have a structuring effect on the actions of employees, so those and other results may suggest thinking about information spaces instead of information space (Will-Zocholl 2021).

The current phase of working in information spaces is – as the results of this explorative study show – also characterised by the simultaneity of work processes in different workplaces and spaces. Dealing with interwoven virtual spaces and physical locations is a challenge for today's knowledge workers. This "being in one place" and being simultaneously integrated into information spaces (not only professional ones) was particularly challenging during the first lockdown in the pandemic: Working from home, possibly with partners in the same room, looking after and schooling children at home at the same time and compensating for the loss of carers and other services (see Gründler 2021 overview). However, simultaneity also poses challenges outside the home office - not least when it comes to organising the workplace, both in terms of time and space. How much simultaneity of virtual and physical presence is desirable? How do places structure work and help employees to deal with increasing simultaneity and complexity? These questions also arise with regard to the design of office spaces. Their design can no longer be thought of solely in terms of their material-objective components, i.e. the built space, the furniture, the light, the air, etc., but through the lens of the information space.

This is primarily because intelligent lighting control or sensor-based measurements (e.g. of sitting time) already make it clear that key components of the built space have also already reached the information level. The actual workplace must therefore be seen as part of the information space and not just as part of the physical environment, which is reflected already in the term “hybrid offices” and goes along with specific challenges (e.g. Sailer et al. 2022; Riratanaphong & Klongnarong 2022).

While the results indicate that the perception of the built environment, i.e. the physical workspaces, decreases the more flexible the work arrangements are, the workplace itself, its organisation and

technical equipment are becoming more important. This trend appears to be continuing with the increasing use of the home office. In addition, the people - at least at the same hierarchical level - with whom one works in the information space are increasingly perceived as "there", so that employees can hardly distinguish between face-to-face meetings and virtual meetings, at least in direct collaboration. However, this development also harbours the risk of further isolation of employees and an even stronger focus on individual (rather than collective) concerns. The latter effect in particular suggests a "normalisation" of the perception of "present absence" (i.e. the co-presence of bodies is becoming less important) and coincides with the many wishes expressed in surveys to continue working from home and the high rates of approval of a legal entitlement. At the same time, new strategies are necessary to manage copresence (Windlinger & Gerber 2022).

Besides the fact that people want “working from home to stay, fewer people want to return to the traditional open-plan office (Nappi/de Ribeiro 2021). And it may be also expected that the highly gamified office space concepts that have recently been touted in the context of "New Work" working environments, e.g. at Microsoft or Google, will become less attractive. This is because office workplaces need to offer "added value" for employees: either colleagues on site, the opportunity to be recognised, better technical equipment (e.g. for group conferences) or creative spaces that are experienced as positive for their own work. And if recognition can be less signalled through the design of the built working environment, because people are less there, other mechanisms are needed to build loyalty to the company.

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Session 6C: Workplace Culture and Experience

Cultural probes for job crafting – The use of cultural probes in the context of hybrid work arrangements

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ABSTRACT

Post-pandemic hybrid work arrangements are increasingly emphasizing the need for individual workers to organize their own work. In this paper, I explore how I applied cultural probes to explore the hybrid work practices and experiences of six Finnish knowledge workers. The study aims to both understand hybrid work practices and experiences as well as test cultural probes as a methodological approach in the context of hybrid work. A set of tailored cultural probes was designed, consisting of a diary, a log book, a one-time-use camera, two maps, postcards and letters. The participants of this study had four weeks to use the cultural probes independently. A follow-up interview was conducted with each participant, which allowed them to share their hybrid work practices and experiences as well as discuss the cultural probes as an approach. The data was analyzed using a directed content analysis. The findings provide insights into the hybrid work practices and experiences of knowledge workers in different job positions and organizations and demonstrate that workers' hybrid work practices and experiences extend to spatial, temporal, social, cognitive and task-related dimensions. The study contributes to the job-crafting literature by providing empirical material that demonstrates that hybrid work arrangements require individual workers to increasingly shape and organize their own work, i.e. crafting their jobs. Moreover, the study indicates that cultural probes can be an effective approach to nurture job crafting practices, because they not only enable the documentation of working practices but offer workers to critically reflect and assess their working practices in light of the current hybrid work arrangements.

Keywords

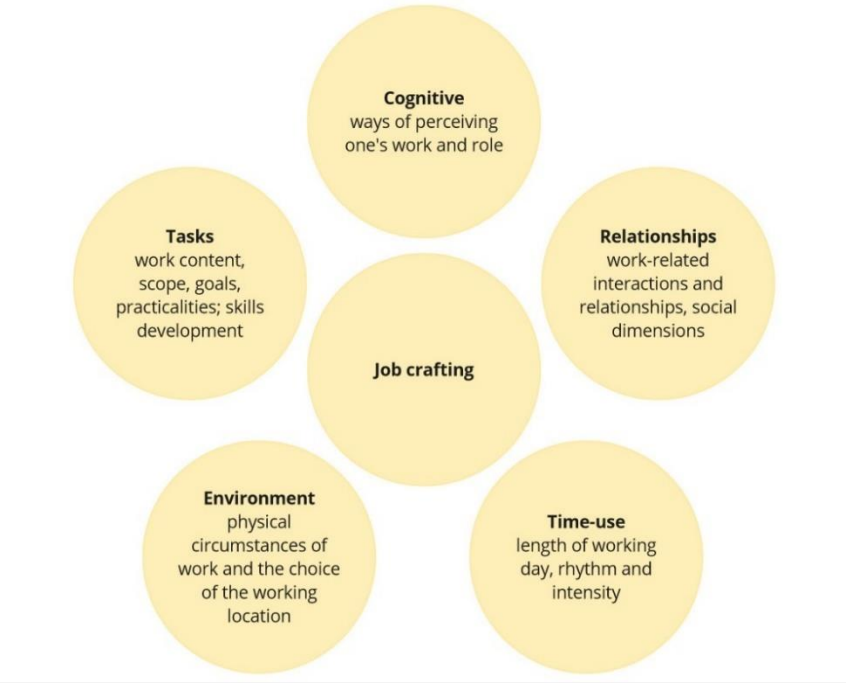
Hybrid work; Cultural probes; Job crafting.

1 INTRODUCTION

Since the COVID-19 pandemic, knowledge work has become increasingly hybrid, with workers regularly working in multiple sites. An international survey of the labor force shows that 40% of Finnish workers work away from their organization's offices at least occasionally, with Finland ranking fifth among other European countries (Taskinen, 2023). Many Finnish organizations have already significantly reduced physical office spaces (Senaatti, 2021), adopted hot desk arrangements (Varma, 2023) and moved many of their operations online. Although current hybrid work arrangements may still vary across organizations, research suggests that hybrid work is here to stay in some form or another. Problematically, the public discourse in Finland appears to be stuck in a binary regarding the advantages and disadvantages of remote work, overlooking the more essential aspects of work: the everyday practices and experiences of hybrid workers. Ultimately, knowledge about how workers practice their work and experience current arrangements can provide crucial insights that benefit leadership and employees alike. With this study, I am interested to explore how workers practice their work and experience post pandemic hybrid work arrangements and in how far these arrangements affect workers' job-crafting practices (Eloranta et al., 2023). Particularly, I am interested in gaining an understanding of the multiple dimensions that affect hybrid workers' everyday lives. For this, I have leaned on the areas of job crafting as outlined by Eloranta et al. (2023), which encompass cognitive, social, spatial, temporal and task-related dimensions (see Figure 1). I am, therefore, investigating job crafting beyond its "task and relational boundaries" as coined by Wrzesniewski & Dutton (2001; pp. 179) or the "job demands and job resources" as framed by Tims & Bakker (2010; pp. 4), and instead looking at the areas of job crafting holistically and in the context of hybrid work.

Figure 1. Job Crafting areas.

Reproduced by the author, summarizing the areas of job crafting as explained in Eloranta et al. (2023).



Empirical research indicates that hybrid work requires individual effort in arranging one's working day or week (Perry et al., 2018; Wang et al., 2021; George et al., 2022), implying a higher demand for actions that can be associated with job-crafting practices. In addition to conventional job-crafting practices, a worker may need to examine the fit between their work tasks and the physical work environment or structure their working day according to both work-related and non-work activities, among others. Furthermore, given workers' different circumstances, workers might be differently equipped to perform job-crafting practices that serve them in the hybrid work setting. Thus, someone with years of work experience might have developed more effective work practices that serve them well in how they navigate the hybrid work context compared to someone just starting out in their career. Or, a worker generally upholding clear routines might be better equipped to manage time even in the flexible context of hybrid work than someone with poorer time management skills. Previous research on remote work has demonstrated that remotely working mothers experienced more workplace loneliness than remotely working fathers (Lyttelton et al., 2020). Another study shows that workers identifying with extrovertism and conscientiousness, traits that typically have demonstrated to be beneficial in today's work environment, showed deteriorating performances in remote work settings (Evans et al., 2022). Currently, an empirical understanding of the dynamics between hybrid work arrangements and workers' job-crafting practices is missing, demonstrating a significant research gap. Increased awareness from both individual workers and organizations is necessary to recognize the impact of hybrid work arrangements on ways of working and to address the need for individual workers to conduct more proactive organizing and shaping of their work, i.e. crafting their jobs. In this study, I aim to undertake an initial exploration of practices and experiences of knowledge workers in the emergent hybrid work environment. In doing so, I develop tailored cultural probes as a methodological approach and through the study, I also test the suitability of this tailored methodological approach for the continuation of my research. In the next section I will explain in detail the development of the cultural probes and their use.

2 APPROACH

In this study I developed cultural probes (Gaver et al., 1999) to explore and uncover the practices and experiences of knowledge workers who work in multiple sites i.e. perform hybrid work. The aim was to understand how the changing between working environments is experienced by workers and whether workers shape and organize their work in this context and if so, how they do it. While the cultural probes of this study were designed to be explorative and open, the individual artifacts were developed to assist participants to think about and reflect on the areas of job crafting as outlined by Eloranta et al. (2023) in Figure 1.

2.1 Designing the probes

The cultural probes of this study were developed to uncover and explore the participants' hybrid work practices and experiences and thus entailed specifically crafted artifacts. Because it was considered valuable for participants to use the artifacts offline with minimal distractions or interference, the cultural probes of this study were physical. They included a diary with supporting questions and tasks, a log book with time-use related tasks, a one-time use camera (participants could also opt for using their personal mobile phone), postcards and letters and two maps – one for the home and one for the

office. In addition to the main artifacts, the probes included colored pens, stickers, stamps and a bag for easier carrying between the different working locations (see Image 1 and Image 2). Each probe kit was accompanied by a greeting letter and instructions. The probes were designed to be approachable, encouraging and yet formal enough to be used in the work setting. The instructions stressed the importance of participants using the artifacts that best suited their own needs and thus, it was mentioned that one can ignore an artifact.

Figure 2. Artifacts

Figure 3. Bag with artifacts

2.2 Participants

The participants of this study included six knowledge workers, who work in multiple sites. All of the participants work for an organization that provides them with a shared office space. Participants were recruited through snowball sampling (Flick, 2009). It was considered important to engage workers of different ages and genders. Moreover, it was of interest for participants to work in different types of organizations and perform different roles and tasks (see Table 1). A criterion for all participants was that they perform hybrid work.

Table 1. Participants

Participant	Organization size* & industry	Job description	Age	Gender	On-site work
Participant 1	(L) Transportation and storage	Content designer	25-30	f	~ 1 day/week
Participant 2	(SME) Other services activities	Project advisor	25-30	f	~ 4 days/week
Participant 3	(L) Education	Researcher	30-35	m	~ 3 days/week
Participant 4	(SME) Information and communication	Intern	25-30	m	~ 4 days/week
Participant 5	(L) Financial and insurance activities	Team lead	55-60	f	~ 0.5 days/week
Participant 6	(L) Financial and insurance activities	ICT specialist	55-60	m	~ 2 days/week

*organization size is defined according to the number of employees as in The Standard Industrial Classification TOL 2008 (Statistics Finland, 2008)

2.3 Procedure

The first step of the study was a one-on-one meeting with each participant, either at their workplace, their home, or a public place. This meeting was organized to introduce myself and the study and to hand over the cultural probes. The participant was then allowed to open the probes box (see Image 3) and explore the different artifacts within it (see Image 4).

Figure 4. Box with greeting letter.

Figure 5. Open box with artifacts.

Participants could ask questions, clarify doubts and read through the Data Privacy Notice of the study and upon agreement give their written consent. The participants had four weeks to use the cultural probes. Throughout the four weeks, I sent each participant three reminders per week, using WhatsApp. Two weeks into the study participants were asked to choose a time slot for the return of the cultural probes and the follow-up interview. Upon return, I did an initial scan of the collected material to prepare for the follow-up interview, which aimed at two things: to learn about hybrid work practices and experiences of each participant and to discuss the use of the cultural probes in this research context. The interviews were semi-structured, allowing for exploration and the co-construction of knowledge (Flick, 2018).

2.4 Data Analysis

The artifacts together with the follow-up interviews generated a diverse data set, comprising diary entries, written postcards, letters, hand-drawn sketches, photographs as well as transcriptions. A directed content analysis method (Hsieh & Shannon, 2005) was selected, allowing me to focus on exploring participants' hybrid work practices and experiences through the lens of the job-crafting areas as outlined by Eloranta et al. (2023). Thus, the "initial coding categories" (Hsieh & Shannon, 2005; pp. 1281) that led my analysis, included spatial, temporal, social, cognitive and task-related dimensions (Eloranta et al., 2023). Further coding categories were created that went beyond the initial ones. Because the follow-up interviews aimed to complement insights found with the cultural probes, the interviews were coded with the same initial coding categories as the probes. However, because the interviews also aimed to discuss and critically reflect on the cultural probes as an approach in this research context, additional coding categories were created that specifically focused on evaluating the individual artifacts from the perspectives of participants.

3 FINDINGS

3.1. Integration of work and non-work

The study shows that hybrid work arrangements have led participants to increasingly integrate work and non-work practices. This integration extends to spatial, temporal and social realms, with workers

flexibly changing between different locations, splitting time and adjusting schedules as well as examining their need for and quality of social interactions. For example, participants show frequent instances of adjusting the physical place of their work according to personal preferences and needs.

“Today I worked at home and in a cafe [...] in public and semi-public spaces one gets exposed to other people’s influences. Sometimes the conversations on the neighboring coffee table may distract or take away from one’s attention, whilst sometimes one gets ideas and new perspectives to think about one’s work [...]” – Participant 3 (diary entry)

“I enjoy sitting on the couch, it is relaxing to work and gives me room to think. No people in immediate proximity.” – Participant 4 (diary entry)

Participants report using the time that is typically spent commuting to rest, to pursue a hobby, or to do household work. While the temporal flexibility is experienced positively overall, some participants expressed an occasional overload of both work and non-work activities due to the possibility of completing non-work activities during typical working hours, thus conflicting with their primary work.

“It was difficult to fall asleep. I decided to not set an alarm and to perhaps not go to the office, because I would have to stay there pretty late, if I want to do 8h.” – Participant 1 (diary entry)

“Taking care of my parents’ things is extremely tiring at the moment, especially if I have to do that while having a busy day at work.” – Participant 5 (diary entry)

“While writing this diary I have started to notice that I work very flexibly during work trips, at the office, remotely and also timewise more flexibly than others.” – Participant 2 (diary entry)

The integration of work with non-work also extends to social dimensions. Participants expressed that the interactions they experienced during their work affected other areas of life and vice versa. Therefore, a worker’s decision to work on-site might stem from a lack of other social interactions or a worker’s choice to work remotely can stem from a need to be alone, emphasizing the importance of the social dimensions at work.

“Weekends I like to spend at home and if I work remotely on a Friday, the lack of social life can impact my mood already on Sunday.” – Participant 4 (diary entry)

“Gloomy return from vacation. Gladly I worked remotely today, so I didn't need to show up “grumpy” at the office.” – Participant 6 (diary entry)

“It would be beneficial for me to again schedule more meetings to discuss [work-related] questions and challenges with others.” – Participant 3 (diary entry)

The findings suggest that the participants experience and perceive working life as a holistic endeavor, suggesting that work and non-work are increasingly intertwined. The integration of work and non-work activities poses both positive and negative sides, on the one side enabling individuals to create a working life that suits and looks like them; on the other side, putting pressure on each individual to be flexible, accommodating and able to organize their work to support them.

3.2 Individual awareness

The study frequently noted participants mentioning their so-called states of mind, including factors like energy level, ability to focus, alertness, as well as confidence. Participants appear to be aware of and actively assess their personal needs in the means of effective work practices.

“Sometimes I open the door and there are no lights on at the office. In those moments I sigh of relief, because I can start my day quietly and do head-/research work in peace straight away.” – Participant 2 (diary entry)

“I noticed from my quality of sleep, that the ongoing report stresses me.” – Participant 6 (diary entry)

“The day started efficiently and I was focused on mechanical work. I am feeling confident and energized, yesterday’s workout left me feeling good.” – Participant 4 (diary entry)

Participants also present a strong awareness of their work tasks and content. This was evident as participants described and analyzed the nature of their work tasks, needed skills and available resources to perform their tasks.

“The fact that I feel a lack of the necessary expertise to complete preparations for the new project adds to my stress. Let alone the lack of time.” – Participant 2 (diary entry)

“I am feeling energized, but work tasks have been boring and repetitive, which has negatively impacted my ability to focus. As a result of this, articles from Helsingin Sanomat (Helsinki area daily newspaper) and Yle (Finland’s national public broadcasting company) have repeatedly ‘appeared’ in my browser tabs.” – Participant 4 (letter)

Last, particular challenges were experienced by team leads, who expressed a wish to be present for team members. The wish to be more present did not primarily stem from a personal need or preference, but a felt responsibility towards other members of the team. Not being able to fulfill this responsibility caused conflict with their role as a team lead.

“As a team lead, I occasionally feel guilty about not being more present at the office.” – Participant 5 (diary entry)

3.3 Participants’ experiences of the cultural probes

The second aim of this study was to assess the use of cultural probes in the context of hybrid work. The richness of the data suggests that the different artifacts enabled participants to document, reflect upon and capture various aspects of their work. The most comprehensive data was generated through participants’ diary entries, encompassing practices, perceptions, desires and emotions. Similar depth to written reflection and analysis was present in the letters and postcards, however only one participant wrote a letter and two participants wrote a postcard.

“[…] it made me kind of pause to think about work identity, my position within the organization, what kinds of things I like and also my own decision making […]” – Participant 2 about diary

“Now I have maybe gotten a grasp of what the moments kind of are in which I notice succeeding in something during the day and noticing it is maybe something, which took me about the time that I had

the probes, that I somehow got a grasp of how writing those cards would be natural." – Participant 3 about postcards

The photographs produced still images of moments, places and ideas. Although as standalone images the photographs appear rather uninformative, they supported the discussion of the follow-up interviews. Participants who reported having a habit of taking photos found this task easier and also returned more photographs.

"I tried to sort of visually document the components of my everyday life as diverse as possible" – Participant 2 about photographs

The maps illustrated participants' home and office environments. Unlike expected, participants seemingly liked this activity and the maps were often referred to during the interviews, demonstrating to be an assistive tool and material for this study. A participant described their map in the following way:

"This was an easy one for me (map of the home), because it was easy to draw, that it actually somewhat represents the space in its actual way and then I realized that maybe it was of interest to understand how I use my home. This was pretty good, maybe this illustrates that I have separated it, that I don't have a laptop here at my kitchen table, but I prepare my breakfast and eat there and then I move to my desk, where I work." – Participant 6 about maps

4 DISCUSSION

Hybrid work is a widely adopted model among organizations in Finland and abroad, and many Finnish organizations have significantly reduced office spaces (Senaatti, 2021) and undergone changes that directly affect individual ways of working. This study aimed to explore and uncover the hybrid work practices and experiences of six Finnish knowledge workers through the lens of job-crafting. A set of cultural probes (Gaver et al., 1999) was developed, which participants used over the course of four weeks to document and reflect upon their hybrid work practices and experiences. The findings show that the individual practices and experiences of hybrid work arrangements play a significant role in shaping how organizations will operate in the future. While hybrid work arrangements offer workers increased flexibility and autonomy (Staniulienė & Zaveckis, 2022), research indicates that workers are increasingly expected to independently organize and arrange their work to support both themselves as well as to fit with the structures of their organization (Babapur Chafi et al., 2021). The collected material shows that the job-crafting practices required from individual workers extend to spatial, temporal, social, cognitive and task-related dimensions. Workers are purposefully choosing between different working locations, independently planning their work schedules and proactively organizing social interactions and examining their quality. Individuals also appear to critically assess and reflect their roles, responsibilities, personal resources and needs. The findings also indicate that individual circumstances, such as living situations, affect individual workers' possibilities to navigate the hybrid work environment, e.g. when simultaneously caring for their parents, indicating that hybrid work arrangements pose challenges that can have long-lasting effects on equality and privilege (Loignon et al., 2022; Manzo & Minello, 2020; Hughes et al., 2021). While previous research has demonstrated that individual workers have been active job crafters before the wide adoption of hybrid work arrangements

(Tims et al., 2022; Parker et al.,), this study shows that the spatio-temporal flexibility provided through hybrid work arrangements increasingly expects workers to do so, putting more emphasis on individual effort, pro-activity and capabilities to navigate the future work environment. In turn, organizations can greatly benefit from the job crafting skills that workers have acquired in recent years.

5 CONCLUSIONS

Hybrid work arrangements have profound implications for individual workers and organizations alike. In this study I explored how six knowledge workers practice their work and experience post pandemic hybrid work arrangements and in how far these arrangements affect their job-crafting practices. I developed a tailored set of cultural probes, which participants used over the course of four weeks. The cultural probes were a valuable methodological approach for uncovering the participants' hybrid work practices and experiences. The insights found through the cultural probes and the reflections given by the participants in the follow-up interviews indicate that the cultural probes can be an effective way to nurture job crafting practices in the context of hybrid work arrangements, because not only were the cultural probes a place for documentation, but they offered individuals to critically reflect and assess current hybrid work arrangements from their point of view. A limitation of this study was the small sample size, which will be addressed in a larger study. In the larger study, the cultural probes are expected to highlight the complexity of the hybrid work environment and enrich the currently binary public discussion around hybrid work in Finland.

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Navigating gender and control in organizational spaces: The role of office design

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ABSTRACT

Research suggests that organizations that emphasize control and authority often align with masculine norms, potentially marginalizing women and other minority groups. The physical design of organizational spaces has the power of reinforce or weaken this relationship, since it creates (or destroys) borders between minority and majority power groups (spatial segregation or integration). This paper examines the relationship between office space design, control, and gender within the workplace. This research aims to expand current knowledge about whether and how spatial segregation within offices influences the perception of organizational control between female and male organizational members. The paper focus on a single organization which has been observed over time. We employ a mixed-method approach including (i) econometric analysis of survey data and secondary data; (ii) qualitative analysis of data from semi-structured interviews and focus groups with employees.

Keywords

Organizational Culture; Control; Gender; Workspace; Spatial Design.

1 INTRODUCTION

The degree to which organizations emphasize control, order, and consistency is key in understanding companies' organizational cultures (Quinn & Rohrbaugh, 1983). Research indicates that organizational cultures characterized by high levels of control and formalization might reflect and perpetuate gendered norms and biases. For instance, Acker's (1990) theory of gendered organizations suggests that organizational structures and practices, including those related to control and authority, often implicitly prioritize masculine ways of working and leading, potentially marginalizing women and other minority groups (Kanter, 1977; Connell, 1987). The design of the organizational spaces has the capacity to influence how an organization physically

communicates its culture (Miller et al., 2014). Office space design likely manifest and reinforce the control dynamics of an organization's culture. For instance, an open-plan office might be intended to promote transparency and collaboration but can also lead to issues of surveillance and a lack of privacy, subtly reinforcing control (Wasserman & Frenkel, 2015). Alternatively, office designs that provide personal spaces and allow for customization might foster a sense of autonomy and lower perceived control. The design of office spaces can thus materially and symbolically reflect the organization's control culture, impacting employees' behaviours and perception of their workplace (Brennan, Chugh, & Kline, 2002). This is particularly evident for women, for whom the importance of some aspects of space design in organizations is more pronounced compared to men (see Migliore et al. 2022, for a recent literature review on the topic). However, scientific knowledge is missing to demonstrate whether the physical design of a workspace influences perception of culture and how this alleged relationship is influenced by individuals' characteristics. This paper advances the idea that organizational spaces' design can moderate the relationship between perception of control and gender. Therefore, the objective of this research is to investigate whether the perception of organizational culture' is different between male and female organizational members and whether this difference is influenced by organizational space's design. This investigation is pivotal for understanding how the spatial design of workspaces can influence the shared norms and values within an organization, which, in turn, shape member attitudes and behaviours crucial for organizational effectiveness and productivity and ethical behaviours (Pasricha et al., 2018; Bourne et al., 2019). This research is particularly relevant to the goals of social sustainability in organizations, aligning with the Sustainable Development Goals (SDGs) by promoting decent work environments and economic growth (SDG 8), reducing inequalities (SDG 10), and fostering innovation and infrastructure (SDG 9). By examining how physical workspace design contributes to a strong, inclusive, and equitable organizational culture, this study aims to provide actionable insights into creating more sustainable and socially responsible organizations.

1 THEORETICAL FRAMEWORK: SPATIAL SEGREGATION VS INTEGRATION

The theoretical underpinnings of this study draw from an interdisciplinary approach, integrating concepts from organizational studies, environmental psychology, and architectural design to explore the nexus between gender, organizational culture and physical workspace design. Organizational culture is conceptualized following Quinn and colleagues competing values framework (1983).

Specifically, this paper focuses on the control dimension, as part of an organization's culture, which reflects the degree to which control, order, hierarchies, and consistency are valued and implemented within an organization (Quinn & Rohrbaugh, 1983; Quinn & McGrath, 1985; Quinn, 1988). High control scores are associated with formal rules, clear hierarchical lines of authority, and structured communication patterns. In contrast, lower control scores might indicate a more flexible, participative, and flat organizational culture. Research has shown that organizational cultures with high control scores can influence gender dynamics, potentially reinforcing traditional gender roles and exacerbating gender disparities (Acker, 1990).

The design of office spaces can reflect and reinforce the control aspects of an organization's culture. Highly structured, uniform office layouts with defined hierarchies (such as executive offices being larger or in more desirable locations) can signal a high control score, emphasizing order, hierarchy, and authority. Conversely, more flexible and egalitarian office designs, such as those with non-assigned seating or a variety of workspaces to choose from, may reflect and promote a culture that values flexibility, autonomy, and less rigid control structures (Duffy and Powell, 1997). The design of office spaces not only reflects organizational culture but can also influence employee perceptions of their work environment, their role within the organization, and their behaviours. Spaces that are designed to emphasize control and order might lead employees to behave in more conformist ways, adhering strictly to organizational norms and procedures. On the other hand, environments that offer more autonomy in how and where work is done can encourage creativity, innovation, and a more entrepreneurial spirit among employees (Kristensen, 2018). For instance, open-plan offices might foster a culture of collaboration and openness but might also reduce perceptions of privacy and increase distractions. In contrast, more compartmentalized layouts could enhance feelings of control and order but potentially limit spontaneous communication and collaboration (Brennan, Chugh, and Kline, 2002). Design strategies can be used to modulate the level of control perceived within an office environment. For example, incorporating elements that provide privacy, such as soundproofing or visual barriers, or allowing workers to express themselves through personalization can help balance the need for openness with the need for individual control over one's work environment (Ashforth et al., 2022). Similarly, the inclusion of communal spaces can encourage collaboration and reduce the sense of rigid control by fostering informal interactions among employees (McCoy and Evans, 2002).

Gendered experiences in the workplace can be influenced by both the physical layout of the office and the prevailing organizational culture. For example, office designs that emphasize hierarchy and control may inadvertently perpetuate masculine norms of leadership and authority, potentially disadvantaging women or those who do not conform to these norms (Ely & Meyerson, 2000). Additionally, gender dynamics can influence how individuals experience and utilize office spaces, with research indicating differences in the preferences and uses of space between genders (Sundstrom, Herbert, & Brown, 1982).

Starting from these conceptualizations, in this paper, we are interested in understanding how much the office space segregate or integrate individuals. With spatial integration we refer to the level to which the physical space makes individual from minority and majority to encounter. An office triggers segregation whether it is built in a way that hinders diverse group to meet (Reuf & Grigoryeva, 2023). Following Reuf and colleagues 2023, a basic measure of micro-segregation is the extent to which organizational

members with different power (i.e., employees and managers) are interspersed in office spaces. In this paper, we therefore, refer to spatial segregation as the likelihood of an individual who has a role in the organizational hierarchy to meet another individual who has a different role, and we expect that the lower the spatial segregation the lower is the perception of organizational control. Spatial segregation is not only about distance but the spatial "difficulty" of encountering someone, which is closely related to space design and to the presence of loci of segregation within the floors. This relationship might be stronger for women, since because women generally have a lower ability to form relationships.

2 METHODOLOGY

Both the data collection and data analysis are distinctly mixed-method. We focus on a single middle-sized organization located in Milan city centre which gave us access to their spaces and

internal materials. We adopt convergent parallel design, in which qualitative and quantitative data are collected concurrently, weighed equally, analysed independently, and then interpreted together (Creswell & Pablo-Clark, 2011). Our corpus of data merge primary and secondary data. Concerning primary data, we developed a survey to collect information on the perception of the organizational culture (i.e., we employed the Competing Values Framework) and on the use of the organizational space. In addition, we collected information about individuals' characteristics, including family composition and homes characteristics. The survey was created in Qualtrics to be mobile friendly and easily accessible. There were 29 questions. The survey was sent out in May 2023 via email with the help of the HR department to all the organization's member (N=254), we obtained 243 responses (response rate = 98%). Our primary data included also 3 focus groups interviews to 7 executives managers and 9 employees. We collected information on the direct experiences in the use of the organizational spaces at different hierarchical level of the organizational structure.

Concerning secondary data, we collected information on (1) the structure of the organization through organizational charts shared by the organization itself, (2) their organizational spaces through plans which included the allocation of each employee to a specific desk, (3) the use and personalization of these spaces through photos of the offices of each organizational member. These secondary data were used to compute variables regarding the level of spatial segregation of the organizational space under analysis. Table 1 summarizes data types.

We employ regression analysis to quantitatively assess the relationship between spatial segregation and organizational control perception. Additionally, the qualitative component involving focus groups and observations served to understand the nuances of how physical workspace design influences cultural perceptions and behaviours. Data analysis is still ongoing and results will be presented during the conference.

3 PRELIMINARY RESULTS

The preliminary results of this work show that female organizational members perceive a culture that emphasize control, hierarchies and formality which is higher compared to the one perceived by male organizational members. This was confirmed also by our qualitative material. For instance, one female manager said:

“Collaboration to date is somewhat formal [...]. When people come in, they spend many hours beyond the standard working hours, so having spaces for relaxation becomes essential, including places to eat, for example.”

A first exploration of our unique dataset show that women and men use and perceive their office differently. While more men are assigned to single offices compared to women who mostly occupy shared offices, we found that men perceive higher level of privacy and concentration given by the environment compared to women. Through regression models, we initially found that the space where these individuals are assigned (being a single office or a shared offices) moderates the relationship between gender and organizational culture perception. This interplay suggests that organizations seeking to promote gender equity and inclusivity need to consider how their cultural values around control and office space design intersect. Designing office spaces that reflect and promote a culture of inclusivity, flexibility, and shared control can be one step toward addressing gender disparities and enhancing organizational well-being. We plan to develop our preliminary analyses in the future steps of these research, by considering several aspects of space design in our econometric model.

We expect this work to have several implications for an ethical management of organizations. Mindful office design, aware of its cultural and gendered underpinnings, can be a powerful lever for promoting gender equity and transforming organizational culture. Our research advocates for a strategic approach to office space planning that aligns with broader organizational goals of inclusivity, equity, and social sustainability.

Data types	***Use in the analysis***
Survey data *243 respondents.*	*Quantitative analysis* *We computed variables on (i) perception of organizational control; (ii) perceived space quality*
Photos	*Photos of interior of the assigned workspaces for each individual.* *We coded the photos to compute variables on the level of territorialization of their offices*
Other Materials *Organizational charts* *Architectural Plans of the organizational space*	*Quantitative and Qualitative analysis* *We used organizational charts to compute variables on team relationship and hierarchical ties.* *We used architectural plans to compute distance (in m) between organizational members belonging to the same team and to compute variables related to the (1) orientation of the office towards the internal*
	courtyard, (2) distance from meeting rooms, and (3) distance from break areas. *All together this information served to build our main EV which is spatial segregation index.*
Focus groups *3 focus groups, lasting between 1.30 and 2 hours*	*Qualitative analysis*
Observations *Site visit to the organizations*	*Qualitative analysis*

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Exploring the effectiveness of design features to incite positive feelings and desired experiences in workplaces.

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ABSTRACT

This study explores designer's ambitions and employees' experiences in workplaces through the lens of innate human needs and engagement which are factors currently in demand. The paper presents preliminary findings from interviews with professionals that canvassed the expectations their clients had for their workplace, the drivers motivating them and the design features and attributes they employed to deliver the expectations. Preliminary findings point to four predominant experiences that reinforce a gradual evolution toward people centric themes that have emerged in the literature over three decades. Recommendations are made for designers to reimagine future digital workplaces that combines space, technology and social contexts to promote wellness, positive employee' experiences, connection and belonging. In addition, the paper suggests evolving workplaces to support change spatiotemporal and emotionally situated contexts of hybrid work.

Keywords

employee experience, satisfaction, pleasure, workplace design, Corporate Real Estate.

INTRODUCTION

Research has documented the social and physiological benefits of work, we know it fills important human needs like connection, pride and a reflection of one's social identity (Pierce & Brown, 2020). Since we spend most of our waking hours at work, it is important to feel good about being there which happens when we feel we belong to a workgroup (Hisch, 2021; Holt-Lundstad, 2018, Jena &Pradhan 2018). It has been argued that belonging at work is more important than in other social settings (Jena &Pradhan 2018).

In social work settings belonging is delivered through companionship, affiliation, connection, and when a persons' experiences fit with others in a group (Hagerty & Putasky, 1995). The physical design of the workplace, and the experience of digital interactions employees have in them, also engenders belonging by reinforcing social-identity and collective psychological ownership (Petani & Mengis 2023). The caveat in this equation is work must be *meaningful* and have a purpose to deliver authentic experiences that establish belonging.

The link between purpose and an individual's sense of meaning has become supercharged in the aftermath of the pandemic (Atlassian 2021). While conditions have evolved, what remains are employee's expectations that the workplace contribute to positive feelings that enhance their work and personal lives (Worktech & HqO, 2022; Jin et al., 2022; Cobert et al., 2015). This in part explains why the average attendance for Australian workers is 76% of pre-Covid levels with Tuesday – Thursday being the most popular days of attendance (CBRE, 2023). The average Australian pays $20 a day commuting to work (Australian Commute report, 2022), weighing rising cost of fuel and public transit, a desire to retain newfound flexibility, autonomy, balancing personal commitments, health and wellbeing; the office is frequently the loser of what is now a complex equation (Tenakwah & Watson, 2024)

A point of friction has arisen between the needs of organizations who believe physical presence is critical with those of the individual (Oppong, 2024). This shines a spotlight on the value of physical workplaces, the designers that create them and their decision-making process which has inherent weaknesses including: bias (Hammond et al.,1998), a failure to regard decision making as an ongoing, iterative process (Lovello and Kahneman, 2003; Luftman and Brier, 1999), and a propensity to make decisions with incomplete knowledge (Argyris, 2008).

We know the workplace affects human performance, productivity, and health and it plays a critical role in employees' experiences (Candido et al, 2019), but our focus on physical aspects of space rather than its effect on people leaves us with a lack of insight into which design characteristics and features contribute to positive human experiences desired in today's context.

More data linking design features to emerging themes of hybrid and changed user expectations is required to assist workplace professionals struggling to imagine a workplace of the future that balances the friction between the needs of individuals and those of the organisations, and the spatiotemporal and multiple locatedness of hybrid work.

HYBRID HEAVEN OR HELL

Work from home is now the most popular term used in online job searches (Ziffer, 2023), despite companies' attempts to entice employees back to the office by linking bonuses to attendance or issuing edicts that harken back to historic management trust issues and presenteeism (KPMG, 2023). Studies indicate employees who have flexibility and control over when and where they work are the happiest and experience good work life balance (Hopkins & Bardoel, 2022). This explains the popularity of hybrid work models offering options of working anywhere an employee can connect to a digital network (Felstead & Henseke, 2017; Kingma, 2019) and at any time given ubiquitous connections to their professional networks (Cavazotte et al., 2014; Hislop & Axtell, 2009; Kelliher & Anderson, 2010).

The potential for employees to avoid the office is likely to be exacerbated when work environments compete poorly with other places where work now occurs (Hq0 & Worktech, 2022). There is low tolerance for poorly performing, lacklustre offices (Yin & Mahrous, 2022), particularly amongst younger digital natives. Physical workplaces require reinvention to address different purposes that are less about doing work, which can happen anywhere depending on one's role, and more about supporting innate human needs like togetherness (Durakovic et al., 2022) that reinforce the meaning of work (Mirvis, 1997).

The rejection of rigid work practices that began well before the pandemic resulted in new spatiotemporal realities inherent in hybrid work models (De Menezes & Kelliher, 2011; Richardson & McKenna, 2014). Added to the economic, cultural and political forces that influence life and drive experiential feeling (Aroles et al., 2021), it becomes clear the focus on physical spaces and technologies over people must expand to include experiences, atmospheres and vibes that space and technology jointly deliver (Endrissat & Leclercq-Vandelannoitte, 2021).

Work experiences today come through multiple channels and complex influences (Baptista et al., 2020; Coetzee, 2019; Dery et al., 2017; Koffer, 2015) including physical spaces, cultural or social rules (Baptista et al., 2020; Kane et al., 2015). In this ecology of work, coined the digital workplace, material aspects of a physical or digital environment cannot be separated from the social contexts, norms and discourses in which they are used (Orlikowski, 2007; Leonardi, 2010).

This boundaryless and transparent concept of work presents significant future opportunities, but it comes with an imperative to evolve the parameters and physical structures of the workplace. New temporal frameworks offer employees high flexibility, digitization and virtualization (Courpasson & Reed, 2004; Richardson et al., 2008) but they come at a cost (Baldissarri et al. 2014). Technology can separate and isolate people, and it can distance or bring them together (Ajzen & Taskin, 2021).

Overcoming intrinsic weakness of digital work to maintain social connections required for organisational culture and collective identity to flourish requires an exploration of new forms of sociality (Aroles et al., 2019). This is an opportunity for workplace designers to lead by expanding into digital environments and embracing the social and material, or sociomaterial, dimensions of technology (Orlikowski, 2007). They also must envision new physical constructs that align with the intentions and expectations of workers.

RESEARCH AIMS AND QUESTIONS

This research aims to provide evidence to improve the design decision making process that often relies on gut instincts and bias. The paper seeks to confirm expectations have shifted, and understand what design features and attributes organisations use in their workplaces to improve employees' experiences. The paper sets the groundwork for a much larger research project examining changing attitudes and expectations of employees regarding physical work environments, and expectations for organisations to leverage their workplace to address broader social issues employees care about.

Findings from a scoping review of industry and academic literature plus a canvas of industry-led events (2021-2023) were used to tease out key topics for questions that were put to industry experts in 32 semi-structured interviews. Preliminary findings are reported that will inform subsequent phases of the project.

METHODS

Participants, recruited through professional networks and Linkedin, agreed to a one-on-one interviews conducted over Microsoft Teams with the primary researcher. The interviews followed a semi-structured, qualitative research approach that allowed for dialogue and modification (Braun & Clarke, 2014). The main topics of discussion were the professional's experiences with clients and their interpretation of what their clients' motivations were in wanting to deliver specific workplace experiences e.g. why and what did they hope it would achieve?

Questions were informed by the literature review which indicates employee's expectations have adjusted due to the widespread adoption of hybrid work practices and other post pandemic shifts in mindset, attitudes, and beliefs about work and by proxy the workplace. The questions explored the physical and pragmatic requirements of the workplace and touched on an environment's ability to positively impact the human experiences of pleasure, satisfaction and motivation.

These words were defined in a workplace context as follows:

Pleasure – facilitates enjoyable interactions and engenders a sense of ownership and identity. Satisfaction – delivers necessary experiences for human performance and sends messages consistent with the company's brand and culture.

Motivation –reinforces connection to the occupants' meaning and purpose in work and encourages participation and engagement.

Participants selected for the study had a minimum of ten-years' industry experience delivering workplaces. Below is a list of participants, the total number interviewed by role and the bias inherent in their role.

Workplace Strategists (5 participants)

Workplace Designers (8 participants)

Experience Designers (3 participants)

Tenant Advisors (5 participants)

Building Developers (1 participant)

Architects (3 participants)

End Users (7 participants)

Interviews were recorded, transcribed with transcriptions cleaned of repeating words, fillers such as 'kind of', 'so', and 'you know' and to improve readability. All identifying information was removed following analysis and dissemination with participant assigned a letter depicting their expertise e.g. D-designer, and number. The transcripts were coded in NVIVO software which uses text analytics and relies on machine learning algorithms to aid and empower analyses through data-coding of analysed text.

A preliminary review of the data uncovered four predominant experiences along with a number of themes that emerged from a review of the presence of words, concepts, or topics within the text that also includes associated words. Using machine-learning algorithms and software for text analytics insights were gained that are not explicitly stated but hidden in the frequency of appearance of key concepts.

Scoping review

The scoping review had two separate and complementary parts. Firstly, the scoping review of 57 peer-review papers published between 1990 and 2023 tested the hypothesis that a shift in focus has occurred related to work environments. Scopus was used as the search tool engine to discover peer-review papers published more recently using a matrix of keywords including: workplace or office and design combined with management, leadership, satisfaction, productivity, motivation, experience or engagement and then location (Australia) was used. After screening for relevance, the sample size a total of 11 papers were found. Secondly, an additional search for industry reports was downloaded from key design and consultancy firms, including Atlassian, Deloitte, McKinsey & Company, HqO Worktech, The Wellbeing Lab and Gensler. A total of 7 reports were included. This additional search aimed to include research reports led by industry that would not otherwise be published in academic literature.

DISCUSSION & Results

Key findings from literature search

The literature review highlights organisations historically viewed the workplace as a cost burden rather than an enabler or investment in people (Oseland, 2021); over the past two and a half decades this has slowly changed with the emergence of impenetrable, people related outcomes such as psychological safety (McQuaid, 2021; HqO & Worktech, 2022), togetherness and belonging (Durakovic et al., 2022), innate human needs (Pierce & Brown, 2020), collective cognition (Akoyo & Askanasy, 2020) and inclusion appearing in workplace literature as highlighted in Table 1.

In tandem themes related to changed ideas about place and time consistent with hybrid work appear that require attention including the spatial and cultural challenges inherent in the 'multiple locatedness' of hybrid work (Hislop et al., 2015; Cousins & Robey, 2005).

The physical workplace is now just one of many portals employees will use to access information, culture and connectivity (HqO & Worktech, 2022). Although technologies make it possible for work to happen anywhere, it is still carried out somewhere - either in physical or digital environments, and more likely in both. In either case, workplaces act as carriers of value for psychosocial work and organisational culture (Oseland, 2021; Nanayakkara et al., 2021; Ronda & DeGracia, 2022) and affect moods, stress levels and happiness (Vischer & Wifi, 2017; Wapshott & Mallett, 2012; Picard et al., 2020).

While emerging spatio-relational configurations offer workers choice and force a consideration of options other than the typical office centric approach, barriers remain to reimagining future workplaces that will satisfy the desires and the opportunities technology offers to work differently. The default to physical place and attendance implied in the phrase 'designing a workplace worthy of a commute' sets a false equation in aligning workplace success with attendance. Being at the office does not prove productive work occurred or satisfactory experiences gained. In fact, being at work is less important than feeling positive while there (Deloitte, 2021). However, despite a plethora of workplace research, there is limited knowledge to aid decisions related to human experiences.

Table 1. Evolving themes in workplace literature

Researcher	**Primary topic/finding**
1990 -1999	
Csikszentmihalyi & Rathunde 1990	Humans are inclined to communicate with others
Nourse & Roulac 1993	Space supports organisations' enterprise by sending messages
Amabile et al., 1996	Space facilitates the transfer of knowledge
Fisk & Rosenfeld 1997	Workplace quality is linked to sick leave
2001 - 2010	
Barclay & York 2001	Space can be orchestrated for connection
Gosling et al., 2001	Symbolism
Ayoko & Hartel 2003	Physical and psychological space are triggers of personal conflict
Zagreus et al., 2004	Layout, colour, furniture and maintenance affect performance
Lindholm & Levainen 2006	Space is important in achieving organisational goals
Becker 2007	Building on Hawthorn, patterns and culture
Fayard & Weeks 2007	Space affordances
Vischer 2009	Supporting human capital
Seppala et al., 2009	Retention, dedication
Mintzberg 2009	Belonging & community
Devine-Wright & Clayton 2010	Symbolic & cultural meaning
Pierce & Jussila 2010	Psychological ownership and collectively held feelings
2011- 2019	
Vischer 2011	Space helps us understand who I am, how I should act
Wapshott & Mallett 2012	Community and organisational hope
Jeacle & Parker 2013	Workplace drives organisational strategy

Bacevice & DeGraff 2013	Value creation
Laing & Bacevich 2013	Leadership, coordination
Haapakangas et al., 2008, 2014	Ambient noise
Holt-Lunstad et al., 2015	Social & physiological benefits of connection
Bammens 2016	Engagement and organisational climate
Spinuzzi 2018	Space & social isolation
Appel-Meulenbroek et al., 2018	Employee needs and preferences
Wang et al., 2019	Work engagement and inclusive leadership
Candido et al., 2019	Employee performance and IEQ
2020 - 2023	
Pierce & Brown 2020	Innate human needs, motivation & belonging
Akoyo & Ashkansy 2020	Collective cognition, Design of work, technology and aesthetics
Bodin- Danielson et al., 2022	Noise & distraction
Ward & Parker 2020	Business hopes
Apple-Muelenbroek et al., 2020	Job burnout, distraction, noise
Spreitzer et al., 2020	Knowledge transfer
Akoyo & Ashkanasy 2020	Connection belonging, motivation and commitment
Danielson 2020	Individual and group performance
Picard et al., 2020	Mindset and behaviours
Hopkins & Figaro, 2021	War for talent
Nanayakkara et al., 2021	Shared culture
Zhang et al., 2021	Spatial affordances in virtual realm
Usher 2021	Creation confused with productivity
Roumpi 2021	Employee resilience
Jin et al., 2022	IEQ health benefits
McQuaid 2021	Psychological safety & human thriving
Cheese 2021	Fairness, inclusion
Lee et al., 2021	Sustainability & negative influences
Appel-Meulenbroek et al., 2022	Performance & face-to-face interaction
HqO & Worktech 2022	Psychological comfort
Wang et al., 2022	Employee willingness and engagement
Ronda & Degracia 2022	Workplace aesthetics & cultural congruence
Collings 2021	Overworked due to job insecurity
Durkovic et al., 2022	Togetherness motivates employee

Preliminary findings from interviews

In design disciplines, “user experience” is a broader term than usability or satisfaction, usability does not inherently imply satisfaction and vice versa (Norman, 2004). This becomes evident in office designs where users experience spaces and artifacts as aesthetically pleasing but also note their flaws (Babapour et al., 2022). Satisfaction in offices is often measured using thermal comfort, air quality or noise control (Kwon et al., 2019). The challenge is indoor environment and comfort are based on using the office over time, not on a single factor-response relationship (Bluyssen, 2014) which is more likely to occur in hybrid. What is also missing is the user’s satisfaction with their experience.

The following table reports preliminary findings of our study exploring the evolution of employees' expectations related to human experiences. Four key expectations appear in the far left of the table followed by the motivations the professional felt that experience was requested. Finally on the right are the design features, attributes and opportunities that were commonly used to satisfy the expectations.

Expectation for the workplace to deliver	Driver or Motivation	Features, Attributes and Opportunities
Community & Connection	Support hybrid and togetherness Convey being a part of something bigger Provide human, social and professional connection Share ideas, insights & strengthening relationships	Kitchen spaces that bleed into other places for informal chats Town Hall spaces Breakout areas Communal tables to share meals A company sponsored food and beverage offering Multifunctional social space
Flexibility & Choice	Flexibility is now an obligation for most workers Desire to work somewhere else other than the office Empower people to work how they work best Support changing lives and more personal elements that reinforce purpose and meaning	Soft spaces for connectivity and future flexibility Multipurpose space with storage Flexible facades Reception spaces become auditorium Studio spaces for projects
Good Technology & Functionality	To equal the level of technology in employees' homes Imperative to connect instantly Ensure the right people and places are available when an employee goes to the office	Introduction of apps: The Work Life app, Calven Walk up help desk Improved collaboration technology in meeting rooms. Lights on sensors

	Improve digital meetings.	Headset & rules. Areas for silence. Social media and Workplace media networks
Curated Hospitality	To create a key differentiator from the home environment. Offer employees services they don't get at home. Provide an experience that is better than what you would experience at home.	A high level of luxury and hospitality Dynamic cleaning White glove service and human touch Hyper curation and well serviced food and beverage offering Coffee bars & barista Curators of the workplace, building & precincts.

CONCLUSION

Over the past decades a definitive shift in the mindsets of both organisational leaders and their employees has taken place in thier attitudes and expectations of the workplace. Trends like hybrid working that began well before the global pandemic have firmly embedded bringing to light challenges of multiple locatedness and digital inclusion. Expectations of human centric outcomes such as togetherness and belonging (Durakovic et al., 2023), innate human needs (Pierce & Brown, 2020), collective cognition (Akoyo & Askanasy, 2020) human thriving, and psychological safety (McQuaid, 2021) are now considered to be necessary workplace outcomes.

While these words have become the lexicon used by designers touting the benefits of their efforts and the value of design, there are significant gaps in knowing which elements effectively deliver the best outcomes. This highlights a vulnerability. Workplaces must produce different outcomes in smaller footprints, if they fail, employees won't use them. Similarly, designers unable to deliver additional value may find themselves competing unsuccessfully against powerful AI tools that are able to generate interior designs in the time it would take a human a decade to deliver (Nayeri, 2023).

Given the nature of hybrid work and the many changes that have taken place, it is understandable that organisations are questioning the importance of investing in workplaces when employees spend most of their time working remotely (Ronda & Gracia, 2022). Companies are confronted with the mystery of

how much space they need and some are debating whether they need space at all (Boland et al., 2020; Naor et al., 2022). For these reasons it is important to understand which features deliver the experiences currently in demand.

Literature and this research confirm a shift in expectations has occurred, but it is also clear physical solutions alone will not deliver the experiences expected. A comprehensive look at the role and purpose of work in our lives, the impact of physical and digital environments and whether the benefits of curated experiences and events continue to deliver over an extended period of time should be brought into discussions related to the design of future office environments.

Supporting connection & community, choice, digital connectivity and hospitality events may be an unfair burden to place on organisations, designers, or the workplace. But the challenges posed in this paper establish an imperative for designers of workplaces to take this on if they hope to deliver value and support psychological aspects of life that employees expect. This has not traditionally been part of a workplace brief, but it needs to be moving forward.

This research will reduce the gap in our understanding by clarifying what elements are used to deliver desired experiences. Subsequent phases of the project will explore the divide between designers' thoughts and intentions and users' feelings in space. Together they will shed light on what works and what doesn't and force the justification of the inclusion of design elements that lack intention. In a future where workplace must do more with less, an appreciation of nuances is required to combat the risk of abandoning physical workplaces at the expense of psychosocial wellbeing.

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The allure of the office environment - Qualitative research among Hungarian office workers

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ABSTRACT

One of the greatest challenges for companies in the post-Covid era is to find the right working arrangements for both work processes and employees. Work psychology research highlights that full-time telework or mostly working from home increases psychological risk factors and reduces job satisfaction. Working in a hybrid way seems to be the most optimal solution, but conflicts still arise. Many employees have the willingness to work from home full time or resent being called in by the employer on a mandatory basis for 1-2 days a week.

The starting point for the research is the assumption that in order to provide employees with an environment where they are willing to go, it is necessary to identify the factors that make employees feel good during their working day in the office, in other words, the factors that contribute to their well-being.

The qualitative research method chosen was autophotography, in which employees (n=18) working in a hybrid work schedule were asked to take photos of places, objects, and moments at the office that inspire them in their work and that have a positive impact on their well-being. They were then interviewed to interpret the photos they had taken.

The analysis of the visual data resulted in seven broad categories: (1) Location; (2) Physical environmental characteristics; (3) Subjective sensation of the environment; (4) Social experiences; (5) Personalisation; (6) Sense of being cared for; and (7) Presence of colleagues as a source of information and support; as factors that have a positive impact on employees' well-being in the office.

The results indicate the role of a caring organisational culture and the importance of team-based activities and shared memories. The study provides a starting point for possible areas of office development.

Keywords

Hybrid work, post-covid office environment, employee well-being, autophotography

1 INTRODUCTION

The pandemic has called into question the previous work practices and the role of the office environment, which organizations need to reconsider in the post-Covid era. There are organisations that have fully switched to telework and their office exists only virtually, but the opposite can also be found, where employees are called back to work in the office 5 days a week (Antunes et al., 2023). In between is hybrid working, considered by many to be the golden mean, where the number of working days per week is split between office and telework days. National trends in teleworking rates before, during, and after the pandemic periods can also be observed. In the case of our study, the Hungarian data shows that during and after the pandemic peaks, organisations were more likely to return to the office, while the proportion of people working regularly or occasionally from home increased from 4.6% (before the pandemic) to 13% by 2023, which is significantly below the European Union average (Hungarian Central Statistical Office, 2023). However, the complete withdrawal of teleworking or an increase in the number of office-based working days could lead to job dissatisfaction when employees prefer teleworking after they have experienced it. Therefore this study aims to investigate how the design of the work environment could reverse this negative attitude and what are those work environment factors that might motivate employees to work on-site. In order to achieve the expected individual and organisational benefits of hybrid work, employers need to create a physical environment that supports employee well-being (Chafi et al., 2022).

In the next section, we review how related research assesses the effects of hybrid and full-time telework on employees from both organisational and employee perspective.

2 Literature review

2.1 Full time versus hybrid telework

The research analyses the effects of teleworking based on whether the work is done remotely on a permanent, partial, or occasional basis (Gray et al., 1993; Lamond et al., 1997). Permanent teleworking is undeniably a cost saving solution for companies in the short term. It can also be seen as a corporate benefit that employees working from home typically have more intensive and longer working days (Antunes et al., 2023), which might be a result of self-imposed pressure to deliver, as suggested by Müller and Niessen (Müller & Niessen, 2019). In the long term, this is associated with several negative factors, such as increasing psychological strain (Bentley et al., 2016) and a decrease in job satisfaction. Longer periods of remote work lead to reduced workplace engagement (Sardeshmukh et al., 2012) and heightened job insecurity (Kaduk et al., 2019). Furthermore, working from home is often accompanied by the absence of proper ergonomics, so workers are exposed to the risks of musculoskeletal disorders (Shende & Das, 2021).

There seems to be consensus in the literature in terms of the negative effects of telework on co-worker relationships and teamwork (Callentine, 1995; Gajendran & Harrison, 2007; Sardeshmukh et al., 2012). Physical distance from co-workers affects the extent of social support (Collins et al., 2016), which is directly linked to mental health based on decades of scientific research (Cohen & Wills, 1985; Miller, 1988). Social support helps employees cope with difficulties, and thus a well-functioning workplace community could also ease the levels of job-related stress (Bailey et al., 1994; Bentley et al., 2016).

Furthermore, the lack of face-to-face communication in sharing information and effective problem solving was also perceived by office workers as a disadvantage of teleworking (Shende & Das, 2021). A systematic review presents seven dimensions regarding the differences in psychosocial risk factors between part-time and full-time teleworking: work intensity and working hours; emotional demands; autonomy; social relationships at work; conflict of values, work insecurity, and home/work interface (Antunes et al., 2023).

In literature, the main motivations of workers for teleworking include the sense of work-life balance, the opportunity to concentrate, being engaged in work, greater autonomy, individual time management, and saving time by not commuting (Baert et al., 2020; Shende & Das, 2021; Vittersø et al., 2003).

However, many of these advantages also apply to hybrid working, so it is a reasonable assumption that companies should adopt hybrid working arrangements instead of full-time teleworking, given the disadvantages presented.

2.2 Factors of employee well-being

In order to analyse the aspects of employee well-being in a systematic way in this research, the well-known PERMA model (Seligman, 2011) of positive psychology will be presented. According to Seligman's (2011) theory, every component of the model contributes to individual well-being. These components are as follows: (1) Positive emotions, (2) Engagement, (3) Positive relationships, (4) Meaning and (5) Accomplishment. These five components are correlated with one another and can be equated for overall and optimal well-being.

Thus, according to PERMA model, well-being at work is high when the workplace evokes positive emotions in the employee, there is good interaction between co-workers, and the work is meaningful, engaging and successful. Among the positive emotions (P), Kern (2014) highlighted the joy and satisfaction that work elicits, while the components of engagement (E) and meaning (M) refers to the expectations a person has about their work. These expectations include finding their work interesting, feeling aligned with its goals, and considering it significant. Aside from a feeling of success, the accomplishment component (A) encompasses the acknowledgment of one's performance by colleagues and supervisors, which holds significant value. Positive workplace relationships are characterised by a sense of belonging to a community of colleagues and mutual support (Kern, 2014).

In the next section, we present the related literature on the inspirational and motivational factors of the physical work environment.

2.3 Related research on inspirational offices

In the first two decades of the 21st century, there was a growing trend to pay more attention to the design of corporate offices. In addition to the importance of the ergonomic quality of furniture and the support of work processes through office functions, many companies have recognised that the office can also be seen as a "business card". It has become an important requirement for office design to reflect and support the organisational culture (Fairs, 2016). The design of the physical working environment of companies is also an increasingly important consideration for young people entering

the labour market. Their job decision is strongly influenced by the office space they can visit during interviews, which gives them an insight into the life of the company (Pataki-Bittó & Kapusy, 2021).

The creative industries in particular have paid attention to office interiors: Google's offices have inspired a new office design trend called creative offices (Thanem et al., 2011). The success of creative offices confirms that the visual components and design of the work environment can stimulate innovation and creativity. The theory that creativity is the result of a complex interaction between individuals and the environment, rather than a skill of the individual, is also strongly supported in the literature (Lee, 2016). In addition, Serrano-Martínez (Serrano-Martínez, 2016) highlights the nature of the interactions between employees in creative offices: employees behave like a group of friends playing together on a playground. In addition to the playful office design, creative offices are characterised by the use of coworking spaces, where people from different areas of expertise work together in a shared office, while the space offers the opportunity to meet and exchange experiences.

Hoff and Öberg (Hoff & Öberg, 2015) proposed a physical environmental support model for creative work, which includes functional, psychosocial, and inspirational support. In addition to the importance of ambient environmental factors and office functions that support individual and teamwork, they highlight the role of inspirational support, which includes brainstorming rooms and imaginative interior design.

In a study by Lee (2016) that analysed the office design of successful start-ups, it was discovered that these offices are dominated by three characteristics: a balanced office space, the availability of collaborative technologies and spaces for idea generation. Lamproulis' (2006) case study emphasised the significance of management in finding a time and a place in which employees can share moments of fun.

A growing number of organisations are thinking about adopting non-traditional office design to support flexibility and creativity (Lee, 2016). While the literature has written extensively on the impact of different office designs on creativity and innovation, our research approaches the question from a different perspective: What are the factors during the working day in the office that add value for employees? What are the physical or social environmental elements that contribute to the well-being of employees in the office?

This perspective is particularly relevant at a time when many companies are struggling to attract their employees back to the office in the post-covid era.

3 Method

The chosen research method was autophotography, as this rarely used method could potentially offer new and interesting insights to research on the world of work. The method was first introduced by Collier (1957) who highlighted the importance and added value of interviews based on photographs in a study on the role of the environment in psychological stress. Following Collier, researchers began to use visual methods, primarily in the fields of anthropology and sociology to elicit self-reflective, emotional and detailed insider perspectives of human experience that other methodologies could not (Harper, 2002). As an example, Harding et al. (2009) used photographs to investigate how children with physical disabilities experience their out-of-school-time activities in their social and physical

environments. Although the method is not appropriate for all research topics, after considering examples from the literature, it is applicable to explore the question raised in our study.

When using autophotography, the researcher asks the participants to take photographs prior to the interviews (Byrne et al., 2016). The participants themselves select and record the moments that they think best represent them, their life or the situation they are in (Noland, 2006). The advantage of this method is that during the interview the participant recalls their own experiences through the photos, so that physical reality can be linked to the experiences described (Hurworth, 2003). Another advantage is that by taking photographs, the participants can express sensitive issues and problems that they would not be able or willing to express in words (Byrne et al., 2016; Chapman et al., 2016). The photographs taken by the participants can be considered as primary data and can be further analysed beyond the verbal information provided in the interview. In their study, Chapman et al. (2016) point out that the analysis of visual data provides researchers with additional valuable research findings.

The method of analysing photographs is similar to content coding for analysing text data. By coding the visual data, both quantitative and qualitative results can be obtained: the frequency of occurrence of a motif on the photographs, and the emotional or symbolic meaning, which relationship with the verbal responses can also be examined. In the case of our research, we have decided to use thematic analyses to gain qualitative results.

3.1 Participants and procedure

For the autophotography method researchers recruited office workers that follow a hybrid work schedule, working 1-3 days in the office each week. The goal was to select a diverse range of employees in terms of occupation, age, company size, and the type of the organization (multinational company, Hungarian company, state-owned institution). The recruitment of participants was started in the researchers' contact groups, and then proceeded with the snowball method to reach more participants who met the criteria. Finally, 18 office workers agreed to participate in the research. Among the 8 male and 10 female respondents, there were economists, engineers, HR managers, an IT specialist, an office manager, a lawyer, an agronomist, a marketing assistant, an event planner, and a marketing assistant. In terms of position, apart from one middle manager and two team leaders, the participants were all subordinates, between the ages of 22 and 54. The interviews were conducted between March and October 2023, excluding the summer months.

After introducing the research process, participants were asked to take 4-8 pictures of their work environment over the following 2 weeks on days in the office, showing places, objects, and moments that inspire them in their work and that have a positive impact on their subjective well-being. Participants were assured that the photos would be used only for the analysis and would not be published or given to third parties. After two weeks, participants were contacted for a face-to-face interview about the interpretation of the photos they had taken. Interviewees were asked to express their emotions, and share both positive and negative thoughts and experiences in connection with the photographs.

The analysis of the interviews was started by processing the photographs. The photographs were numbered with the corresponding part of the interview transcript. After the thematic coding of the

interviews, the themes associated with the photographs were written on post-its attached to the photographs. The team of three researchers (an organizational psychologist, an ergonomist, and an interior designer) then began to organise the photographs (n=68) into thematic groups - supported by the themes. The groups of photos were then named - first individually, then by consensus.

4 Results

The analysis of the autophotography interviews resulted in seven thematic groups: (1) Location, (2) Physical environmental characteristics, (3) Subjective sensation of the environment, (4) Social experiences, (5) Personalisation, (6) Sense of being cared for, and (7) Presence of colleagues as a source of information and support.

Location was strongly associated with proximity to nature and good views. Photos were taken not only from windows, but also from rooftop terraces with a view of the city, a beautiful historical building or a park. Rooftop terraces were included in more than one category: in physical environmental characteristics, as part of the building, and as a place of social experience.

Among the **physical environmental characteristics**, office glass walls were highly valued and were associated with transparency of space, high quality, sophistication and modernity. Also, furnishings (e.g. ergonomic chairs, comfortable armchairs) and IT equipments (monitors with holders) were associated with high quality. In addition, the use of colours that reflect the brand, wall decorations that fit the corporate design and the large size of the company logo were also favoured by respondents. They said that this gives them a sense of pride when they enter the office, but respondents who have been with the company for several years also had a feeling of "I'm in a good place", and some even used the phrase "I'm at home".

A separate category has been defined for the impression or **sensation of the environment** and the feelings it evokes, as in several pictures the interviewees did not highlight any specific physical element/furniture, but emphasised the feeling itself: cleanliness, peacefulness, tidiness or freedom (mostly in the context of photos of large spaces).

The next category is **social experiences**, which included photos of self-organised yoga classes, coffee, lunch with colleagues and team building meetings.

The category of **personalisation** includes the possibility of displaying personal objects (e.g., lego figures, souvenirs), but in connection with photos of wall decorations and decorative objects interviewees highlighted the possibility to influence the decoration of the office environment and to add their own objects (e.g., a gift from a client).

In this category, objects and photos that evoke shared memories of the group's teambuilding activities or business travels were highlighted as well, which means that group personalisation is also an important factor. One image showed a picture of Frank Sinatra, which the interviewee explained as representing the coolness of their team.

In the next group of pictures named as **sense of being cared for**, the role of caring was expressed: there is always fresh fruit, good quality coffee for the workers, or regular events such as a fruit day. But there

were also photos of plants and an aquarium, highlighting the positive feeling that it is the employees who have to take care of them - they have a responsibility in the office.

And the last large group of photos showed employees at their desks. In this context, respondents highlighted that they are also motivated in the office by the fact that they can help each other efficiently, get their questions answered quickly, and don't have to write emails or hope to be answered on the phone. Hence the name given to this group is the **presence of colleagues as a source of information and support.**

5 Conclusions

First of all, it is worth noting that the autophotography method could indeed contribute to the discovery of office values that were not limited to the physical environment, but focused on the deeper understanding of the employee experiences. The findings of this study align closely with Hoff and Öberg's (2015) physical environmental support model. Specifically, furniture, technical equipment, and specific office functions fall under the functional support category, while social events and the opportunity to help one another fall under the psychosocial support category. This research also identifies inspirational support—but not as brainstorming spaces in offices, but rather as office decoration that can be customised to the individual and to the team. Lamproulis'(2006) finding should also be highlighted from the literature presented, as this research also supports the importance of "finding a time and a place in which employees can share moments of fun."

In the following, the results are interpreted according to the previously presented PERMA well-being model (Seligman, 2011). In the thematic categories created, in accordance with the objective of our research and the instructions of the autophotography, *positive emotions* are strongly present by the atmosphere of the environment, the personalization, the community, the architectural environment, and the services offered by the company. *Positive relationships* are created through social experiences and the support of each other. Summarising these two components, a caring organisational culture and the way it is expressed in practice strongly contribute to positive feelings among employees.

The *accomplishment* component appears on two levels: gifts from clients as a symbol of success and appreciation, and effective problem-solving through face-to-face interactions.

Two components were given a minor role in our research: one is *meaning*, which is to some extent related to brand identity: when the employee is proud of working for the goals of the company. However, the *engagement* component did not appear during the analysis (no mention of the possibility to concentrate or the feeling of flow), which suggests that this is the component that days spent teleworking can add to employee well-being.

Finally, the most important finding of the research is, that not only the present, actual state matters to the employees in the physical environment, but also the material representations of previously shared memories and successes at work. This finding is considered particularly important because in today's design-led offices, dominated by corporate design elements and clean desk policies, it is crucial to acknowledge that office spaces accommodate communities with a shared past that can hold them together and give them a reason to work together in the office with a personal presence - to build their collective future.

6 Limitations and further research

Some limitations of this paper need to be acknowledged. Firstly, the chosen research method is not adequate for exploring all the aspects contributing to the well-being at the office; nonetheless, the selection of this method has shown the potential of utilising autophotography. The second limitation is related to participant selection: the results could be influenced by cultural and personal characteristics. Despite the effort to involve individuals from various work environments, the workplace culture should have been also considered. However, it is worth considering more research on autophotography as a means to focus on the home-based working environment or the negative experiences in the office.

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Session 7

Session 7A: Human Centred Workplace

Making room for autism at work: Designing a participatory research project

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ABSTRACT
Finding and keeping a job is challenging for people on the autism spectrum, due to employee-workplace misalignment related to daily work routines and interpersonal communication. Yet, how different spatial aspects of the work environment (e.g., location, spatial layout, indoor environment and its sensory qualities) support or hinder autistic people is rarely considered. Our research project '*Making room for autism at work*' seeks to address this gap by investigating the role of the built work environment in how autistic people experience and manage their working conditions. The aim of this contribution is to share our experiences of designing and starting up a participatory research project involving the autism community (i.e., autistic people and autism researchers) in all phases—from research set-up to quality assurance. In the first part, we examine the multi-disciplinary scholarship on autism in the workplace and highlight two knowledge gaps: (1) the need to focus on autistic people's real-life challenges (like (un)employment), starting from their lived, first-person experiences in researching the everyday realities of autism and (2) that available knowledge on built environment design related to autism focuses mainly on autistic children and learning environments, largely involving proxies (e.g., parents, teachers) rather than autistic people themselves as research participants. In the second part, we present our experiences of involving the autism community in the early project stages of research design. In particular, we explore and discuss the implications of the participatory research approach with resulting choices and adjustments related to the (1) methodological set-up, (2) selection of workplace contexts, (3) participant recruitment strategy, reflecting the diversity of people with autism, and (4) navigating ethical challenges of (non)disclosure of autism diagnosis at work. Based on these considerations, we highlight the importance and possible challenges of participatory (autism) research on inclusive workplace design and diversity at work more broadly.

Keywords
autism, inclusive workplace design, participatory research

1 INTRODUCTION

Finding and keeping a job is challenging for people on the autism spectrum[19], despite their capacity and willingness to work (Baldwin et al., 2014). Compared to other adults, they are more likely to be

[19] Most autistic people, research suggests, prefer identity-first language (Kenny et al., 2016). In this paper, we use multiple formulations to accommodate the diversity of preferences: identity-first language ('autistic

un(der)employed, overqualified and/or -educated (Goldfarb et al., 2024; Scott et al., 2015), which negatively affects their physical and psychological health, financial and personal independence, and quality of life (Brouwers et al., 2023). These employment challenges have been linked to attitudinal barriers and lack of support and resources in the workplace (Lindsay et al., 2021; Southey et al., 2024). To address such employee-workplace misalignment, research highlighted the potential of physical workplace accommodations for autistic employees (e.g., managing noise levels and lighting) (Khalifa et al., 2020; Weber et al., 2022). Yet, a systematic understanding of how different spatial aspects (e.g., workplace location, spatial layout, indoor environment and its sensory qualities) support or hinder autistic people at work is lacking. Our research project '*Making room for autism at work*' seeks to address this gap by investigating the role of the built work environment in how autistic people experience and manage their working conditions. On the one hand, we explore how the design of the built work environment (spatial design and indoor environment) affects autistic people and their experiences in the workplace. On the other, we aim to gain insight into how autistic people manage their working conditions as 'everyday designers' (Wakkary & Maestri, 2008) by using, appropriating, and adapting their work environment, i.e., as user-directed environmental crafting (Roskams & Haynes, 2021).

In this paper, we reflect on the process of designing and starting up this project as participatory research involving the autism community, i.e., autistic people and autism researchers, in all phases—from research set-up to quality assurance. Involving people on the spectrum in particular lies at the core of our research approach and is informed by two knowledge gaps. The first knowledge gap—the need to focus on autistic people's real-life challenges (like (un)employment), starting from their first-person experiences—is linked to the ongoing shift in autism research from the dominant medical towards a more inclusive, neurodiversity-informed model (Pellicano & den Houting, 2021). The neurodiversity paradigm conceptualises autism as a specific way of information and sensory processing: it is one of the many gradually distributed sensorimotor differences within human minds/bodies (like height) (van Es & Bervoets, 2021), which affects how individuals interact with the environment (Jelić et al., 2016). Accordingly, in a work context, an autistic person may be disabled by the (social and/or built) work environment (Heylighen et al., 2017; Narenthiran et al., 2022), through the interaction between their sensorimotor differences and environmental factors. Following such reasoning, the autism community calls for more research focusing on autistic people's everyday life challenges (Pellicano et al., 2014), of which successful employment is among the most critical ones (Brouwers et al., 2023). The second knowledge gap relates to the limited knowledge about autistic adults' experiences of the built environment—particularly in the work context. Rather than from built environment disciplines, research on autistic people's employment challenges primarily originates from fields like management, organisation and work psychology, disability and rehabilitation studies (Waisman-Nitzan et al., 2021; Weber et al., 2022). What is more, available knowledge focuses mainly on autistic children and design of the learning environments (Tola et al., 2021). Existing studies on the built environment—such as on autism and indoor environmental quality (IEQ)—often involve proxies (e.g., parents) rather than autistic people themselves as research participants (Caniato et al., 2022). Taken together, these knowledge

person/people'), people-first language ('person/people with autism'), and the metaphor of the autism spectrum (person/people on the spectrum), while accounting for recent language recommendations in autism research (Bottema-Beutel et al., 2021).

gaps emphasise the need to take their lived, first-person experiences seriously as a starting point in researching the everyday realities of autism (Hens, 2021)—including their interactions with the built (work) environment.

Our aim with this contribution is to share our experiences and lessons learned to inform future studies about the possible research strategies as well as the advantages and potential challenges in doing participatory research on autism in the workplace from a built environment perspective. In the following sections, we start by providing a brief summary of the project's research design and objectives. Secondly, we outline how we conceptualised this project as participatory research and the ways in which we have involved the autism community in research design. Finally, we present and discuss the implications of the participatory research approach with resulting choices and adjustments. Based on these considerations, we conclude by highlighting the importance and possible challenges of participatory (autism) research on inclusive workplace design and diversity at work more broadly.

2 THE project CONTEXT and RESEARCH DESIGN

The '*Making room for autism at work*'[20] is a 4-year research project conducted by researchers at the Department of Architecture, Research[x]Design research group and the Department of Civil Engineering, Building Physics and Sustainable Design section at KU Leuven (Belgium). With disciplinary backgrounds in architecture, architectural engineering and building physics, the research team brings expertise on understanding the diversity of people's experiences of the built environment through the first-person perspectives and involvement as 'user/experts' (Ostroff, 1997) as well as on the IEQ. We build on the team's previous research conducted with autistic participants in other spatial contexts (e.g., housing, residential facilities, university buildings) that highlighted the importance of taking a broad view on how a space feels, what it affords, and what it means for an autistic person (Baumers & Heylighen, 2010; Kinnaer et al., 2016; Nguyen et al., 2020a, 2020b; Tackx et al., 2022). Moreover, the Research[x]Design group is fortunate to have in-house personal experience with autism and other forms of neurodivergence (e.g., raising an autistic child). At the time of writing, we are six months into the project, which started in October 2023. To better situate this paper, in what follows we briefly summarise the project's research design and main objectives.

2.1 Diversity of autistic participants and work environments

Besides the participatory research set-up (elaborated in the next section), the project places attention to the diversity of autistic participants, their work experiences and work environments. The research involves individuals ≥18 years old, with and without intellectual impairment, who have an autism diagnosis, self-identify as autistic, or are in the process of seeking/awaiting a diagnosis. We seek to cover as diverse types of work experiences as possible: paid full-time/part-time jobs, self-employment, student jobs and internships, retirement, unemployment (with experience in having or searching for a job), voluntary work, vocational training, day activity centres, and other employment forms. We aim to recruit participants from various work environments to research spatial contexts beyond office spaces

[20] Project link: https://rxd.architectuur.kuleuven.be/projects/the-role-of-the-built-environment-in-unsupportive-working-conditions-learning-from-experiences-on-the-autism-spectrum/

and desk jobs, expecting to enhance our understanding of the built environment's role across different work contexts. Lastly, in line with research on workplace design and occupant well-being (Forooraghi et al., 2020; Roskams & Haynes, 2021), we conceptualise the *built work environment* through interrelated factors (1) spatial design (e.g., location, spatial layout, interior design) and (2) IEQ (e.g., indoor air quality, acoustic, (hygro)thermal, and visual conditions). We understand (3) socio-spatial factors as shaped by factors 1&2 i.e., as an interplay between a space and its users, reflected in e.g., social interactions, perceived privacy, territoriality, and autonomy.

2.2 Research design: two tracks

Designing workplaces with autistic people's experiences in mind requires gaining insights from two angles: from the person perspective ('bottom-up' understanding through insights into how autistic people experience, use, and adapt their work environment) and from the building design perspective ('top-down' understanding of how the design of the built work environment affects their work experiences). We adopt a two-track research strategy (Figure 1) to gain insights into autistic individual-workplace alignment:

- the *Autistic people* track (different individuals, different work environments) investigates which *spatial aspects* in the built work environment (e.g., location, spatial layout, interior design) are important for autistic people, how these aspects support or hinder them in their everyday work activities and interactions, and how they deal with the (un)supportive spatial elements through everyday design practices.
- the *Built work environment* track (different individuals, same work environment) investigates differences and similarities in how autistic people and their co-workers experience the *indoor environment and its sensory qualities* within a specific work environment and the role of the workplace design in facilitating or hindering the adaptive strategies they use to manage environmental (dis)comfort.

Within the *Autistic people* track, we take an open-ended, qualitative approach to gather insights into autistic people's lived experiences from a first-person perspective. We envision offering a range of methods for the participants to choose from, including semi-structured and go-along interviews, visual methods (e.g., drawing, photovoice, videovoice), text-based methods (e.g., diary and other forms of written expression like poems), and participatory activities in the workplace. This approach allows tailoring methods to specific participants' interests, skills, and preferences as well as whether (and to what extent) they disclose their autism condition in the workplace. Autistic individuals are invited to choose how long to participate in the research: from a single interview to collecting data about their work experiences spread over a six-month period (±1.5h/month) to explore patterns, trends, and variations over time.

Within the *Built work environment* track, we employ a mixed-methods approach by combining quantitative and qualitative data to provide a more nuanced understanding of how participants experience indoor environmental (dis)comfort. We envision two-phased data collection: (1) a quantitative phase, including sensor-based IEQ measurements (e.g., temperature, light and sound levels), experience sampling study to capture participants' experiences of indoor environmental comfort and satisfaction together with sensory sensitivity measures (Weiland et al., 2020); and (2) a

qualitative phase, including semi-structured interviews to gain insights into participants' adaptive strategies and to qualify the results emerging from quantitative data collection phase. Participants are invited to participate in three data collection cycles, spread over three different seasons (summer, winter, and a transitional season, spring or autumn) to examine the potential impact of seasonal influences on work experiences.

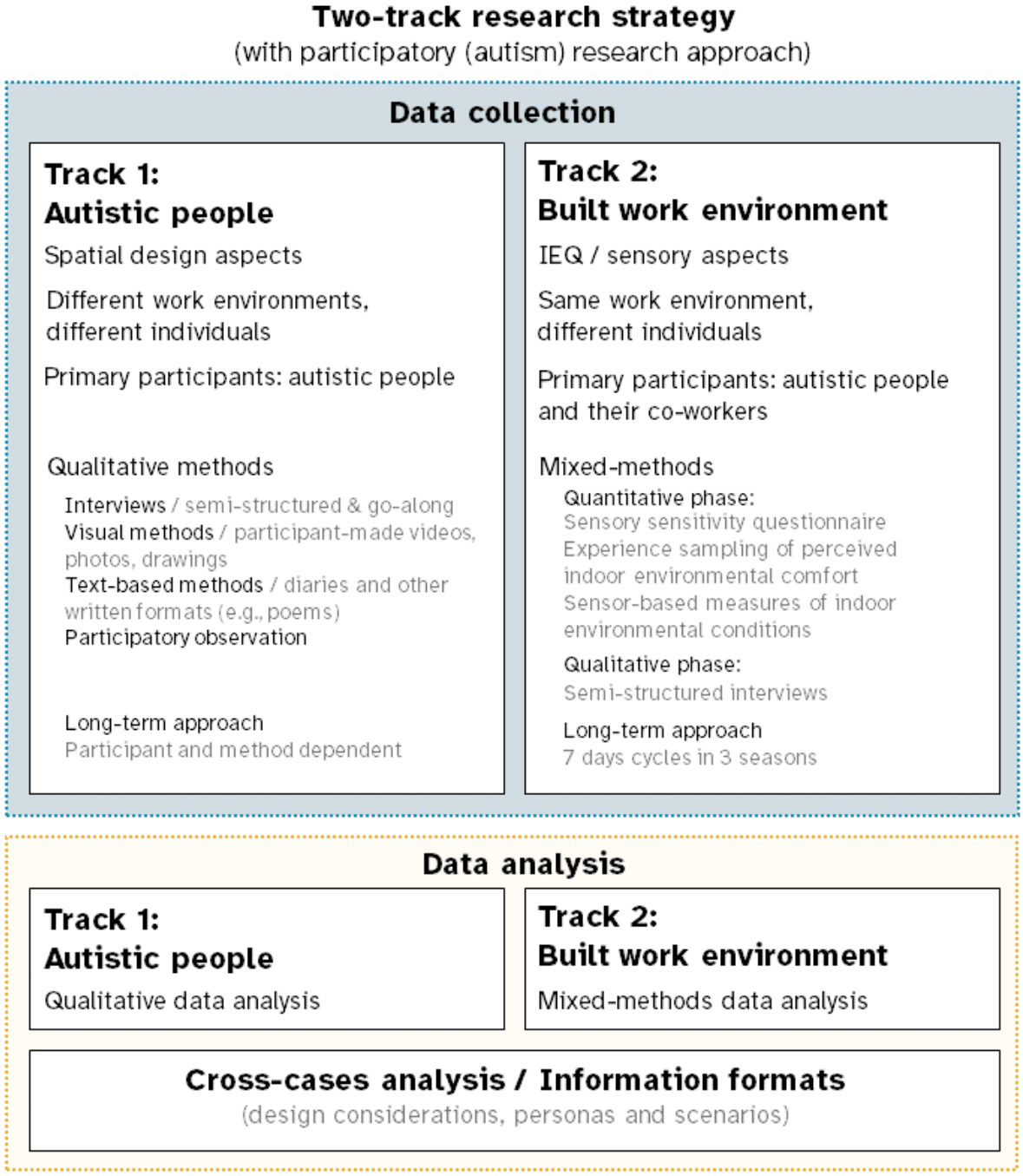

Figure 1. The two-track research strategy: overview and methodological approach

3. DESIGNING A PARTICIPATORY RESEARCH PROJECT: OUR APPROACH

Within the autism community, there is an increasing attention to 'participatory *autism* research', advocating that "research about autism is best conducted with the involvement of autistic people" (Costley et al., 2023, p. 693). The emphasis is on different types of involvement—not only as research participants (meaning: as research subjects), but also as research partners (autistic people as co-researchers and co-creators of knowledge) and research leaders (by autistic researchers) (Chown et al., 2017; Fletcher-Watson et al., 2019). In this section, we outline how we conceptualised the project as participatory research and the ways in which we have involved the autism community in the research design development. For the purposes of this paper, we highlight examples of planned and/or undertaken participatory activities within three project phases of: (1) research design, (2) data collection, and (3) data analysis and quality assurance. Additionally, one of our expected research outcomes—developing information formats such as design personas (i.e., user profiles) and spatial scenarios (Van der Linden et al., 2019) to facilitate knowledge exchange within and beyond the autism community—is envisaged as a form of participatory dissemination. Yet, as this merits a more extensive presentation, we do not discuss this research phase here.

The involvement of the autism community in research design covers development from proposal writing to early project stages and is exemplified in several ways. Through (in)formal conversations with autistic individuals within our (research) networks we regularly sought (and still seek) feedback on research design (e.g., choice of methods) and ethics-related matters (e.g., crafting informed consent forms). During proposal writing, we also had preliminary discussions with several organisations (within academia, R&D, technological and real estate industry) attentive to neurodiversity and/or autism in their practices that strengthened the feasibility of the project (e.g., related to participant recruitment) as well as affirmed the relevance of considering the sensory *along with* other spatial and social factors in the project. Besides engaging with the autism community in preparatory research phase, after the project start we had formal consultation meetings with members of the not-for-profit Autistic Adults' Reading and Advisory Group (LAVA; a Belgian expert group of autistic individuals) and the Leuven Autism Research (LAuRes) interdisciplinary consortium[21]. LAVA organises free online reading sessions to discuss and give feedback on study designs and interim findings—from their perspective as experts and/or experts by experience. In the first project month, we participated in one such feedback session. To prepare for the session, the LAVA members who volunteered to attend the meeting (8-10 members) read the shared project proposal. Following a short presentation, each of the attending LAVA members provided their input and/or clarifying questions to our presented research design and addressed our open questions at the time. Notably, our reading session was the first to discuss a project at the proposal level—and thus in an early project stage. In turn, the LAuRes meeting entailed a more common academic set up: presentation with open questions followed by a discussion of salient

[21] For more details, please see LAVA (https://www.lavavzw.be/) and LAuRes (https://www.kuleuven.be/laures).

points. The meeting gathered LAuRes-affiliated researchers as autism experts across disciplines (e.g., neuroscience, psychology, educational sciences, authors as built environment researchers) as well as LAVA members. All this (in)formal feedback resulted in research design adjustments, which further informed the ethics application, as elaborated in the following section.

As we move into the data collection phase, we envision conducting *pilot studies* that will allow us to further test and refine the methodological set-up. For example, we envisage the possibility to seek feedback on the interview questions and include the input from autistic participant in the subsequent interviews. Or, similarly, to optimise and clarify the set-up and questions within the experience sampling study. The range of methods that autistic participants can choose from is intended to suit the diversity of their preferences, skills, and interests. At the same time, these different methods entail different roles that an individual with autism can take in the data collection phase: as a research participant (e.g., by participating in a semi-structured interview or an experience sampling study) and a co-researcher (e.g., by engaging in participatory video making and initial spatial analysis). Hence, our participatory research approach is not guided by the 'ladder of participation' in a homogenous way, with co-research/co-production being advocated as the most desired mode of giving voice and power to autistic people in shaping what research is conducted and how (den Houting et al., 2021). Rather, the different ways and levels of involvement offered are meant to align with the heterogeneity of autism and autistic participants' preferences (similarly to recommendations by Gowen et al. (2019)) as well as to address anticipated differences in workplace (non)disclosure that can set limits to possible research participation (at least in the data collection phase). Finally, it is worth mentioning that our collaboration with the autism community extends to 'allies' of autistic participants—through involvement of co-workers, housemates (in case of participants with a home office), (job) coaches, managers/employers, and HR personnel—with the intention to gather their insights into autistic people's work experiences. Importantly, these other participants will be recruited in agreement with autistic participants—in contrast to research studies with proxies.

In the *data analysis and quality assurance*, we envision different possibilities of involving the autism community. In the informed consent forms we offer autistic participants the choice to take part in the data analysis as a way of validating the (preliminary) findings—placing them in the position of co-producers of (scientific) knowledge. Continuing the research group's successful experiences in other projects, we will further guard the findings validity by organising ad-hoc (inter)national user/expert panels, with members of the autism community (among other relevant experts, such as workplace and organisational studies researchers). It is worth noting that potential user/expert panel members were also identified through the researchers' recruitment process. Following the advice from autistic individuals within our (research) networks on e.g., vacancy text and inclusive interview practices, our open position succeeded in attracting several candidates with experiences of/with neurodivergence—and who expressed interest in joining the user/expert panels.

4. lESSONS (BEING) LEARNED

As we are in the early project stage, the lessons learned considered here are limited to the experiences of engaging the autism community in the research design. In this section, we discuss the implications of the participatory research approach—specifically, the (in)formal consultations with autistic individuals and autism researchers—for the research design. The resulting design choices and adjustments concern (1) methodological set-up, (2) selection of workplace contexts, (3) participant recruitment strategy, reflecting the diversity of people with autism, and (4) navigating ethical challenges of (non)disclosure of autism diagnosis at work.

In terms of the *methodological set-up*, the conversations highlighted the importance of considering the (built) environment and situations beyond the workplace like the commute to work. This confirmed and reinforced our initial design aiming to capture these experiences through e.g., go-along interviews, encompassing the route from an autistic participant's home to the workplace. In turn, we lessened the focus on participant observation as feedback indicated possible discomfort of some autistic people with being observed.

In relation to the *selection of workplace contexts*, our intention of researching beyond the office spaces and ensuring a variety of work environments was affirmed. The autism community expressed interest in considering jobs that include mobile work activities and multiple locations— which inspired us to think more about the role of the built environment in autistic people's work experiences when not only (social) situations but spatial aspects frequently change. The team's previous research suggested that for autistic people, to counter the social world's unpredictability, the built environment may act as an anchor by being predictable, consistent, comprehensible, and controllable (Kinnaer et al., 2016).

We adjusted the *participant recruitment strategy* with more emphasis on intersectionality and ensuring heterogeneity of autistic participants through other aspects of diversity e.g., gender, ethnicity, cultural backgrounds, socio-economic status, different disabilities, other neurodivergences etc. We clarified and opened participation to autistic people in diverse work experiences such as unemployed individuals (e.g., due to a burnout from an unsupportive workplace). We were also attentive to preparing recruitment materials (e.g., information letters and informed consent forms) in a manner that balances the specificity of provided information (as some autistic individuals' preference) on what research participation entails with possible cognitive burden. For example, creating visual step-by-step explanations of the research participation aligns with the guidelines on participatory autism research (Gowen et al., 2019). Moreover, an important point of attention is the reimbursement of autistic participants as user/experts and how procedures at the systemic level (e.g., university and social security regulations) can conflict with appropriate and recommended reimbursement practices and privacy protection.

In relation to *navigating ethical challenges of (non)disclosure of autism diagnosis at work*, a point of concern was raised that autistic people may disclose their autism condition (to the researcher(s) at least) to be able to participate in the research—an issue to be mindful about

as the disclosure cannot be retracted. Furthermore, there is a possible sampling bias when recruiting organisations that are already open to discussing and supporting neurodiversity at work—and how this may be handled in a research set-up (*Built work environment* track) where priority should be given to protecting participants' (non)disclosure preferences by recruiting at least one autistic participant who discloses their autism condition in the workplace.

Overall, we observed several advantages of involving the autism community in research design. The (in)formal feedback and consultation meetings provided us with an opportunity to think through and think (even) more deeply about our research approach—from the envisaged methodology over recruitment strategy to meticulous preparation of the ethics applications. The first-hand input from autistic people acknowledged and affirmed the significance of the project's focus, which was an extra boost to our motivation to conduct this research. Lastly, these initial participatory activities have incited discussions within the research team about what we can do better and differently in the future, with an outlook for what participation may mean for the later project stages (e.g., co-authoring publications with autistic participant(s)/advisor(s)). While we did not encounter many challenges with participatory research in these early stages, we have two observations: on the one hand, the doctoral training regulations and the project funding's formal requirements (such as obtaining ethics approval within a certain time period) can occasionally create a conflict between finding moments to engage with the autism community and the need to resolve daily research challenges as quickly as possible—with some similarity to experiences reported by Pickard et al. (2022) and Taylor-Bower et al. (2024). On the other, we should acknowledge that feedback availability from LAVA may not be feasible for many researchers, as such organisations are still not common in the majority of the countries around the world.

5. Conclusion

The '*Making room for autism at work*' project investigates how autistic people experience and manage their working conditions. Our aim with this contribution is to share our experiences with the participatory research approach involving the autism community in research design to inform future studies. This process resulted in methodological set-up refinements including: diversity of offered methods and ways of being involved (from research participant to co-researcher/co-producer of knowledge) and diversity of autistic participants, their work experiences, and work environments. Ongoing challenges remain the reimbursement of autistic participants (as research participants and/or project advisors) due to systemic issues (e.g., linked to social security regulations) and access to autistic individuals as user/experts. Overall, participatory research with autistic individuals can shed light on how to set up research on inclusive workplace design, in a methodologically and ethically sound manner.

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From Space Construction to Mental Construction - How Constructivist Thinking Can Provide a Fresh View on the Importance of User Involvement for Workplace Project Success

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ABSTRACT

Purpose

Through a constructivist perspective, this study investigates communication issues as a potential reason why many new workplace projects fail to deliver the intended improvements in user satisfaction. We focus on user engagement and learning during the concept development phase to draw attention to the process instead of investigating what might have gone wrong with the concept itself. We show that individuals engage in mental model construction and learning processes that greatly influence their understanding and decision-making which is relevant for the quality of the project outcomes.

Design/Methodology/Approach

We conduct an integrative literature review that applies theories from psychology, learning science, and communication research onto workplace project processes with a change management focus.

Findings

Knowledge differences between end-users and experts (CREM, consultants, architects) within projects often lead to misunderstandings. However, when involved in concept development stages, users must grasp the implications before making decisions. This mental task cannot be delegated to experts. Taking the constructivist viewpoint reveals that early engagement of users plays a pivotal role in enabling decision-makers to develop mental models as foundations for their choices - a crucial factor contributing to overall project success. Additionally, our results emphasize the significance of initiating

a change process right from the beginning rather than waiting until after key concept decisions have been made.

Practical Implications

By reframing workplace projects as mental construction processes instead of physical ones alone - highlighting individual mental model construction and addressing communication challenges between RE-experts and end-users (laypeople) - this research provides valuable insights into improving project outcomes. It also enhances professionals' awareness for the importance of effective communication with non-experts.

Originality/Value

By integrating concepts such as individual mental model construction and expert/laypeople communication into workplace research, this paper offers a fresh perspective on success factors by focusing on user engagement instead of concept content.

Keywords

Project success, workplace change, user engagement, mental models, constructivism

1. Introduction

More and more organisations implement desk-sharing and Activity Based Working (ABW) (Marzban *et al.*, 2023). It is very problematic that many such workplace projects fail to deliver the intended results for their users (Appel-Meulenbroek *et al.*, 2018; Hoendervanger, 2021; Kämpf-Dern and Will-Zocholl, 2022). Even if the circumstances like industry, size of the organisation or cultural setting are comparable, the success of ABW implementations varies a lot (Brunia *et al.*, 2016; Babapour, 2019). Yet, managers must make crucial decisions during the concept phase with limited knowledge of the impact their decisions will have after occupation (Appel-Meulenbroek *et al.*, 2018; Marzban *et al.*, 2023). Changing key concept variables later in the process will result in higher costs and increased project complexity (Blyth and Worthington, 2001). Hence, though through decisions that fit the real needs are important in the beginning (Hodulak and Schramm, 2019).

To improve the understanding of why similar concepts succeed in one place but fail in another, a different perspective might be helpful. By adopting a radical constructivist perspective (Glasersfeld, 1995), we examine how this school of thought can improve workplace concept development and implementation processes.

Radical constructivism posits that knowledge is actively constructed as mental models by individuals based on their experiences and interactions with the environment (Glasersfeld, 1995). We make the proposition that – during such a workplace process – individuals engage in mental model construction and learning processes that greatly influence their understanding and decision-making. Fostering this mental construction process right from the beginning leads to better concepts and less dissatisfaction and frustration post-move.

Workplace projects can have very different goals: Some might focus on space and cost reduction, or on different ways of working, or on enhancing employee experience. Normally, all approaches share, that user satisfaction with the new workplace environment should be increased or at least not

decreased compared to the old space. Hence, we define "project success" as an increase in the self-reported satisfaction with the work environment.

To explore these topics further, this review study is based on the integrative literature review process described by Snyder (2019) and Torraco (2005). The integrative review aims to take perspectives and theories as well as empirical results from different fields to combine them into a new theory or model that can be applied to the research topic and consequently helps to provide a theoretical answer to the research questions from a specific viewpoint (Torraco, 2005). It does not try to cover all the available literature or to conduct a quantitative meta-analysis with extensive coding (Snyder, 2019). As our viewpoint we chose constructivism to explore its application in workplace (section 1 of the paper), revealing how different the levels of knowledge of involved people are. Exploring further, we reviewed how the understanding between experts (RE-professionals) and laypeople (end-users) can influence project success (section 2). Based on these two theoretical perspectives we conducted a search in the areas of empirical workplace studies and change management literature to look for existing evidence, that mental model construction is at play here (third section). . The found sources were reviewed for applicability of the constructivist thinking. Consequently, we answer our main research question about how the constructivism perspective can improve the understanding of workplace change processes and discuss our new view on project success factors, which focuses on the 'how' (learning process) instead of the 'what' (concept content).

2. Applying the mental construction of knowledge to the workspace

Radical constructivism has been developed by Ernst von Glasersfeld (1984, 1995) as a framework for cognitive development and learning. It focuses on the intricacies of individual learning and that all knowledge is the product of subjective interpretation of experiences. The "radical" part of this theory is the perspective that an ontological, objective reality might exist, but that we as human beings can only observe it through our subjective senses. Therefore, knowledge is not a reflection of an external truth but a cognitive construction of the individual, based on current and past experiences and prior knowledge. Due to its subjective nature, it is not possible to "objectively" describe something. These constructs will be named mental models here as it points out that it is an individual, internal re-presentation of the external world (Argyris and Schön, 1996; Senge, 2006; Jones *et al.*, 2011). The nature of mental models implies, that any two persons can never have an identical mental construct of any piece of knowledge – even if they acquire the knowledge within the same setting. Neither their observations nor their prior knowledge nor their cognitive construction process can be identical (Glasersfeld, 1995).

Von Glasersfeld based this theory heavily on the empirical work on the acquisition/learning of words, language, and abstract terms in the cognitive development of children by Jean Piaget (Piaget, 1955). Humans are not born with any knowledge of words or their meanings. This is constructed through repeated cycles of observation and imitation until a viable construct has emerged. "Viability" is a key term within constructivism as it replaces "truth" (Glasersfeld, 1995). Much like scientific theories, viable mental constructs are used because they work in the context, they are used in. But they need to be re-evaluated and changed if situations are encountered in which they do not work anymore (Xie, 2021). The nature of mental models is that they are mainly subconscious (Jones *et al.*, 2011). They shape how we behave and think about things without the ability to explicitly say why (Argyris and Schön,

1996). In addition, existing mental models are persistent. They might have been constructed and refined over years or decades and proved viable so far (Jones *et al.*, 2011). Changing or re-constructing them fundamentally means that for this person, reality changes. This takes time and it is unlikely that one single experience has the power to reshape a deeply rooted belief (Senge, 2006).

Within the workplace context, the constructivist perspective shifts the focus away from space design or organizational development towards the subjective nature of the workplace change process. Existing research already recognises that each user involved must go through an individual process (Kämpf-Dern and Konkol, 2017; Xie, 2021). People involved in or affected by the project have different mental models. Some might understand "open space", "single office", "ABW" or "we are going to work differently" positively or negatively. They might have detailed mental models regarding such terms or very simple ones, all based on their individual experiences. However, they are the individual's reality. This perspective can help to explain, why, for example, an office user with 20 years of experience in a single office, cannot imagine working differently.

Every workplace project involves learning (and un-learning) regarding a wide variety of topics. Examples are space use, available space types, mobility, communication patterns, or new ways of working - whatever they are in the given context. At the start of the process, the framing of the problem and agreement on goals is key for a smooth start (Blyth and Worthington, 2001). People are used to their environments and if this status quo is challenged they will usually defend it (Schabracq, 1998; Kromah *et al.*, 2020). To let go and accept something new, users need to learn and understand what is going to happen and why (Wilhoit, 2016; Bull and Brown, 2012; van Vuuren and Elving, 2008). Fostering user acceptance of the new concept is a task for the whole project, including the early concept phase and cannot just happen at the end (Davis, 2020).

3. (Mis-)Communication between Experts and End-USers

Within a certain social group (a team, a family, a country) that shares many experiences, similar mental models will emerge. They are viable to each other and ensure that understanding each other works. Yet, mental models are also the source of misunderstanding. If the mental re-presentation of a word, the associated meaning, differs a lot, the parties involved in the communication might believe that the message is clear because, for them individually, it is the "real" meaning. But what one person thinks by saying something is not necessarily what the other person understands (Schulz von Thun, 1981).

The difference in mental models is especially important to be recognised between experts and laypeople. The distinction between experts and laypeople is defined by the quality and quantity of knowledge they have regarding the given topic (Schön, 1991; Rambow and Bromme, 2000). The strength of experts is that they can very efficiently communicate with each other. They can rely on having viable mental models for technical terms. They could just state that something should be built according to ISO XYZ and colleagues would know what to do and what implications this might have for other parts of the design. The challenge in expert/laypeople communication is to translate this for the laypeople to follow. A simple translation from an expert to a common language that has the same meaning is unlikely to exist (Rambow, 2000). Moreover, the broader associations and implications that are obvious to experts need to be explained to laypeople without overwhelming them with complexity. Rambow (2000) has empirically researched expert laypeople communication within the field of architecture. His experts were architects and his laypeople randomly chosen people with no

professional relation to architecture or the built environment. His focus was on how architects communicate about architectural designs with laypeople and how they – architects and laypeople – think that the other party thinks about architecture. He revealed that communication ability varies significantly between architects and that this is related to the ability to change perspective and reflect one's way of thinking (Rambow, 2000). Based on the different levels of experience, 3D pictures, photographs, 2D plans, and technical drawings are perceived very differently (Völkel, 2012). An expert can imagine a space from 2D plans and they can interpret signs on a floorplan – e.g., an electrical floor box embedded in the carpet – correctly. A layperson might interpret the same sign as a column in the middle of the space and some research exists on how to practically improve communication, e.g., with virtual reality, that can overcome limitations from 2D-plans etc. (Paes *et al.*, 2017; Weerasinghe *et al.*, 2023).

All workplace projects involve different people who need to work together and communicate successfully (Senaratne and Ruwanpura, 2016) to promote project success (Kämpf-Dern and Konkol, 2017; Redlein *et al.*, 2020; Appel-Meulenbroek and Danivska, 2021). Some of the involved (e.g., consultants, architects, CRE managers) are experts on the topic of workplace concepts. The users of the new space however, including management and decision-makers, are mostly laypeople, meaning that they do not normally think about their office environment in detail. Being part of a process to re-think and re-design how they will work in the future might happen only once during their professional career. They will have different mental models regarding specific terms compared to the experts. Existing mental models influence users towards what they already know and understand, especially if the alternatives are not understood properly (Piaget and Inhelder, 1975), and the existing workplace environment is what they know best (Oseland and Catchlove, 2020; Vischer, 2012). Hence, the existing mental models might impede good decisions (Hayes, 2022).

To make strategic decisions on the future workplace, users therefore need to learn and re-construct their mental models to understand the new concept implications. This learning takes time, and a learning process cannot be outsourced. If it does not happen sufficiently, decisions will be based on individuals' old mental models and the understanding about what has been decided might vary greatly between the users and the experts and can lead to project failure.

However, there are also topics relevant to the concept development where users are the experts. By knowing how they work and their daily routines, they are an important source of knowledge, which is widely accepted in both academia (Vischer, 2012; Finch, 2012; Kaisa, 2014; Riratanaphong, 2014; Kämpf-Dern and Konkol, 2017) and practice (Kernohan *et al.*, 1996; Blyth and Worthington, 2001; Usher, 2018; Oseland, 2022). Hence, they need to be included and their needs assessed as the foundation for any conceptual decision.

4. Managing the Change of Constructs

The knowledge differences between all people involved in workplace projects are a manifestation of their different mental models, and awareness of the likelihood of hidden misunderstandings is needed. This awareness is asked of the experts who are tasked with delivering a successful project and who therefore have the need to manage a process that is not limited to the technical/design/cost part of the project (Kane, 2020; Schön, 1991) but allows for the individual learning and re-constructing of mental models of all people involved (Wilhoit, 2016). From an expert's perspective, this might look like the

'reinvention of the wheel' because they might have done similar projects many times and might think that they know better (Rambow, 2000), but the users invent the wheel for the first time and need to do it themselves (Locock, 2001). Simply applying best practice solutions in complex situations does not work (Vischer, 2012; Kämpf-Dern and Konkol, 2017). The old way of thinking needs to be interrupted through interventions (Blake and Mouton, 1983) to allow the development of something new.

4.1 Workplace Change Management

In general, the term change management (CM) is associated with facilitating processes to implement something new in an organisational context with an emphasis on taking the people affected by the change along to make it successful (Burnes, 2017; Hayes, 2022). The need for CM in workplace projects is accepted in research, but still often neglected in practice (Kämpf-Dern and Konkol, 2017). Additionally, CM often starts only after the decision on what is going to change has already been made, treating it as part of the implementation only, not as part of the strategy phase. Given the described need to re-develop mental models before the decision-making, this would be too late.

A central basis for CM is a clear vision and project goals that help the change leaders in sense-making communication (Hayes, 2022). This vision development and goal agreement is, from a constructivist perspective, a key part of the change. The process of making sense, understanding, and acceptance of the reasoning is a mental model construction process (Gioia and Chittipeddi, 1991).

For workplace change projects in particular, Kämpf-Dern & Konkol (2017) developed the comprehensive performance-oriented office ecology model. This framework identifies 14 success factors for workplace CM that are organised around the office ecology model by Windlinger et al. (2014). For this study on constructivist thinking three success factors are of special interest because they involve or foster the mental construction process: (1) "Manageability of change" includes that users need to be trained to understand the concept and to acquire the skills to use the future space. They need to be able or be enabled individually to cope with the change without being overwhelmed. To succeed in this factor, enough time is required. (2) "Involvement & participation" will give users some control over what is happening to them and includes that experts seriously listen to user feedback early, as well as after the move. (3) "Openness to change" is seen here as a general individual characteristic pointing towards how open involved people are to re-evaluate their opinions and learn something new. Kämpf-Dern & Konkol (2017) conclude that the change process is more important than the concept content as it is needed even if a perfect concept would 'fall from heaven'.

4.2 (Early) Workplace User Involvement

Empirical findings from workplace change and success factor research also provide evidence for the importance of user involvement and effective process facilitation right from the project beginning. This can be read as a need to foster mental model (re-)construction early and throughout the project duration. Babapour (2019) found in her case-based research of the satisfaction with ABW implementations after occupation several process-related success factors. They include a clear project intent/vision, clarifying ambiguities, user participation, user training and shared understanding of future behaviour. The cases in which a clear vision existed from the start and where users were involved in choosing the future base concept had higher satisfaction post-move (Babapour, 2019). Users saw it more as their project instead of something that happened to them. The cases with more

intense training and the development of a shared understanding of the new ways of working (which equals viable re-constructed mental models within the group) also showed higher satisfaction. In general, the success was bigger if more intense user involvement throughout the process was reported. Furthermore, shortcomings early on led to a limited understanding of user needs that led to non-fitting solutions (Babapour, 2019). Riratanaphong (2014) found as well, that involvement during the whole process duration, from early project to post-move is key. The case in his sample that had the smallest involvement showed the highest rate of misinterpretations and dissatisfaction. Such misinterpretations can directly be linked to failed (expert/end-user) communication that led to non-viable mental models.

Brunia et al. (2016) investigated the four cases with different satisfaction levels (two high, two low) of ABW implementations, all within the same organisation and country. They found the main dissatisfaction rooted in design/space differences, e.g., insufficient enclosed spaces, but also differences in the satisfaction with the implementation process, namely the limited ability to influence the concept and a lack of supervision on how to use the new space properly. The last issue points towards a lack of guided learning opportunities to construct new mental models throughout the process including post-move. Furthermore, the dissatisfaction with the space itself might go back to design decisions that were made based on insufficient understanding and involvement in the process beginning.

Workplace research is interested in change, but also change research is interested in workplace cases. Smollan and Morrison (2019) found that the intense participation process let to a perception change regarding an open work environment in a law firm. Jemine *et al.* (2020) focussed on the politics framing, and different agendas during an ABW project, and Näsänen and Vanharanta (2017) found how different managers and employees argue about work and space, both studies stating that these negotiation processes between the involved actors, that can be read as reconstructing mental models, are crucial for project success.

Within other research fields, the importance of user involvement is much better established. Within software development, a quantitative review study by Kujala (2003) already found that involvement in the early phase led to reduced need for training and support and to higher productivity and acceptance after deployment. An additional value of the early involvement could be less need for alterations/iterations later, resulting in an overall smoother process (Kujala, 2003). The clear benefits have led to the development of standards like ISO 13407 (1999) on human-centred design, which has also been applied to workplace (Kwon and Remøy, 2022).

5. The value of a constructivist's understanding of workplace change

After reviewing expert laypeople communication, (workplace) change management and related findings through the lens of constructivism, workplace projects can now be described as cognitive (re-)construction, learning and communication processes. Because it is an individual process, which takes experience as a basis, the constructivist perspective helps to explain why terms like "open space", or "new ways of working" are often understood so differently. Not learning enough about the concept and decision implications or neglecting the need to learn throughout the process could be a major reason why projects fail, and satisfaction post-move is sometimes low.

Early involvement of users also has its challenges. It might be hard for users to answer questions from experts because they still lack the understanding of what is possible and how they will need to change (Vischer, 2012). This only strengthens the value of understanding workplace processes as individual learning journeys, as shown above. Experts who fail to foster the learning of the users they work with or users who neglect the need to re-evaluate their own mental models risk project failure. Relying on "best practices" and concepts that have worked elsewhere to reduce managerial and process complexity is a high risk. Being in the new space later with the old mental models will result in cognitive dissonance (Festinger, 1957; Cooper, 2019) that can also lead to dissatisfaction.

The facilitation of the early process activities (how and with whom) needs to be managed carefully. Handling the complexity of such projects and processes is a task for the involved experts who need expertise beyond the design, technical, and financial aspects. Dissolving misunderstandings – mental models that are not viable to each other – should be a goal in the early phase of each project. Drawing experts' attention towards the communication obstacles that are likely to occur in such project settings can enhance their awareness and help them to appreciate the value of CM. Combined, this can help more projects to succeed.

Further work is needed to develop this conference paper into a journal article. We plan to expand and systematise the review in section 4 by including more studies, also from the field of strategic & project management. Additionally, we will integrate all findings into an influence model that treats user involvement activities as independent variables influencing satisfaction and project success through learning/mental model construction and enhanced decision quality.

Further research is needed to empirically test the theoretical considerations of this study. More analysis of real-world projects could reveal and evaluate activities in (early) user involvement that help in the mental model construction and that are already used in practice. Empirical research with new interventions that are designed based on our findings and which try to foster early involvement, learning and understanding will be needed to confirm our assumptions.

Integrating the insights presented above, we found compelling arguments that constructivist thinking can provide a fresh view onto the ongoing research question of why some workplace projects fail, and others succeed even if the conceptual "hard facts" are similar.

For more projects to succeed, the involved experts need expertise in communicating with laypeople and the laypeople depend on thorough communication to understand, learn, and accept a new concept. Reframing workplace projects as mental construction processes, instead of seeing them as mainly physical construction tasks, can be used as a viable metaphor. It can increase awareness of learning and communication pitfalls, which could otherwise arise. Both construction processes – physical and mental – need careful planning, facilitation, execution, and quality control. Both are equally important, need time and deserve the same attention right from the start.

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Session 7B: Hybrid Working 2

Navigating the hybrid work landscape: unveiling perspectives of the ageing workforce through persona and thematic analysis

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ABSTRACT

In response to the widespread adoption of hybrid work (HW) models, this qualitative research investigates the complexity of the ageing workforce's experiences, preferences, and challenges within this evolving work environment. Utilising persona and thematic analyses, this study aimed to illuminate the nuanced narratives that shape the attitudes of employees aged 50 and above toward HW

arrangements. The persona analysis component involves creating representative profiles that encapsulate the diverse identities within the ageing workforce. Complementing the persona analysis, our thematic analysis explores recurring patterns and emerging themes across the narratives collected through interviews. By systematically categorising and interpreting qualitative data, we uncovered shared perceptions and experiences of older employees regarding HW arrangements, illuminating the significance of HW in enhancing human interaction and social support, impacting their personal and family lives, and the autonomy and trust in shaping the HW experience for older employees, thus providing actionable recommendations for organisations seeking to optimise HW strategies and foster a supportive work environment conducive to older employees' success and well-being.
Keywords
Hybrid work, Ageing workforce, Future of work, Flexible work, Older employees

1. INTRODUCTION

The COVID-19 pandemic and rapid technological advancements have profoundly reshaped the world, notably impacting how we work (Howe et al., 2021). This disruption has led to the rapid adoption of new ways of working globally (Memon et al., 2022), emphasising technology-supported flexible arrangements. This reliance on technology has changed workplace dynamics and prompted discussions about future work trends and productivity (Burgess & Cornell, 2020).

Understanding the perspectives of older employees on HW is crucial in today's evolving workplace. With the adoption of remote and hybrid models, assessing their impact on all employees, including older workers, is essential. Older workers bring valuable experience and skills, enriching HW initiatives and bridging generational gaps. However, they may encounter challenges related to technology, resource access, and work-life balance in remote or hybrid setups. Addressing these differences can foster more inclusive workplace policies, advance diversity and inclusion efforts, and promote a culture of respect and belonging. Recognising and meeting the needs of older workers is not just about fairness; it also provides a strategic advantage. By leveraging the strengths of multi-generational teams, organisations cultivate a more resilient and successful workforce. Thus, we aim to explore how persona and thematic analysis elucidate the diverse experiences, challenges, and adaptive strategies of employees aged 50 and above in HW environments.

2. LITERATURE REVIEW

HW, which divides work time between conventional office settings and remote work, surged in popularity during the pandemic. Remote work typically occurs in "third places" such as coworking spaces and local cafes (Hopkins & Bardoel, 2023), a term coined by sociologist Ray Oldenburg (1997) to denote places where people exchange ideas. The post-COVID era prompted a shift towards digitization in order to enhance productivity, employee satisfaction, and work-life integration (Hopkins & Bardoel, 2023). Recent research by Hopkins and Bardoel (2023) indicates a significant improvement in the overall work experience with the HW model, reducing employee turnover by 35% (see Figure 1).

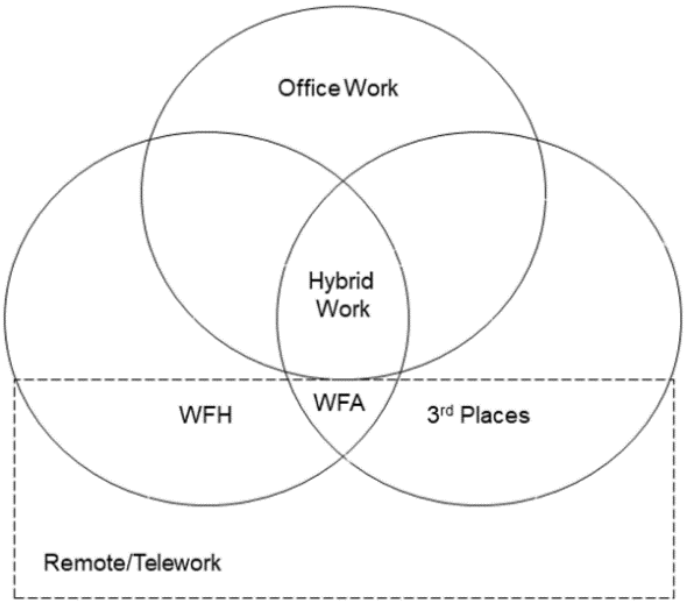

Figure 1: Positioning hybrid work within the existing academic literature. (Hopkins & Bardoel, 2023).

Transitioning to hybrid and remote work post-pandemic has increased reliance on digital technology, posing challenges for older workers (Anderson & Kelliher, 2020; Gigauri, 2020; Morrow-Howell et al., 2020). The pandemic accelerated retirement for many older workers and heightened unemployment and retirement rates (Davis et al., 2021), impacting their work attitudes and behaviours (Kayaalp et al., 2023). Despite exhibiting resilience to pandemic stressors, older workers may face difficulties with technology, workload, and family interference (Anderson & Kelliher, 2020; Gigauri, 2020; Kanfer et al., 2020; Morrow-Howell et al., 2020). Job insecurity and demands may impact work attitudes and behavioural intentions, with inconclusive findings (Camgoz et al., 2016; Podsakoff et al., 2007; Shoss, 2017). Proficiency in coping strategies may mitigate stressors, but heightened job insecurity and demands can increase turnover intentions due to resource strain (Kayaalp et al., 2023; Bakker et al., 2003; Deery et al., 2014).

Despite the growing body of research on HW, there is a critical gap regarding the experiences of the ageing workforce. Previous studies often overlook the unique perspectives and potential challenges faced by older employees (Teng-Calleja, Mactal, & Caringal-Go, 2023). Existing research often stereotypes older workers as resistant to change or less technologically adept (Bal et al., 2011; Lazazzara & Bombelli, 2011; Paul & Townsend, 1993). This research challenges these assumptions by revealing the nuanced narratives and diverse needs of older employees in the HW landscape.

3. Methods

This exploratory study utilized online surveys and semi-structured interviews to gather qualitative data from employees in the United States about their perspectives and experiences with HW in their organisation. Data was analysed through persona and inductive thematic analyses.

3.1 Participants

This exploratory study collected qualitative data from eight active employees aged 50 and above with experience in HW in the United States. Participant recruitment included various job roles excluding academia (teaching or research at a college or university). The sample comprised 50% female and 50% male participants, with ages ranging from 56 to 65 years (50%), 50 to 55 years (38%), and 60 to 65 years (13%). Participants had been in their current roles for between 1 and over 5 years, with an average tenure of 3.6 years. They worked in different types of organisations: corporations (63%), government (25%), and others (13%), with organisation sizes ranging from 250 or more employees (63%), 50 to 249 employees (13%), 10 to 49 employees (13%), and 1 to 9 employees (13%). The participants held various positions such as educational outreach coordinator, analyst, administrative, academic advisor, property manager, general manager, film owner/president, and president. Participants are coded with IDs such as ID000X to maintain anonymity, and their names have been altered.

3.2 Data Collection

This study was approved by the college's Institutional Review Board (IRB). Participants were recruited using digital media and word of mouth, including LinkedIn, a professional social media platform. Emails were sent to eligible employees and professional networks, with recipients asked to refer potential participants. All participants signed up via a Qualtrics link and received a scheduling link. Among the eight interviews, 62.5% (5 interviews) involved both an interviewer and observer, while 37.5% (3 interviews) were conducted solely by an interviewer. All sessions were remote, completed within three weeks (March 2024), and lasted approximately thirty minutes each. The interview process included introductions, an overview of the study aims, virtual IRB consent via DocuSign, completion of the Qualtrics survey, and recorded interviews.

The survey covered demographic information such as age, gender, job position, years of experience, organisation type and size, current work arrangement, and technology usage frequency. Participants also shared their satisfaction and engagement levels with the HW model and their usage of video conferencing, communication, and collaboration tools. During the semi-structured interviews, participants were asked open-ended questions to explore the ageing employees' perspectives on HW. Topics included experiences, preferences, challenges, adaptation, support, well-being, engagement, and future expectations.

3.3 Persona Analysis

A persona entails a detailed description of a user's characteristics and goals (Cooper, 1999). Haak (2017) noted that the user persona concept, originally prevalent in marketing, has progressively gained traction in human capital management. Employee personas represent a group of employees sharing similar attributes within a fictional framework, spanning demographics, skills, and competencies. The personas were constructed by analysing the surveys each participant completed, which contained their characteristics and profiles.

3.4 Thematic Analysis

Interview videos recorded through Microsoft Teams and Zoom were transcribed verbatim and analysed using Microsoft Excel. A grounded theory approach was utilised in the data analysis process (Miles &

Huberman, 1994). Three authors deductively coded the transcriptions into Table 1 to reduce bias. The themes were then inductively generated based on commonalities across the participants' feedback.

4. RESULTS

4.1 Personas

The personas are classified into three levels based on their hierarchy and decision-making influence: low-level, mid-level, and high-level employees. They represent employees across hierarchical levels within organisations, offering insights into their experiences with HW arrangements.

Table 1. Classification of personas based on their hierarchy and decision-making influence.

Persona	Hierarchical Level	Job Title	Company Size	Industry Experience	Work Arrangement	Participants
Bryan	Low-level	Educational Outreach Coordinator	250+ employees	10+ years	Hybrid	ID0008, ID0003
Jessie	Low-level	Analyst	250+ employees	15+ years	Hybrid	ID0004
Jane	Mid-level	General Manager	250+ employees	20+ years	Hybrid	ID0001, ID0005, ID0007
Joe	High-level	President	<10 employees	20+ years	Hybrid	ID0002
Lee	High-level	President	250+ employees	20+ years	Hybrid	ID0006

4.2 Emerging Themes

While conducting the interviews, several inductively generated themes emerged. These themes include the desire for autonomy and trust, the importance of human interaction and social support, and the impact on personal and family life. The following section will detail each theme, supported by quotes from the interviews to underscore their significance.

Desire for Autonomy and Trust

Participants expressed a strong desire for autonomy and trust in their work arrangements. They emphasized that HW should be a choice rather than a privilege to be earned. Trust is seen as foundational, with managers needing to balance supervision and autonomy to foster a productive and trusting work environment.

> *"Hybrid work should not be something we have to earn. Hybrid work should be something we choose."* – ID0001
>
> *"Well, I think number one is creating trust. So, trust starts with a little bit of supervision. You don't just trust for no reason; you trust because somebody's producing."* – ID0002

Participants highlighted the importance of trust in the HW model, suggesting that excessive monitoring could be counterproductive. They preferred a trust-based approach where performance and productivity are the primary measures of success rather than constant supervision.

> *"Unless I have a timeline that you need to meet and it's really more by the trust method. I don't believe they monitor our computers at all because that's just counterproductive."* – ID0007

Importance of Human Interaction and Social Support

Human interaction and social support emerged as crucial elements in HW. Participants noted the positive impact of occasional in-person interactions on mental well-being and professional relationships. They emphasized that in-person engagements enhance communication, reduce misunderstandings, and foster a sense of community.

> *"So, I think definitely being there a couple of days is helpful for myself, probably mentally as well, to interact with people you know, and I hope that they feel the same with me."* – ID0003
>
> *"But again, sometimes I purposely come in the office just so I'm with my team, and just so I'm with my peers and get that engagement and come to get our little meetings and do stuff, discuss things and things like that. So that's really the true reason of coming into the office."* – ID0005

Participants also highlighted the depth of professional relationships developed through face-to-face interactions, noting that such interactions foster a stronger sense of connection and team cohesion than virtual communications.

> *"So, it's actually like coming in from a little mini vacation where I'm happy to see everybody. I haven't seen them for a few days. We do the customary check-up. How was your weekend? And then we go about our day and do our business and then you still feel that connection. You still feel that synergy from the workplace, and you don't feel like you're losing touch."* – ID0007

Impact on Personal and Family Life

The impact of HW on personal and family life was a recurrent theme. Participants appreciated the flexibility HW offers, allowing them to manage personal commitments alongside professional responsibilities. This flexibility significantly reduces stress and improves overall well-being.

> *"I do not enjoy working from home, but again, for the flexibility of having to handle other personal matters. My organisation certainly supports that."* – ID0004
>
> *"My wife is in the same industry as I am. She's also in property management, and she works a couple days from home, and we find that there's a little less stress with that. The ability to work from home means we're not always on the road trying to get back and forth to work, having to battle rush hour, having to sit in a car for an hour and a half. When we're home, it's actually very productive."* – ID0007

Participants emphasized the positive effects of HW on family life, particularly in reducing commute-related stress and allowing more time for family activities. This balance contributes to a more harmonious and fulfilling personal life, enhancing overall job satisfaction and productivity.

5. DISCUSSION

This study aims to unveil the shared perceptions, concerns, and aspirations of employees aged 50 and above toward hybrid work arrangements. Through an exploration of personas and thematic analysis, we uncover the importance of HW in enhancing human interaction and social support, impacting their personal and family lives, and the autonomy and trust in shaping the HW experience for older employees.

The personas constructed in this study offer insights into the diverse experiences and viewpoints of employees at various hierarchical levels within organisations. Lower-level employees, exemplified by Bryan and Jessie, highlight the positive impact of hybrid work on their mental well-being and professional relationships. Mid-level employees, represented by Jane, present a more balanced view, reflecting a mix of organisational influence and personal autonomy, particularly in their desire for trust and autonomy in work arrangements, both from employees above and below.

Higher-level employees, epitomised by Joe and Lee, provide a broader organisational perspective, emphasising strategic considerations and the need to balance autonomy, trust, productivity, and effective results.

The thematic analysis explores key themes from participant responses, shedding light on the multifaceted nature of hybrid work experiences. The desire for autonomy and trust emerges as a prominent theme, with participants expressing a need for hybrid work to be a choice rather than a privilege. Trust is seen as foundational, with a preference for performance-based assessments over constant supervision. This underscores the importance of trust and autonomy in fostering a supportive and productive hybrid work environment.

Furthermore, the thematic analysis highlights the critical role of human interaction and social support. Participants value the positive impact of occasional in-person interactions on mental well-being and professional relationships. These interactions enhance communication, reduce misunderstandings, and foster a sense of community, underscoring the significance of human connection in hybrid work satisfaction. Studies indicate that older employees, particularly Gen X and Baby Boomers, show a higher preference for some in-person interactions in hybrid work arrangements compared to younger employees like Gen Z and Millennials. Older employees value the structure and social aspects of the office, while younger employees prioritize the flexibility of remote work (Choudhury et al., 2024; Bloom, 2021; De Smet et al., 2023).

The impact on personal and family life also emerges as a significant theme. Participants appreciate the flexibility hybrid work offers, allowing them to manage personal commitments alongside professional responsibilities. This balance reduces stress and improves overall well-being, highlighting the importance of accommodating personal and family needs in hybrid work arrangements.

The findings of this study resonate with existing research on hybrid work dynamics (Yang, Kim & Hong, 2021; Barrero, Bloom, & Davis, 2021; Gibson et al., 2023). It also aligns with the study positing that flexible working practices increase trust in management and job autonomy, which in turn reduce job-related anxiety and enhance well-being (Yunus & Mostafa, 2022). Additionally, that psychological contract fulfilment, combined with job autonomy and trust, especially among experienced employees, positively influences organisational citizenship behaviour and in-role performance, underscoring the importance of trust and autonomy in enhancing work behaviour (Noble-Nkrumah, Anyigba, & Mensah,

2022). Persona development in this study is constrained due to the small sample size, and the findings from the thematic analysis may not be age-dependent, as these three themes are also significant for younger employees (Choudhury et al., 2024; Bloom, 2021; De Smet et al., 2023; Yunus & Mostafa, 2022).

6. CONCLUSION

In conclusion, our study provides valuable insights into the nuanced perceptions and experiences of older employees regarding hybrid work arrangements, highlighting the importance of autonomy and trust, how it enhances human interaction and social support, and the impact on their personal and family life. These findings offer valuable insights for organisations aiming to enhance and optimise hybrid work strategies and create a supportive environment conducive to the success and well-being of older employees.

Our recommendations for organisations include developing flexible policies that respect individual preferences and balance work-life needs, investing in technology and infrastructure to support remote work and collaboration, offering training and resources to facilitate the adaptation to hybrid work models, prioritising communication and transparency to foster a sense of connection among remote and in-office employees, and continuously evaluating and adjusting hybrid work policies based on employee feedback and evolving organisational needs.

This study contributes to the growing body of research on hybrid work models and the perspectives of an ageing workforce by providing insights into the experiences and preferences of older employees. It offers practical implications for organisational leaders and underscores the importance of considering individual differences and diverse perspectives in the design and implementation of hybrid work policies. This approach will help foster a more inclusive and adaptable work culture.

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Team rules matter: Workplace preferences for team-based knowledge work in hybrid settings

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ABSTRACT

Hybrid teamwork among knowledge workers, characterised by dynamic shifts in place and time, has received limited research attention compared to team activities at the company location, remotely at different locations, or virtually (Kilcullen et al., 2022; Vartiainen and Vanharanta, 2023). In response, this article presents findings from an interdisciplinary research project that bridges architecture and psychology. The project "RAW_Reallabor" (Real-world laboratory of hybrid workplaces for knowledge work) analyses work-related characteristics, organisational conditions of team-based knowledge work, and knowledge teams' spatial needs in hybrid settings.

Data collection and analysis were based on the model by Bosch-Sijtsema et al. (2011), which specifies characteristics of (1) the team, (2) the workplace and (3) the organisational context as performance determinants of knowledge teams. We adopted a mixed-methods approach, combining quantitative surveys with qualitative methods such as semi-standardised group interviews, diamond rankings, and expert interviews. Data were collected from four knowledge teams, each compromising five to eight employees from two Berlin-based companies.

Preliminary results indicate that three areas of activity (individual work, planned teamwork, spontaneous team exchange) are essential for knowledge work in hybrid teams, with variations in frequency and quality across different teams. The teams prefer diverse workplace solutions based on specific team activities and tasks: Complex tasks, involving intensive information exchange benefit from collaborative formats on-site. Urgent and/or complex tasks require more time for spontaneous team exchange in the physical workplace if needed, provided that teams ensure appropriate time allocation by establishing rules for presence and work time. Our findings emphasise the need for a wider range of workplace types for teamwork in hybrid settings compared to current on-site locations. Based on these findings, we discuss conceptual approaches for designing and organising hybrid workplaces for knowledge teams.

Keywords

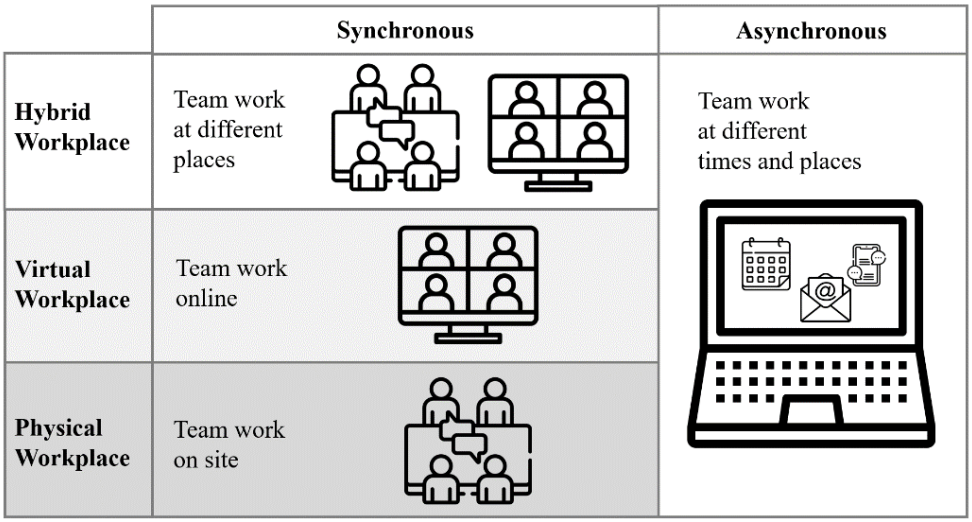
Teamwork, Hybrid Workplace, Tasks and Activities, Knowledge Work

1 INTRODUCTION

Even before the COVID-19 pandemic, it was clear that knowledge work in teams with flexible collaboration formats in terms of place and time would increase, making the design of hybrid working environments a key challenge for employers (Daum et al., 2020; Schellinger, 2020). Knowledge work refers to activities that aim to bundle and communicate information into new knowledge, using creative processes to (further) develop (im)material products or services (Hube, 2005; North and Güldenberg, 2008; Kelter et al., 2009). Knowledge workers' tasks are characterised by complexity, novelty and constant change, so their activities have a low degree of standardisation and predictability and a high degree of autonomy. Knowledge teams therefore need to constantly review their work processes and results in order to adapt their collaboration and communication. With this in mind, workplaces should support the alternation between individual and collaborative knowledge work, while allowing team members the flexibility to work where and when they want. (Böhle et al., 2008; Camarihna-Matos and Afsarmanesh, 2008; Kelter et al., 2009).

Despite its high relevance, team-based knowledge work in hybrid settings has been poorly researched, with studies mostly limited to virtual teams. (e.g., Bosch-Sijtsema et al., 2011; Krumm et al., 2016; van der Lippe and Lippényi, 2020; Kilcullen et al., 2022). In a hybrid work model, people work alone or in teams at different places, whereby the activities can be carried out synchronously (at the same time) or asynchronously (at different times), supported by digital technologies (Vartiainen and Vanharanta, 2023) (see Figure 1). As team members can work in different places and/or at different times, the organisation of the respective setting requires a combined analysis of team characteristics and the requirements for suitable hybrid workplaces.

Figure 1. Team work and places in hybrid settings[22]



[22] Icons made by Freepik from Flaticon (2024).

In response, this article presents findings from the interdisciplinary research project "RAW_Reallabor" (Real-world laboratory of hybrid workplaces for knowledge work) at the interface of architecture and psychology. The project addresses three research questions: What are the characteristics and requirements of team-based knowledge work in hybrid work settings (R1)? What are the needs and requirements of knowledge teams for the design and organisation of hybrid workplaces (R2)? What are the relationships between team characteristics and the use of hybrid workplaces (R3)?

2 Theoretical Background

Bosch-Sijtsema et al. (2011) proposed a model that specifies predictors of knowledge team performance in virtual settings at three levels: characteristics of (1) the organisational context, (2) the workplace, and (3) the team, the latter comprising (3a) team tasks, (3b) team structure, and (3c) team processes. We used a recent extension of the model that transposed its assumptions from virtual to hybrid work settings (Dehmel et al., under review) (see Figure 2).

In terms of team processes, our primary interest was in knowledge work activities, which are recognised by Bosch-Sijtsema et al. (2011) but not further specified. In their review, Niekel et al. (2022) concluded that although taxonomies of knowledge work activities are conceptually distinct, they tend to be broad and difficult to distinguish from each other, and are therefore not yet very useful for research. They recommend a less granular approach that takes into account the characteristics of the context, particularly for workplace analysis.

To enable an analysis of work activities within knowledge teams in hybrid settings, we therefore integrated existing taxonomies with different granularity (Steffen, 2022; Hoendervanger et al., 2022; Niekel et al., 2022). Our integrated taxonomy distinguishes three activity domains (individual work, team work, and team exchange), each with three activities (see Table 1 and Figure 2) that reflect the three central attributes of task-related knowledge work: complexity, novelty, and autonomy. This includes the central distinction between individual and team work with different levels of complexity, the distinction between planned and unplanned activities, and acknowledges the specific nature of the unplanned but more informal exchange within teams.

Table 1. Taxonomy of knowledge work activities in teams

1. Individual Work	2. Team Work	3. Team Exchange
1.1 Routine administrative tasks requiring little concentration (e.g. written communication, planning and organising tasks)	**2.1 Meetings** to coordinate activities (e.g. planning, organising, and controlling tasks within the team)	**3.1 Spontaneous exchanges** to co-ordinate tasks (e.g. scheduling appointments in the hallway, kitchenette or across desks)
1.2 Factual knowledge for building, deepening, and documenting, which requires concentration (e.g. researching and reading texts, structuring notes)	**2.2 Working meetings** to build up, deepen and document expertise (e.g. joint analysis of problems with a focus, coordination of cooperative approaches and documentation).	**3.2 Spontaneous collaborative problem solving** to develop solutions to new, complex problems (e.g. brainstorming in the hallway, in the kitchenette or across desks).
1.3 Developing new solutions to complex problems that require concentration (e.g. developing approaches to solutions)	**2.3 Workshops** for developing new solutions to complex problems (e.g. creative development of new ideas within the team, knowledge, combining knowledge for problem solving and documentation)	**3.3 Planned informal meetings** to share knowledge within the team and analyse problems together (e.g. during lunch time)

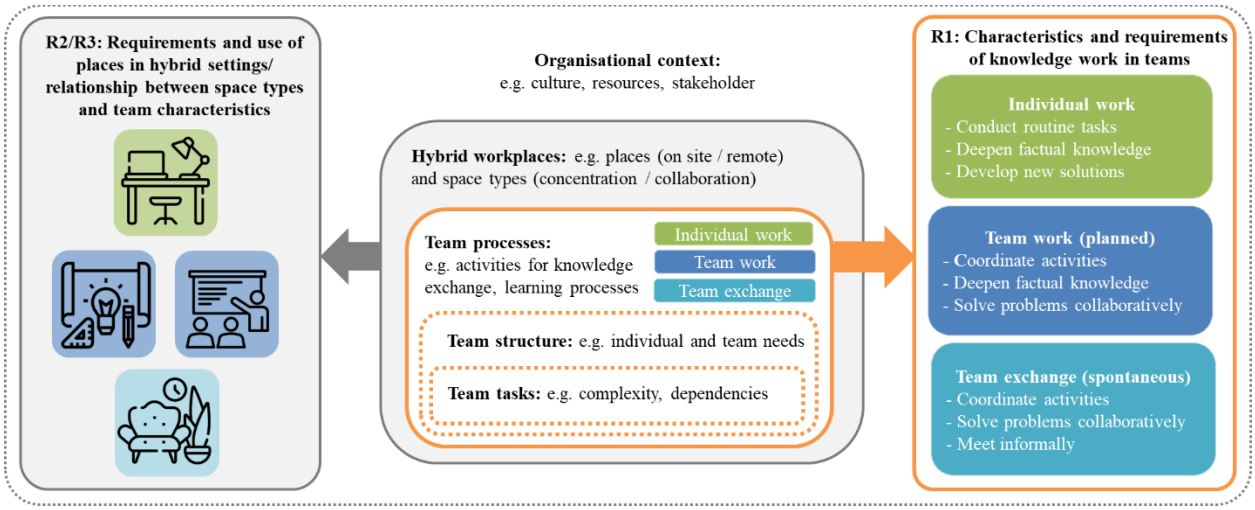
3 Methodological approach

To investigate the research questions, a mixed-methods approach was adopted, combining quantitative surveys with explorative, qualitative methods in two phases. In line with a bottom-up approach, data were primarily collected in four knowledge teams of five to eight employees each from two Berlin companies in the business and administrative sectors. The teams were diverse in terms of professional background, age (between 30 and 55 years old), gender (14 women and 9 men) and length of service (between 1 and 10 years)[23]. In each company, one team was primarily responsible for strategic tasks, while the other team was primarily responsible for operational tasks. Each team used an organisationally and spatially defined

[23] A profile of each team was created at the beginning of the project. To ensure confidentiality, we did not collect any further data on individual team members.

area. Professional contact between teams was not mandatory. Within the teams, colleagues worked together in a hybrid way.

Figure 2. Conceptional research approach based on the model of Bosch-Sijtsema et al. (2011)[24]



In order to assess the *characteristics of knowledge work* in teams (R1), an online questionnaire was created using the Unipark survey tool, which was completed by the team members at the beginning of March 2023. Where available, validated self-report instruments were used, for example to assess interdependencies in terms of tasks, goals and outcomes (Campion et al., 1993). Where appropriate, the wording of items was adapted to the context of team-based knowledge work. In addition, based on conceptual considerations from existing research, new items were developed to assess the importance and frequency of the nine activities (see Table 1, Figure 2) in terms of actual and desired importance, as well as the estimated time share of these activities in total working time.

To analyse *requirements and the use of hybrid workplaces (R2)*, a second online survey was developed and conducted in April/May 2023. Referencing existing research, items addressing the importance and frequency of the nine central activities at the company location, alongside actual and desired importance, were newly developed. Further, participants were also asked about rules and reasons for working alone, or with the team, at the company site, or remotely. Both surveys were analysed for psychometric properties, descriptive statistics and correlation patterns using SPSS.

[24] Icons made by Freepik from Flaticon (2024).

In order to better understand the survey results regarding research questions R1 and R2, they were discussed and reflected upon in two semi-standardised group interviews. The group interviews on team characteristics took place at the end of March 2023, the group interviews and diamond rankings on hybrid workplaces in June/July 2023. To gain more insight into the fit between team characteristics and selecting/using hybrid workplaces (R3), the group interviews were complemented by a diamond ranking (Clark et al., 2013). Following the differentiation of zones in activity-based workplaces (van Meel, 2020), the teams ranked nine types of spaces. These included spaces of open design, such as open workstations, cubicles, booths and stand-up areas, and of closed design, such as focus rooms, study rooms, project rooms and meeting rooms, as well as informal space types, such as lounges, kitchenettes and cafeterias. These were ranked by the teams according to their spatial needs in the context of individual work, (on-site and hybrid) team work and (on-site and hybrid) team interaction. Both group interviews, including the teams' discussion of the diamond rankings, were transcribed, deductively and inductively coded, and interpreted using content analysis (Mayring, 2002).

To capture (additional) characteristics and requirements at the level of the organisational context, expert interviews were conducted with selected members of the management of both companies using a semi-structured guideline to identify specifications and design approaches for hybrid workplaces. In addition, the project involved associated partners who are experts in the field of designing and organising (hybrid) workplaces for a wide range of organisations in the business and administrative sectors, in order to regularly reflect on new findings from our small sample and discuss their generalisability to a broader work context. We also used national and international workshops in the academic community to reflect on and test findings and interpretations of the quantitative and qualitative data.

4 Summary of key findings

The key findings for each research question are presented below.

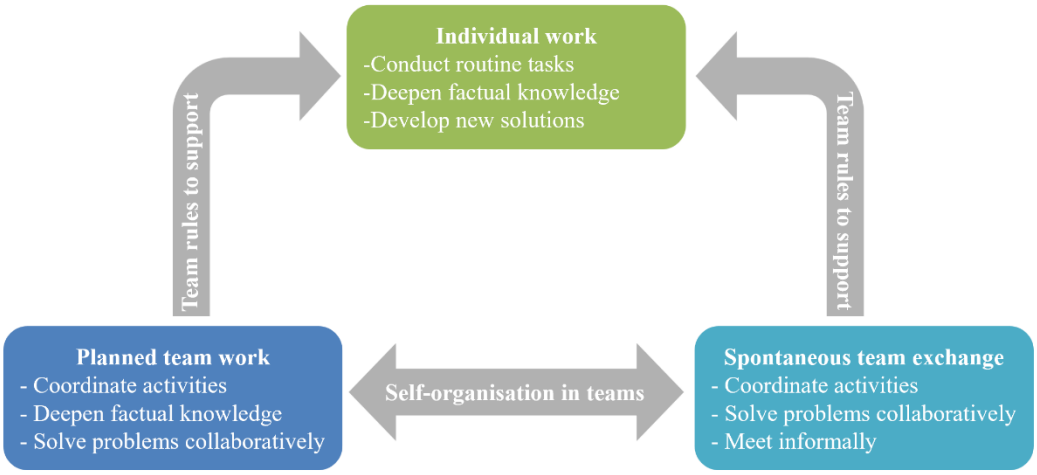
4.1 Team characteristics in hybrid settings

In relation to R1, the following team characteristics were identified: The importance and frequency of the three activity domains - *individual work, planned teamwork and spontaneous team exchange* - depend, among other things, on the complexity and urgency of the tasks, the defined workflow, the distribution of tasks/roles and the scope for decision-making. Individual work is the most important activity in teams, and its successful implementation is supported by planned teamwork activities and spontaneous team exchanges (see Figure 3).

The teams differ in terms of the quality of their activities supporting *individual work* and the self-organisation of the team in terms of planned teamwork and spontaneous team exchanges. Both aspects are predicted by, among other things, the tasks and interdependencies in the work processes, the team goals and/or the company-specific regulations. In addition,

collegiality within the team seems to have an impact on the relevance and frequency of teamwork and team exchange.

Figure 3. Relation of individual work, teamwork, and team exchange



In terms of *planned teamwork*, all teams favoured more frequent meetings to exchange factual knowledge. In terms of *spontaneous team exchange*, however, the teams rated meetings for coordination or work-related exchange as more important than meetings for problem solving. To promote self-organised support within the team, rules are needed on where, when and how much time is reserved for teamwork and spontaneous team exchanges, so that they can be used as needed.

4.2 Workplace requirements in hybrid settings

Regarding R2, the following requirements for the design and organisation of hybrid work settings were identified. The teams favour different locations for individual work, teamwork, and team exchange. To avoid disturbances, all teams at home and at the company site prefer *individual workplaces* with suitable technical equipment that enable quiet and concentrated work. At the company site, individual workplaces are ideally situated at short distances from the team members to facilitate easy initiation of spontaneous dialogue, if necessary. The most favoured space types for individual work are focus rooms and study rooms as well as cubicles in an open environment. The dimension of time seems to be a relevant factor in the selection of certain places: the preferred space type depends on the amount of time a worker spends in it, throughout the day, and/or across the week.

To facilitate *planned teamwork* at the company location, all teams prefer project rooms and meeting rooms with a variety of (technical) media to support the three corresponding activities

(see Table 1) of coordinating, exchanging facts or solving problems, as required. Relevant characteristics for the space type selection include the length and topic of the planned teamwork, and required resources. Desired space solutions for hybrid teamwork are more diverse and vary depending on the number of participants, the activity (more coordinative or more explorative) and/or the task to be completed (whether regular or not). The most favoured space types for hybrid teamwork also include project rooms and meeting rooms; in addition, stand-up spaces, workstations and cubicles are mentioned. More important than spatial features are appropriate technical equipment and protection from unwanted disruptions.

For *spontaneous team exchange*, the following findings emerged: To promote spontaneous dialogue at the company site, if needed, all teams require informal places with a pleasant atmosphere such as booths, lounges and kitchenettes. Relevant aspects for the selection are (constant) approachability of team members and proximity to the team workplace, within sight and short walking distance. The teams prefer an easy transition from one workplace to another without organisational barriers, such as mandatory room booking. Desired space solutions for spontaneous hybrid team exchanges show more diversity and vary greatly between teams. Most preferred are workstations, focus rooms, meeting rooms, booths and cubicles. The selection of a specific place depends on various factors, for example, the need for confidentiality or from the desire to avoid disruption.

4.3 Relation between team characteristics and workplace requirements in hybrid settings

With regard to the relationships between team characteristics and the use of/requirements of hybrid work settings (R3), the following findings emerged. High interdependencies within/between teams, along with high complexity in task processing require internal team communication, which should ideally take place on-site. The teams note that planned teamwork and spontaneous team exchanges require physical face-to-face interaction to support individual work. Even when task interdependencies and complexities are less pronounced, team-internal communication may still be necessary, for instance, within micro-teams. Technical equipment should enable access to team-related work materials regardless of time and place to facilitate joint, creative problem-solving.

Task complexity, aligned with workflows within/between teams, defines the requirements for team-related communication and thus the spatial needs for teamwork and team exchange: The more complex and time-intensive a team task is, the more space types the teams need to use. These workplaces should, on the one hand, enable concentrated individual work, such as with focus rooms or study spaces, and on the other hand, promote spontaneous exchange within the team, such as with cubicles or project rooms, so that individual work can be supported as required. If quantity and/or quality of team activities for individual work, teamwork and team exchange change, the allocation and thus the necessary number of team-

related space types may also change. In terms of their characteristics, space types for teamwork and team exchange should be:

- easily accessible and close to workplaces for individual work,
- technically equipped in such a way that interaction within the team can be extended from on-site to hybrid, integrating remote team members at any time,
- accessible at core times (on-site/hybrid) to support spontaneous team exchange, if needed, and
- designed in a way that enables confidential interaction between team members. Especially, rules are required for the use of different space types for all team activities to:
- avoid disturbances caused by noise during spontaneous team exchange,
- make sure that team members are available for spontaneous team exchange,
- allow the shared usage of space types within and across teams (who uses what and when).

A shared mindset among team members is a prerequisite for appropriate use of workplaces. To ensure a shared understanding, rules for use need to be negotiated within and between teams. One team member can take on the role of an experience manager to explain and communicate the mindset. In addition, different spaces types with different usage characteristics should be designed, equipped and organised to suit the intended and desired use. Organisational barriers, such as booking applications for rooms, should be minimised in order to facilitate supporting activities for individual work through spontaneous team exchanges in an uncomplicated manner. Conversely, easy to use booking applications should be available for planned teamwork activities.

5 Discussion

The project findings suggest that all three activity domains- individual work, planned teamwork and spontaneous team exchange - are relevant to team-based knowledge work, although their frequency and organisation varies from team to team. Activities involving the processing of complex tasks require face-to-face collaborative formats that support the execution of individual activities. For complex and/or urgent tasks, knowledge teams also need more time for spontaneous face-to-face team exchanges. However, this can only be achieved if sufficient time budgets are set aside in advance and team members are accessible on site through negotiated rules and spatial conditions. Spontaneous exchange is encouraged when team

members can easily meet each other due to short walking distances, with spatial solutions ideally promoting eye contact and a pleasant atmosphere.

A new finding is that in hybrid settings for teamwork and team exchanges, teams want a greater variety of space types. Overall, there is a need for clear rules within teams about the place, time, duration and frequency of teamwork and team exchanges in order to achieve an appropriate fit between team activities and different workplaces.

5.1 Implications for knowledge work in hybrid settings

The findings show that the design and organisation of knowledge work in teams, and of appropriate workplaces, depends on a number of variables. It is clear that internal or external changes in team characteristics can alter needs in terms of location and working hours/time (Ancona et al. 2021). It is therefore advisable for employers to regularly analyse the characteristics of teams - especially with regard to individual work, team work and team exchange activities - in relation to the location of these activities, and to ensure that appropriate team rules and team workplaces are adapted if necessary (Arena et al. 2022; Schermuly 2023).

Tools can help teams and stakeholders within organisations to analyse knowledge work in teams and to support responsibilities in planning and realising work settings (Ringeisen et al., forthcoming). From a bottom-up perspective, teams should be enabled and supported to analyse and discuss their team characteristics - team tasks, team processes and team structure - in order to assess the importance of on-site presence for (sub)teams. Based on such an analysis, the team should define rules for on-site presence with time slots for planned teamwork and spontaneous team exchanges to support individual work.

Taking into account team characteristics and presence rules, teams and relevant stakeholders can identify key workplace requirements and translate these into appropriate space types (at the company site) and rules for their use. In this way, the fit between team-specific activities and hybrid workplace requirements can be ensured in the context of change processes. It is recommended that home office rules are not completely individualised, but rather limited by self-determined team rules that allow team members to be present at the company site for specific activities.

5.2 Conclusion and outlook

In summary, research and practice show that the analysis and organisation of hybrid knowledge work needs to be viewed consistently from a team perspective and not just from a company or individualistic perspective. When organising and designing hybrid work settings, it is essential to consider the scope of action for supporting the self-organisation of teams when assigning them to a workplace at the company site. Following a bottom-up approach that assesses the relevant characteristics of team-based knowledge work, aligned with the Bosch-

Sijtsema et al. (2011) model, we gained a thorough understanding of the fit between team characteristics, knowledge work activities, hybrid work requirements and organisational frameworks. We recommend future research to replicate, extend and specify our findings in order to validate the assumptions of the modified model of team-based knowledge work, which has recently been extended from virtual to hybrid work settings (Dehmel et al., under review).

In order to assess the requirements for hybrid workplaces, tools are needed that enable teams to assess and explicate their needs in order to develop suitable spatial, technical and organisational scenarios together with relevant stakeholders. This will ensure a fit between team-based knowledge work and hybrid workplaces in the context of often constant change processes in team tasks, team structures and team processes. Middle management in particular has a crucial role to play in mediating between teams and top management, and in initiating negotiation processes to reconcile corporate goals and values with team-level needs. Based on these implications, the second phase of the research project will develop tools to support the development and realisation processes of hybrid workplaces.

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How different workplace settings at the office and at home support work activities, task profiles and productivity

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ABSTRACT

This study looks at first large-scale experiences of workers with combining work at different physical workplace settings in the office and at home. It identifies experienced support of different work activities and perceived productivity from workers with differing task profiles. Building on the theory of affordances, stating that the characteristics of a physical environment or artefact enable or constrain certain behaviours, it is assumed that different workplace settings relate to their perceived support of different work activities and the ability to be productive. After literature review, statistical analyses are performed on a Leesman dataset (N=57,286) with surveys on employees' workplace experience both at home and at the office; gathered between March 2020 and May 2021. After descriptive insights, significant relationships are discussed from bivariate and cluster analyses.

Findings show that employees perceive higher productivity support in all possible home workplace settings than in an office with flexible seating, and in most home settings over the dedicated office desk as well. The least supported activity at the office is telephone conversations and at home this is hosting people and having informal social interaction. Offices seem most suitable for task profiles combining collaborative work with concentrated activities, although those focused on concentration also feel quite productive there. People with highly diverse task profiles perceive the lowest productivity support from the office and are also not as optimally supported at home either in comparison to those doing concentrated work and having only 'simpler' types of meetings.

This study is one of the first to explore how the same sample of employees perceives their productivity and activity support both at the office and at home simultaneously while deep-diving in different types of activities. This informs workplace managers on possible adaptations of the office and policies on future hybrid working.

Keywords

Workplace settings, activity support, productivity support, hybrid working

1 INTRODUCTION

The COVID-19 pandemic disrupted office work for a substantial period and resulted in an unanticipated large-scale experiment of working from home (WFH) fully and/or obliged alternating WFH with the office. This forced employees to perform work-related activities at home that beforehand were considered unsuitable for that. Since the end of the lockdowns, there has been a large-scale adoption of so-called hybrid working, where workers divide their working hours and -activities between the office and time WFH (or in other locations outside the office). Resulting lower office occupancy rates challenge workplace managers to identify potential adjustments to their office workplace and which activities are best supported at the office and which at home.

Before the pandemic studies already investigated the experienced support by the physical workplace, but generally either focussed on the office (e.g. De Been & Beijer, 2014; de Croon et al., 2005) or on the home workplace (Ng, 2010). Since the start of the pandemic both locations receive more attention, but few studies simultaneously analyse employees' perceived productivity and workplace satisfaction in both work environments (e.g. Awada et al., 2021; Moretti et al., 2020; Umishio et al., 2022). So far, such studies have not yet intensively studied the different types of workplace settings in both locations, nor taken a detailed look at support of different types of work activities and task profiles by both locations. Given that hybrid working seems here to stay,

first experiences with alternating between both locations can provide valuable insights for future workplace design and use.

This paper therefore questions employees about their perceived productivity support and support of a broad list of activities in different types of home and office workplace settings. In addition, it identifies differences in the experienced support of these settings by groups of workers with differing task variety. Besides insights for workers and workplace managers, it builds on connecting hybrid work to the theory of affordances (first developed by Gibson (1977)), which poses that the characteristics of the physical workplace are perceived by its users to enable or constrain certain behaviours (Colenberg et al., 2022).

2 activity and productivity support of workplace settings

De Croon et al. (2005) distinguished three dimensions of office workplace settings: 1) the office location where the worker performs activities, 2) office layout, and 3) office use (whether workplaces are assigned or have a flexible use). Regarding layout, the most common distinction is between open and

enclosed workplaces. Open-plan offices generally provide more types of workplace settings than enclosed, cellular offices. For example, individual workplaces in the open office environment can be production tables or regular open workplaces (Appel-Meulenbroek et al., 2011). For home workplaces, older studies state that employees most commonly choose workspaces with well-defined boundaries as their dedicated home office (Magee & Arch, 2000), but during the pandemic people without such places had to work from home as well, such as in a spare bedroom, the living or dining room or the kitchen. The latter options can be considered as more visually and physically open, while a spare bedroom and dedicated work room have a more enclosed nature. And both at home and in the office, workplaces can belong to a person or may need to be shared with other users.

Several studies examined the impact of these physical dimensions and more detailed workplace features on workplace satisfaction and self-assessed productivity support in different office settings (e.g. Brunia et al., 2016; Danielsson & Bodin, 2008; De Been & Beijer, 2014; de Croon et al., 2005; Kim & de Dear, 2013; Seddigh et al., 2014; Van der Voordt, 2004). From these studies, it can be concluded that the workplace settings and the physical aspects of the workplace relate to employees' perceived productivity in many ways. Brill & Weideman (2001) even argued that the average effect of the workplace design contributes 5% to individual performance and 11% to team performance. The impact of WFH on individual outcomes such as job satisfaction and self-assessed productivity support has also been studied (De Croon et al., 2005; Fonner & Roloff, 2010; Gajendran & Harrison, 2007; Golden & Veiga, 2005; Kieft, 2021). An explanation for the generally found advantage of WFH for individual productivity could be related to fewer disruptions and distractions (Bailey & Kurland, 2002). Additionally, WFH allows employees to tailor or modify the workplace to better match how and when they do their work. However, recent studies on WFH during the COVID-19 pandemic show different results for employees' productivity (Moretti et al., 2020; Toscano & Zappalà, 2020).

Regarding activity support, it is generally assumed that employees prefer to do concentrative activities at home and collaborative activities at the office (Erlich & Bichard, 2008; Joy & Haynes, 2011; Appel-Meulenbroek et al., 2022). Nevertheless, the few studies that investigated both work environments simultaneously, mainly analysed productivity and work-related outcomes but did not consider the support of different activities (Moretti et al., 2020). As Maarleveld et al. (2009) showed, satisfaction with the support of the office workplace to perform activities significantly influences self-assessed productivity support. Also, knowledge workers perform a wide range of activities. The combination of different activities implies that employees' tasks are characterised by a high degree of so-called task variety (Morgeson & Humphrey, 2006). Doing many different activities might require different aspects of the workplace to be able to support all activities in the best way. Therefore, it is interesting to identify the perceived productivity support of the physical workplace at home and at the office, depending on such task variety of workers.

3 Research approach

The Leesman database of office surveys is currently one of the largest databases of its kind (https://www.leesmanindex.com/). In March 2020, Leesman launched a new Home Working Survey to gather office occupiers' responses regarding both their office and their home workplace. The data used for this research stems from the start of the pandemic lockdown, March 2020, till May 2021 and

comprises 57,286 respondents. The selected respondents answered both the home working survey and the regular Leesman office survey at one point in time, which provided the unique opportunity to explore the office and home experience of the same people, measured simultaneously. As the data stretches over a whole year, some respondents may have been confined to home in the pandemic, while others have had more liberty in choosing where to work.

First, some characteristics and general data of the respondents were asked, including time with the organisation, gender, and age group. Regarding the different workplaces in the survey, Table 1 presents an overview of the included workplace settings by Leesman in relation to the office type dimensions of De Croon et al. (2005); showing that all dimensions are represented. Next, the survey includes activity-related questions. If an activity is checked as important, a scale appears asking the respondent to rate the support of activities when WFH (and similarly in the office part of the survey) on a 6-point scale ranging from -3 to 3. In total, the survey questions 21 different activities. Next it elaborates on the importance and satisfaction of the physical features of the home and (separately) the office workplace. The respondent should check features that are important to him/her for an effective workplace. If a feature is considered important, the respondent is asked to rate his/her satisfaction with the specific features on a 5-point scale ranging from highly dissatisfied to a highly satisfied score [-2;2]. There is also an option "not provided" available. In total, eleven features of the home workplace are included and 24 of the office workplace. Last, the question is asked if the home and office workplace enable the employee to work productively. The scale used is a 7-point scale ranging from strongly disagree to agree strongly.

Table 1. Types of workplaces in the survey

Workplaces in Leesman survey	Location		Layout		Use		Category based on layout and use
	Home	Office	Open	Enclosed	Assigned	Shared	
Desk in a spare bedroom	X			X	X		Dedicated workplaces in an enclosed environment
Desk in a dedicated room	X			X	X		
Desk in living or dining room	X		X			X	Dedicated workplaces in a shared environment
Work spot in the kitchen	X		X			X	Flexible workplaces in a shared environment
Work spot on the couch	X		X			X	
Dedicated cellular office/cockpit		X		X	X		Assigned workplace in an enclosed environment

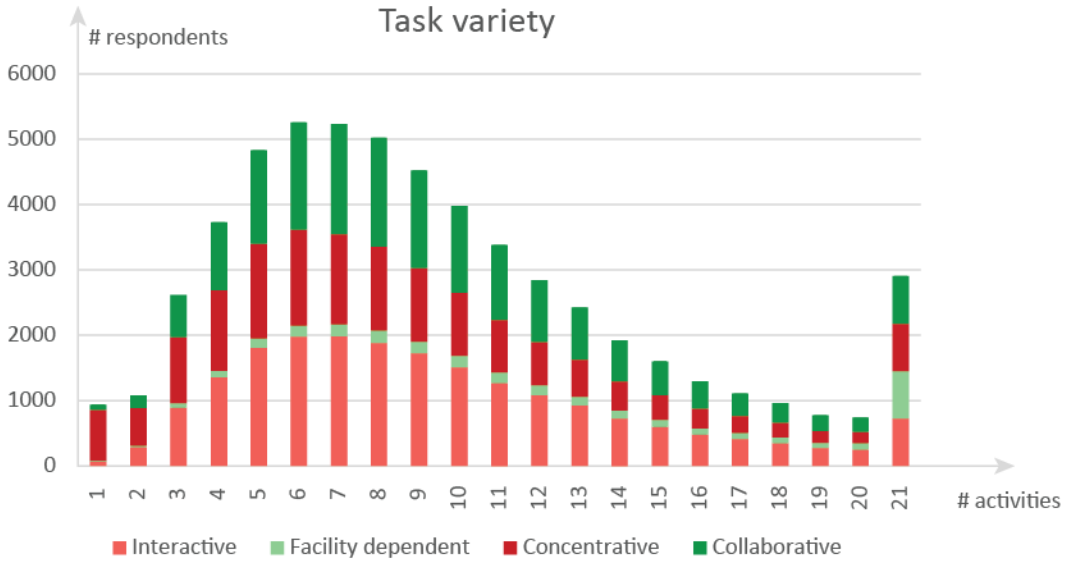
Flex cellular office/cockpit		X		X		X	Flexible workplaces in an enclosed environment
Cubicle		X	X	X	X		Assigned workplace in an open environment
General open workplace		X	X		X		
Production table		X	X			X	Flexible workplace in an open environment
Team/meeting tables		X	X			X	
Single or double lounge workplace		X	X			X	
Touchdown areas		X	X			X	
Dining table at canteen/pantry		X	X			X	
Desk in a shared room		X	X	X	X		Shared room
Closed meeting rooms		X		X		X	Meeting facilities
Brainstorm/project room		X		X		X	

After providing the descriptives of this dataset, a K-means cluster analysis is performed on the importance assigned to the list of activities, to be able to identify consistent task variety clusters. Then bivariate analyses are performed to explore the significance of direct relationships between the included variables.

4 results and implications

The sample is somewhat male dominated (65%), normally spread age-wise, with generally long tenures (only 14% <3 years). In the office, many employees reported working in either a flexible open work environment (35%) or an assigned open work environment (39%). At home, most employees reported utilizing a dedicated workspace, either enclosed (45%) or open (30%). Regarding the variety in activities, Figure 1 shows the number of activities per respondent. The largest group selected six different activities, but also many ticked all 21 activities as relevant. Only 985 respondents marked just one activity as important, generally focused on a concentrative activity (mostly individual focused work, desk-based), so indeed there is substantial task variety in the sample.

Figure 1. Number of activities



4.1 Productivity support

ANOVA analysis showed that employees perceived the level of productivity support in their home workplace to be slightly higher compared to the support experienced in the office workplace ($F(6, 57044)= 89.827$, $p = 0.000$). The ANOVA for different office workplace settings and perceived productivity support was significant too ($F(6, 57044)= 170.357$, $p = 0.000$). Table 2 shows the means of perceived productivity support per workplace setting, which the Games-Howell post-hoc test showed to be significantly different between all workplace settings except 'other'. The highest productivity support at the office is reported for an assigned workplace in an enclosed environment, followed by assigned workplaces in a shared room. Respondents reported the lowest productivity support in meeting rooms, with flexible workplaces in an enclosed environment also scoring lower than those in an open environment. De Been & Beijer (2014) also found that office employees in individual and shared room workplaces rated their perceived productivity support higher compared to employees working in more open layout settings, so the autonomy and flexibility of hybrid working do not seem to have changed this.

Regarding the home workplace, the highest mean productivity support is reported for a dedicated workplace in an enclosed environment, which is also higher than in the office (see Table 2). Awada et al. (2021) found that employees reported higher productivity levels when they worked in dedicated home workspaces than those who did not. So, the current study not only corresponds with existing findings, it also adds further insights through a more diverse typology of workplace settings to compare. Apparently, even a dedicated home workplace in a shared environment still scored higher than any workplace setting in the office. Only non-dedicated home workplace settings score lower than the top 2 of office settings, but still higher than all non-dedicated office settings.

Table 2. Workplace types and productivity support

Office work settings	**Number of respondents (N)**	**Mean (M)**	**Standard Deviation (SD)**
Assigned workplace in an enclosed environment	7450	1.52	1.348
Assigned workplace in a shared room	4411	1.40	1.361
Assigned workplace in an open environment	22335	1.09	1.510
Flexible workplace in an open environment	19924	1.01	1.515
Other	843	0.96	1.626
Flexible workplace in an enclosed environment	1195	0.82	1.725
Meeting or project room	893	0.52	1.636
Home working settings			
Dedicated home workplace in an enclosed environment	25381	2.24	1.029
Dedicated home workplace in a shared environment	17292	1.82	1.264
Other	608	1.19	1.654
Flexible home workplace in a shared environment	13770	1.13	1.589

4.2 Activity support

Regarding the perceived support of activities, individual desk-based focused work is considered an important activity by most of the employees, with most of those respondents stating that it is well supported at the office (>70%) and at home (80%). Over 80% considered planned meetings important for their line of work as well. Again, approximately 70% of the respondents mentioned that it is well supported at the office and also at home. The least supported activity at the office is telephone conversations with 18% of the respondents mentioning an under-support of the activity, where at home these activities are hosting visitors, clients, or customers and informal social interaction. One-way ANOVA analyses (see Table 3) show that all activities are supported significantly different between the office and the home workplace. The difference between the experienced support of individual focused work in general is small between the home and office environment. However, reading and creative thinking are perceived substantially better supported at home. Interestingly also many planned interactive activities are supported better at home (phone calls, video conferences and confidential or private conversations). Only for meetings with larger audiences and more collaborative activities (e.g. collaborating on creative or focused work, learning from others) the office seems a better support. Especially informal social interaction, facility-dependent activities and hosting visitors are supported best by the office. This seems to support the premises of the theory of affordances that the office has specific characteristics that support some activities but other activities less so.

Table 3. ANOVA analyses support of activities, ordered by difference in means

Better supported in...		Mean support office	Mean support home	Difference	F-Value	p
the office	Informal social interaction	0.65	-0.14	0.79	5075.893	0.000
	Hosting visitors, clients or customers	0.25	-0.31	0.56	3015.862	0.000
	Audio conferences	0.76	1.06	0.30	3780.69	0.000
	Collaborating on creative work	0.73	0.22	0.51	4228.308	0.000
	Learning from others	0.63	0.21	0.42	6784.218	0.000
	Informal unplanned meetings	0.65	0.37	0.28	2193.323	0.000
	Larger group meetings or audiences	0.42	0.18	0.24	4338.356	0.000
	Collaborating on focused work	0.88	0.69	0.19	5093.582	0.000
	Using technical specialist equipment or materials	0.17	0.05	0.12	3590.447	0.000
	Planned meetings	1.44	1.47	0.03	4645.895	0.000
at home	Telephone conversations	0.51	1.18	0.67	1089.422	0.000
	Individual focused work, away from your desk	1.13	1.66	0.53	3116.771	0.000
	Reading	0.24	0.78	0.54	800.808	0.000
	Thinking, creative thinking	0.21	0.64	0.43	690.199	0.000
	Private conversations	0.26	0.65	0.39	977.801	0.000
	Business confidential discussions	0.33	0.64	0.31	1845.558	0.000
	Relaxing, taking a break	0.55	0.79	0.24	2057.107	0.000
	Video conferences	0.66	0.83	0.17	4040.48	0.000
	Spreading-out paper or materials	0.09	0.18	0.09	608.183	0.000
	Individual routine tasks	0.70	0.79	0.09	11240.23	0.000
	Individual focused work, desk-based	0.30	0.36	0.06	616.731	0.000

Sample size (N = 57051), Degrees of Freedom (DoF = 6)

4.3 Task variety profiles of workers

To study task variety, the four-cluster solution was selected as it showed the most diverse activity clustering without overlapping of activities within the clusters (see Table 4). A K-means ANOVA test shows that learning from others (F = 12280.854) has the greatest influence in forming the clusters. In total, 45% of the respondents marked this activity as important. Business confidential discussion (F = 10770.656) and larger group meetings or audiences (F = 10367.575) yield the second and third highest F-values, as not so many respondents (35%) mark both activities as important. Individual desk-based focused work (F = 452.062) and Planned meetings (F = 3457.336) had the lowest F-values, meaning the least influence in the formation of the clusters, because these activities scored highest in all clusters

(respectively first and second). Workers in the first cluster mainly perform concentration-related activities. Individual focused work desk-based shows the highest score (0.86), followed by planned meetings (0.60). The second cluster includes both concentration work and formal and informal meetings (also with larger groups and business confidential discussions) and video/audio conferences. The third cluster contains people with both concentrated and collaborative work and meetings. Learning from others scores high (0.77) in this cluster compared to the first and second clusters. The third cluster also differs from the second by focusing less on online activities and more on collaborating with colleagues. The fourth cluster includes the most diverse set of activities, as importance of all activities scored high.

Table 4. Clusters of activities

	Cluster			
Activities	Concentration	Concentration and meetings	Concentration and collaborative work	Various activities
Individual focused work desk-based	0.86	0.91	0.93	0.98
Individual focused work away from your desk	0.13	0.24	0.24	0.71
Individual routine tasks	0.25	0.32	0.46	0.80
Reading	0.17	0.33	0.47	0.85
Collaborating on focused work	0.34	0.61	0.78	0.94
Collaborating on creative work	0.15	0.27	0.53	0.84
Informal unplanned meetings	0.22	0.66	0.68	0.94
Planned meetings	0.60	0.91	0.88	0.98
Informal social interaction	0.15	0.40	0.66	0.91
Business confidential discussions	0.10	0.50	0.17	0.87
Private conversations	0.11	0.42	0.29	0.89
Telephone conversations	0.31	0.81	0.50	0.96
Thinking/creative thinking	0.16	0.25	0.54	0.90
Learning from others	0.21	0.19	0.77	0.90
Audio conferences	0.28	0.76	0.44	0.92
Spreading out paper or materials	0.06	0.12	0.12	0.66
Using technical specialist equipment	0.07	0.08	0.12	0.55
Relaxing/taking a break	0.24	0.44	0.73	0.92
Larger group meetings or audiences	0.08	0.42	0.27	0.90
Hosting visitors, client or customers	0.06	0.28	0.10	0.74
Video conferences	0.19	0.76	0.35	0.92
Respondents (N)	20256	13967	13073	9755
Percentage (%)	**36%**	**24%**	**23%**	**17%**
			0.65 < 1.00	Strong
			0.35 < 0.65	Moderate
			0.00 < 0.35	Weak

The ANOVA tests show significant differences between these four task profiles in perceived productivity support. In the office ($F(3, 57047)= 34.977$, $p = 0.000$) people from the 'Concentration and collaborative work'-cluster perceived the highest average mean support of productivity (see Table 5). For the home workplace, a non-parametric test (Kruskal-Wallis H) was used, because the productivity variable was not normally distributed. At home, the 'Concentration and collaborative work'-cluster showed the lowest mean for productivity support (although still higher than in the office) and the 'Concentration and meetings'-cluster the highest support ($H(3) = 13.085$, $p = 0.004$), although differences between the clusters are smaller than in the office. These results show that, currently, offices seem most suitable for people doing collaborative work in combination with concentrated activities, although the 'Concentration'-cluster feels supported to be productive there as well. People with the most diverse task profile lack support at the office and also do not feel as optimally supported at home as those only doing concentrated work (and those having 'simpler' types of meetings). This seems to support the current difficulties of organisations to get their knowledge workers (generally having diverse activity profiles) to come back to work in the office after the pandemic (Gibson et al., 2023).

Table 5. Perceived productivity support of the clusters

Task profiles		**Office**		**Home**	
	N	Mean	Std. Deviation	Mean	Std. Deviation
Concentration and collaborative work	13073	1.21	1.48	1.79	1.366
Concentration	20256	1.15	1.46	1.85	1.322
Concentration and meetings	13967	1.06	1.51	1.86	1.298
Various activities	9755	1.05	1.60	1.82	1.385

5 conclusion

This study contributes to identifying relationships between different activities and task variety and the perceived support of activities and productivity at home and at the office. In addition, it shows that besides workplace location, different workplace layouts and flexible uses are also related to perceived productivity support at home and the office. As the data collection was conducted during the COVID-19 pandemic lockdowns (a turbulent period), this might have affected personal and societal circumstances influencing the perception of productivity support. Nonetheless, the new insights and knowledge gained from this study can be used for further research and in practice.

They can assist workplace managers with optimising the work environment and future workplace design. It is recommended to invest and incorporate sufficient and adequate workplaces in the office building, offering support for a broader task profile and not just for collaborative/interactive activities. In addition, organisations and companies could take an even more supporting and facilitating role in

assisting the employees to perform their activities more productively in the most optimal work setting and location.

Future studies should provide further insights into how to support all task profiles better, especially at the office as it scores lower for all clusters than the home workplace. The theory of affordances can be used more substantially, by asking people specifically which characteristics of the workplace settings make these activities best supported. In addition, it is recommended to combine the home and office work environments in an integrated path model.

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