Sustainable digitalisation and implementation of ISO standards for facilities management

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Abstract

Purpose

This viewpoint paper is aimed at discussing sustainable digitalisation of facilities management through the implementation of the newly recognised ISO standards within the ISO 41000 series.

Methodology

This viewpoint paper provides a review of the literature of the recent ISO documents and academic study. The content is also dependent on the authors' opinions and interpretation.

Findings

Facilities Management (FM) is currently shifting emphasis toward a strategic focus through the adoption of the new recognised international ISO standards that consider sustainable digitalisation in business decisions. However, the FM sector is encountering potential risks to the implementation of the new recognised international ISO standards. Digitalisation is one kind of force that has shaped the management of the built environment and FM recently and rapidly, especially in the Covid-19 period. This is impacting the facilities management industry. As standardisation aims at establishing a constantly evolving baseline of proven practices, standardisation can be considered a part of sustainable FM. It is believed that standardised and strategic level support is crucial for the smooth adoption of sustainable FM practices and processes. Standards such as the ISO standards, applied to the global FM industry, help in objectively quantifying the added value of FM to the core business. Advanced technology and digitalisation can contribute to the sustainability of any profession and industry, but it also requires a community to tackle the problems.

Originality

This paper contributes to the FM industry by making recommendations for improvement in the use of digitalisation. In summary, the significant finding of this viewpoint paper is that digitalisation offers both possibilities and problems in the application of the new recognised international ISO standards within the FM industry.

Keywords: risks, barriers, sustainable digitalisation, key performance indicators, ISO standards community, viewpoint paper

Paper Type - Viewpoint paper

Introduction

The ISO/TC 267 technical committee for facilities management first started in 2012 ISO (2022a). In 2022, there are 51 countries participating in this FM technical committee. Six standards have been published up to now, including the following:

- ISO 41001: 2018 (Facility management | Management system – Requirements with guidance for use),
- ISO 41011: 2017 (Facility management | Vocabulary),
- ISO 41012: 2017 (Facility management | Guidance on strategic sourcing and the development of agreements),
- ISO/TR 41013: 2017 (Facility management | Scope, key concepts and benefits),
- ISO 41014: 2020 (Facility management | Development of a facility management strategy),
- ISO 41018 (Facility Management | Development of a facility management policy),
- ISO/IEC TS 17021-11 (Conformity Assessment - Requirements for bodies providing audit and certification of management systems. Part 11: Competence requirements for auditing and certification of facility management (FM) management systems) (together with ISO's Committee on Conformity Assessment, CASCO).

The first standard was published in April 2017 (ISO 41011). Currently, there are five standards under development including ISO 41015 (behavior), ISO 41016 (technology), ISO 41017 (epidemic preparedness), ISO 41019 (sustainability and resilience) and ISO 41020 (performance). The ISO 41016 (technology) is a standard for digitalisation. Table I indicates the flow chart of working activities of the International Organization for Standardization (ISO/TC 267 "Facilities management").

The definition and scope of Facilities Management remains a contentious issue and definitions depend on the local culture, organization's interest and people's personal interest (Anna-Lissa, 2005). In Europe, many actors use the terms facilities management to impress clients, but do not provide professional FM services (David, 2000). Facility management is not the same as facility services. In general, standardisation in service sectors has increased in the last decade (Barthet, 2005;

Blind, 2003; DIN, 2002). ISO 41000 is not about standardisation of services. The standards focus on the requirements. De Vries (1999) has shown that standards may be feasible in-service sectors and may concern service organisations, employees, service delivery, service results, physical objects supporting the service delivery, workrooms, and (back office as well as front office) communication. The model has formed the basis for an international guide on services standardisation (ISO/COPOLCO, 2004).

Sustainable digitalisation and implementation of ISO standards

The ISO standards of facilities management help to provide a basis for sustainable digitalisation in FM. This viewpoint paper, whereby content is dependent on the authors' opinion and interpretation (Emerald Group Publishing, 2022) focuses on new emerging disciplines that will affect the operations phase of buildings and the people working therein. The word 'digitalisation' can be interpreted in many ways and is often used interchangeably with 'digitisation', although some authors draw a distinction between these terms. BSI (2022) explains in simple terms that, by making something digital, it has been digitised. For example, by scanning old drawings, documents and photographs with a digital camera, the physical form has been transformed into a digital form that a machine can read. Therefore, digitisation can be taken to mean the conversion of analogue inputs into digital forms (Leonardi and Treem, 2020, Prause, n.d.). Digitalisation is defined in the literature as going beyond digitisation, for example by Prause (n.d.) as "when data from throughout the organization and its assets is processed through advanced digital technologies, which leads to fundamental changes in business processes that can result in new business models and social change." Gartner (2022) defines it as "the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business." Leonardi and Treem (2020) argue that organisations digitalise the organisation by taking advantage of the digitised nature of work to produce new forms of organising.

Different digitalisation topics such as BIM, machine-readable standards, service management, IoT, energy use and AI can require different kinds of ISO standards. This paper is to discuss digitalisation from a holistic point of view related to data, digital and information techniques within the built environment. Future digital FM research directions include the application of digitalisation technologies, including 1) building information modelling (BIM), 2) reality capture technology (including 3D laser scanning, point cloud), 3) the Internet of Things (IoT) (including radio frequency identification (RFID) and sensor network technologies) and 4) geographic information system (GIS) Wong et. al. (2018).

Research problem

We believe that effective digitalisation can further enhance the productivity and efficiency of the FM service. Although digitalisation is generally understood within the FM community, FM services may not be effectively arranged without suitable IT applications. Though ISO FM standards and digitalised applications have already been launched and applied, their use is not universally prevalent as there have been insignificant outcomes on the provision of FM services throughout the industry. Ghaffarianhoseini, et. al. (2017) mention that continued digitisation of the construction industry offers the opportunity to completely reinvent contemporary design and delivery practice for future development, but the lack of widespread uptake of such digitisation appears to be linked to the risks and challenges that are potentially impeding its effectiveness. Linkov, et. al. (2018) address that different manifestations of digitalisation are affected by adaptive governance approaches to the economic and social sustainability challenges. Therefore, problems may still exist.

British Standards Institution (2018) clarifies that FM is a strategically important discipline to all organisations in the management, operation and maintenance of the workplace, its assets and operational efficiencies". This is understanding that the aim of facilities management is to achieve a high quality of daily living and working lives. To achieve a high quality of life, we need to achieve high performance in facilities management. The performance of FM services can be excelled and advanced by sustainable digitalisation and ISO FM standards.

In the construction industry, leading and lagging indicators have been used to measure safety performance and prevent injury on a company level using administrative data (Versteeg et al., 2019). Manuele (2009) defined that a leading indicator is significant only as it relates to increasing or decreasing risk. It is believed that the leading indicators can predict future conditions such as predictive maintenance, interactive monitoring, risk assessment, process planning and optimisation in terms of efficiency and cost. Birkel, et al. (2019) explain that risks can be associated with technical risks, e.g., technical integration and standards, information technology (IT)-related risks such as data security, and legal and political risks, such as for instance unsolved legal clarity in terms of data possession. With a clear understanding of these kinds of risks, FM professionals can effectively implement sustainable digitalisation and international ISO standards.

However, FM traditionally uses lagging indicators which can assess the current state of business such as measurement of effectiveness, performance, compliance and so on. A leading indicator shows how to produce desired results, but a lagging indicator measures current production and performance. While a leading indicator is

dynamically difficult to measure, a lagging indicator is easy to measure, but difficult to change. They are opposites, and as such a lagging indicator is sometimes compared to an output metric.

There is also an exponentially growing need for digitalisation in the FM industry. As for the opportunities technologies can bring such as the Internet of Things (IoT), big data analytics, modelling, simulation and sensor technology, this study is an exploration of the barriers to such sustainable digitalisation and ISO FM standards generating real value for FM businesses.

Addressing the digitalisation of ISO facilities management standards as a driver for sustainability is of paramount importance. This may mean a paradigm shift in the way that standard is delivered and acquired to help enable a more resilient world and more sustainable practice in workplace and facilities management.

Research aim and questions

The definition of sustainable digitalisation in this study is the impact of digitalisation on sustainability factors in general. Sustainable digitalisation in this study is in the context of FM and the requirements of standards. In addition, digitalisation will lead to more sustainable FM through direct reference to the different sections of the coming ISO 41019. The aim of this viewpoint paper is to investigate sustainable digitalisation and the implementation of FM ISO standards. This will be achieved through the following research questions:

What is the significance of sustainable digitalisation and ISO FM standards to the built environment? What is the link between FM Key Performance Indicators (KPIs), sustainable digitalisation and ISO FM standards? What are the challenges in developing sustainable digitalisation and implementation of ISO standards for facilities management?

Literature review

The relationship between sustainable digitalisation and ISO FM standards

The European Digital SME Alliance (2022) proposes a new application for the term ‘sustainable digitalisation’, also known as ‘sustainable digital transformation’, as referring to the process of digitalising the economy in a long-lasting, green and organic way. In this paper, we refer to digitalisation as ‘data-driven tooling used for realising business intelligence’. The aim is to use vast quantities of data and transform this into information and then find a way to use this information to gain knowledge and insight (learning/business intelligence) and ultimately achieve FM wisdom. Digitalisation could be the key to this evolution. This may not sufficiently interpret the word ‘digitalisation’, but this is another way that all these systems aim at making more

future-proof and sustainable decisions. This viewpoint of digitalisation implies going much deeper than data and information alone but it can add context to the information to make better decisions and learning.

Bröchner et al. (2019) argue that digitalisation and sustainability are the two main forces that have shaped FM since the 1970s and this is impacting the role of Facility Managers. Sustainable FM can be embedded into building performance; sustainability tools and standards; user perception, satisfaction and productivity; sustainability management; construction and sustainable building materials; building design and sustainability; urban development; and benefit of green buildings (Nielsen et al., 2016). Sustainable FM brings together the concepts of FM and sustainable development through use of technology and innovative business practices that balance the social, economic and environmental impacts of business decisions. However, Atkin and Bildsten (2017) found that informal media are concerned with more speculative themes, particularly the internet of things (IoT) and artificial intelligence (AI), which are indicative of disruptive technology. These themes are debated mostly by practitioners.

A study by Collins et al. (2019) that explored the gap between sustainable buildings and sustainable FM found that the need to bridge the traditional gap between design, construction and FM demands more effective solutions based on life cycle assessments. Opoku and Lee (2022) asserted that the emphasis of FM is moving towards a long-term focus by adopting practices that consider social, environmental and economic benefits of business decisions. They provide a discussion of how the FM sector can contribute to the realisation of various aspects of the 17 Sustainable Development Goals (SDGs) at various organisational levels, integrating data driven management technologies. The adoption of sustainable FM practices will reduce energy, water and waste in the maintenance and operation of buildings. Lee and Kang (2013) include use of environmentally friendly materials that enhance indoor air quality, water reuse, efficient energy use for thermal comfort, sustainable renovation and retrofitting, flexible design and circularity. Opoku and Lee (2022) further suggested that the FM sector should be at the heart of the engagement and drive towards integrating sustainability into daily FM practice to bring improved customer service. However, Lok et al. (2018) added that organisational level support is required for the smooth adoption of sustainable FM practices and processes. This part summarises the key performance indicators theoretically affecting sustainable digitalisation and ISO FM standards. The objective of this viewpoint paper is to study how sustainable digitalisation in FM fits with the ISO standards.

Measurement of FM Services by Key Performance Indicators (KPIs)

The measurement of performance as KPIs depends on who actually uses the performance assessment (e.g., executives, managers or supervisors), the public or private nature of the organisation, the assessment objectives (financial, functional, or physical) and prevailing trends in the industry (Amaratunga et al., 2000b; Cable and Davis, 2004; Cripps, 1998; Eagan and Joeres, 1997; Hinks, 2004; Lebas, 1995). Lavy et al. (2010) list four categories of KPIs in FM such as financial, functional, physical and user satisfaction. For instance, the financial category of KPIs may include operating, occupancy, utility and capital costs of FM outsourcing services. The functional category includes building physical condition, resource consumption—energy, water, property and real estate, waste, health and safety, indoor environmental quality and security of FM outsourcing services. The physical category includes productivity and space utilisation of FM outsourcing services. The user satisfaction category includes customer/building occupants' satisfaction with products or services of FM outsourcing services. A similar approach (Brackertz, 2006b), complements the view of Lavy et al. (2010), extending the view of FM by six different perspectives – service, community, financial, physical, utilisation and environmental. Lavy et al. (2014a) contended that the current assessment of facility performance measurement emphasises financial aspects such as business, organisational goals, job satisfaction, work environment, environmental issues and other non-financial qualitative aspects in a detailed manner holistically. It is generally accepted that the FM services can be assessed by both non-financial aspects and financial qualitative aspects of KPIs through the utilisation and implementation of ISO FM standards.

Non-financial Qualitative Aspects Mendell and Heath (2004) addressed Indoor Environmental Quality (IEQ) of a building as a primary concern today as it reflects and influences the health and well-being of its occupants. According to Fowler et al. (2005), IEQ has major impacts on occupant health and productivity and eventually could adversely influence occupants' turnover rate, absenteeism and satisfaction. Furthermore, IEQ-related problems possess economic implications, as Prakash (2005) suggested that IEQ-related problems, such as sick building syndrome, other building-related illnesses and absenteeism result in increased costs.

Kockat, et al. (2018) explained that buildings can efficiently operate with high indoor environmental quality and facilitation on digitalisation of knowledge-sharing. Digitalisation of the built environment is considered as a significant factor for innovation in the Architecture, Engineering, Construction and Operation sector (Mannino et al., 2021). Improved IEQ performance of a facility enhances the satisfaction and productivity level of its occupants (Heath, and Mendell, 2002; Fisk, 2000; Ford, 2006; Fowler et al., 2005; Mozaffarian, 2008 and Prakash, 2005). An enhanced IEQ not only increases productivity and reduces the financial burden; it also

enhances confidence in the organisation's ability to provide a safe, comfortable and healthy atmosphere (Fowler et al., 2005; Prakash, 2005 and Mozaffarian, 2008). Mendell and Heath (2004) concluded that the performance of students in school or non-school indoor atmospheres demonstrates a direct relationship to indoor pollutants, thermal comfort and building characteristics because of health-related problems. Bakker and Van der Voordt (2010) and Smith, Tucker and Pitt (2011) discovered that plants can have a positive impact on the productivity of human beings. Those studies indicate that the non-financial qualitative aspects of the IEQ relate to Lavy et al.'s (2010) three categories of KPIs in FM including functional, physical and user satisfaction. The issue of indoor environmental quality has direct impacts on the quality of all kinds of FM services.

Financial Aspects Facilities Management (FM) provided supportive services to core businesses for companies (CEN, 2006) such as infrastructure maintenance, equipment repair, etc. Companies (especially large ones) that are faced with the challenge of maximising business productivity and reducing costs are increasingly considering outsourcing their non-core activities such as FM (Maechling and Bredeson, 2005). Cui and Coenen (2016) argued that FM service suppliers can add potential value in this dimension by improving employees' productivity, increasing user satisfaction and innovating customers' business processes in business relationships. Haugen (2003) explained the client–supplier model regarding long-term gains in productivity. The client–supplier model had a greater focus on the core business of the local authorities and was anticipated to reduce the administrative and operational aspects of organisations. From the perspective of facilities management, key performance indicators of facilities management can be used to measure the FM performance. Lavy et al. (2014b) explained that the current assessment of facility performance measurement emphasises financial aspects.

Productivity Clements-Croome and Kaluarachchi (2000) discussed the occupant productivity measurement and how the various factors that affect it can be quantified into measurable entities. Table II indicates the factors affecting productivity in modern offices. There are also other factors that affect productivity; Bradley (2002) proposed that the business measures that can be derived from the balanced scorecard, and are specific to real estate and workplace, are as follows: productivity (e.g., space utilisation, process speed and quality, waste levels). Productivity is generally defined as the ratio of output (produced goods and services) and input (consumed resources/corresponding offers) in the production transformation process (Oeij, 2012; Tangen, 2002 and Van der Voordt, 2004). As a result, productivity is closely linked to the available resources; this means that productivity is reduced if the resources are not used properly or if there is a lack of appropriate resources. On

the other hand, productivity is strongly linked to the creation of value. This means that high productivity is obtained when adding value to the produced goods and services in the production transformation process (Tangen, 2002). The built environment has incontrovertible effects not only on the health, safety and productivity of building occupants, but also on the elemental systems ecology of the natural world (Lavy, 2014b). It is widely understood that measurable and quantifiable efficiency of the built environment can affect the FM performance.

Correlating FM Key Performance Indicators to sustainable digitalisation and standards

Lok *et. al (*2021) addressed the importance of measurement and quantification of FM sustainable digitalisation on outsourcing services through use of KPIs. The future of FM was influenced by society's need for improving efficiency following the economic crisis of the mid-1970s and the evolvement of new public management (Klungseth, 2015). Haugen and Klungseth (2017) explained that since its conception, FM has focused on productivity and since the late 1980s, one crucial topic for discussion has been the efficiency of FM services related to their quality. Nowadays, the focus is also on cost control, customer satisfaction and service quality through using digital technology and how it is being applied in facilities management.

The effectiveness and efficiency of sustainable digitalisation on ISO FM standards are considered to have an impact on productivity in offices. Poor FM practices cannot have positive impacts on the productivity of the client (Ikediashi et. al., 2012). It is valuable to measure users' satisfaction, comfort and productivity (Fleming, 2004). Hou et al. (2016) claimed that comprehensive strategic planning and effective budget analysis are key to improving FM performance and relationships. Organisations in Europe have focused recently on cost efficiency, improvement of procedures and reduction in headcount (Ernst and Young, 2013). Quantifiable and measurable indicators are necessary as Pintelon and Puyvelde (1997) suggested that performance metrics are mostly ratios demonstrating effectiveness, efficiency or productivity.

More research studies in providing quantifiable KPIs for strategic decision-making in organisations are vital (Shohet, 2003). The performance indicators to measure facilities and/or organisations need to be quantifiable to make valid analysis and references (Augenbroe and Park, 2005; Cable and Davis, 2004; Chan et al., 2001; Gumbus, 2005; Ho et al., 2000; Shohet, 2003; Tsang et al., 1999). For example, advanced quantifiable and measurable methodology with digitalisation technology such as ANN is used to measure the performance metrics of FM outsourcing services (Lok et al., 2021]. In the daily operational process, the artificial intelligence approach using Artificial Neural Networks (ANN) can quantify and measure the intangible FM

outsourcing services objectively and robustly (Lok et al., 2020).

Among major facility performance measurement practices are benchmarking, the balanced scorecard approach, post-occupancy evaluation and measurement through metrics of KPIs (Lavy et al., 2014). To express the performance of the facility in a holistic manner, developing performance metrics is an imperative step in the process of performance evaluation (Amaratunga et al., 2000a; Brackertz, 2006a; Cable and Davis, 2004; Lebas, 1995; Varcoe, 1996). Cable and Davis (2004) critically asserted that the senior management team can make strategic decisions for performance measurement by using established KPIs. This is the cause and effect between key performance indicators and high-quality service performance. This paper also contends that KPIs can measure the effectiveness of facilities management services even if digitalisation is applied. However, there is little in-depth research or discussion on the association of FM KPIs to sustainable digitalisation and standards.

Discussion on Sustainable Digitalisation and ISO FM standards

Standards of facilities management have become prevalent and facility managers can use the standards to truly improve their operational services. Both sustainability and security/emergency management have gained such an organisational tailwind that, if managed properly, they will be at the forefront of all facility managers' practices (Roper and Richard, 2014). This section explains sustainable development in terms of facilities management in the context of this research and why this may be related to the sustainable digitalisation and ISO FM standards. Recent studies in sustainability research include Olawumi and Chan (2018) who focus on various subject categories such as green and sustainable technology and construction and building technology. They also observe that the emerging research and global trends in sustainability research are in the areas of sustainable urban development, sustainability indicators, environmental assessment and public policy. Nielsen et. al. (2016) provide an overview of theoretical and practical knowledge which can guide: how to document and measure the performance of building operations in terms of environmental, social and economical impacts systematically such as sustainability tools and standards.

Why is FM digitalisation and standardisation important? As a start from a generic viewpoint, FM is a horizontal management discipline that integrates multiple vertical columns. As a first attempt at creating logical connections for the FM-professionals between technology and separate disciplines, integration by the FM professional becomes important. For example, it seems that the landscape of digitalisation is divided into columns within the physical and virtual space, and the transient area in between which we could classify as 'the edge'. The physical world has various grids

and networks and there is the rapid emergence of further automation, monitoring and delivery. The edge is defined by new systems for transactions, security and storage. The virtual realm develops new applications focusing on customer experience. All these new areas are extremely significant, but integration is often lacking in the industry. This is one of the reasons why ISO/AWI TR 41016 (Technology in FM - Scope, key concepts and benefits) is currently being developed by ISO/TC 267.

The sustainable digitalisation and ISO FM standards are not only gaining importance for various building assets around the world, but they also impact (or are impacted by) sustainable development objectives. With the possible exception of security, each of them fits into environmental, social and economic strands of sustainable development. In addition, the ISO 41001: 2018 standard is in alignment with United Nations Sustainable Development Goals. ISO (2022b) explained that they have published more than 22,000 International Standards and related documents that represent globally recognised guidelines and frameworks based on international collaboration, most significantly contributing to the achievement of every one of the SDGs.

Table III indicates that the categorised FM key performance indicators in terms of each of the environmental, social and economic strands are derived from sustainable digitalisation and ISO FM standards. In other words, the key performance indicators regarding sustainable digitalisation and ISO FM standards of the published ISO 41001 standard (Facilities management - Management systems - Requirements with guidance for use) can be significantly linked by sustainable development. However, the global development of sustainable digitalisation and ISO FM standards is sluggish. There are possible risks in terms of digitalisation and the FM ISO standards referring to the four perspectives of FM KPIs such as finance, function, physics and user satisfaction respectively. Figure I introduces the profile of understanding the sustainable digitalisation and ISO FM standards. On the point of view of research, it can consider the financial, physical, functional and user satisfaction perspectives independently and interactively.

Financial perspective Brackertz (2004) aims to provide facilities that are economically sustainable and are affordable to the community including service cost and building cost. Various kinds of businesses are suited to implementing the new FM international ISO standards, especially international companies or organisations. However, they may not consider these standards to be their top priority or even regard them as unimportant and may be unwilling to invest substantial finance and resources into implementing the standards. The fact is that most organisations already have implemented various ISO management system standards, such as 9001, 14001, 55001. In many cases, the added value of ISO 41001 is not directly seen and

the business case for implementing yet another Management System is not positive. If the primary focus for FM is on cost reduction instead of creating strategic value, this issue will remain (Lok and Baldry, 2015).

Physical perspective Brackertz (2004) aims to provide buildings that are fit for the purpose for which they are being used including building condition, maintenance, compliance, risk and duty of care, IT capability, flexibility. Some traditional FM practitioners perhaps do not understand the importance of new FM international ISO standards to the benefits of their assets or organisations and their steps are behind the global pace of change. Generally, long-established companies consider that they can run their business well as usual without the FM ISO standards. The new standards have recently originated from the western parts of the world. The fact is that ISO FM practitioners are still pushing the relevant ISO standards. The ISO 41001 Annex ("Guidance on the use of this document") facilitates productive use of the standard, explaining and listing specifically functions to assign and assess. Each organisation and each solution are different, but the universal framework applies to all (Reynolds, 2022). However, some traditional FM practitioners have only shown little interest in the importance of this new ISO standard to their business. This may have an adverse impact on the productivity of the FM services.

Functional perspective Brackertz (2004) aims to provide facilities that are available to the community at times of demand and that are well utilised including opening hours, user numbers, capacity, demand by utilisation perspective and aims to provide facilities that are environmentally sustainable including rating scheme, energy management, recycling, waste management and building materials by environmental perspective. Facilities users or operators from various kinds of businesses may consider these standards and high computing technology to be low priority or unimportant in the life cycle of building assets. The new FM ISO standard can develop a new environmental ecosystem for the industry globally. If companies are willing to join and utilise the new digitalised techniques for the data under appropriate governance measures, stakeholders may have sufficient incentive and financial support to overcome potential economic and/or social challenges (Linkov et al., 2018). All the stakeholders' investments are sustainable with extra finance, resources and technology during the process. All the financial and non-financial problems can be constituted as barriers to the environment. This is a challenge in the functional category around whether companies can have a positive return and better productivity after overcoming the digitalisation and implementation of the new FM ISO standard.

User satisfaction perspective Brackertz (2004) aims to provide facilities that enable the effective delivery of services that are appropriate and meet the needs of

the community including transport accessibility, safety, location, disability access, equity, design and fitout, building functionality by service perspective and aims to provide facilities that support and facilitate the delivery of services that meet the needs of the community including community satisfaction and community participation by community perspective. Insufficient data and information can affect the digitalised development of FM (Mannino et al., 2021). Perhaps the existence of psychological obstacles for individuals or communities leads to the FM practitioners not understanding or neglecting the importance of new FM technology and development for the benefit of their companies or organisations. They may be unwilling to put effort into the development of digitalisation in their businesses. They may not fully understand the needs and expectations of the users in terms of digitalisation, in which case, users' experience needs cannot be satisfied.

Individuals may have their own problems in facing the new technology of AI or advanced technology. Questions are such as "How can FM people around the FM world become digital people?" "How to improve understanding of the importance of digitalisation on the business?" "How to connect understanding of the importance of digitalisation with the FM ISO standards and the impacts on services?".

FM practitioners perhaps do not consider AI or any advanced computing such as machine learning or techniques that can help and support their FM business (Lok et. al., 2022). These professionals may still use their traditional mindsets to operate and run their existing businesses without recognition that big data or new advanced technology can improve their business or help make it more successful. They may be afraid of new technology or even object to any change with the use of new things. However, understanding digitalisation and FM ISO standards may help them to update their mindset. General user satisfaction experience perhaps cannot be achieved due to practitioners lacking experience in advanced digitalised services.

Conclusions

This viewpoint paper is an initiative to discuss the new international ISO FM standards and their application in pursuit of sustainable digitalisation in FM. Although there have already been seven standards successfully published, it is inevitable that the FM professionals will need to solve different and new problems during the process of implementation of these standards. Modernised digitalisation is important to different industries. More effectively and efficiently applying the new innovative international ISO standards, academics and FM professionals can understand and use digitalisation. Facility management is complex, and the facility management systems should follow the requirements of ISO 41001 to be certifiable. The ISO standards can provide the possibility for easing access between digitalisation management and FM

systems. In addition, it is important to reduce waste sustainably.

According to the literature review, several issues of FM KPIs which affect sustainable digitalisation and FM ISO standards were identified, including function, user experience, physical and finance. To address some of these issues, FM research has emerged in productivity, efficiency, customer service, resource allocation, assets and cost. In this sense, this paper is organised into two sections: The first one provided a review of FM key performance indicators. The second section focused on the discussion of the implementation of sustainable digitalisation and FM ISO standards.

In the end, we should reiterate the fact that understanding the implementation of sustainable digitalisation and FM ISO standards not only leads to cost and resource efficiency gains but also elevates the satisfaction of users by increasing the quality and reliability of FM services. We have identified several areas that need an update and further research. The development of sustainable digitalisation and implementation of ISO standards for facilities management should be systematically linked through an integrated model that considers the criticality of services, from the four FM perspectives including function, user experience, physics and finance for these services.

Further, sustainable digitalisation should go beyond assessing the performance based on the functionality of FM services and should link the performance of the FM services to its impact and contribution to the efficiency and effectiveness of the routine daily operations in the building assets. In addition, the implementation of ISO standards for FM, owing to its criticality of services, should consider adopting availability-based strategies currently in practice in the global FM industry, to ensure service continuity while avoiding over-expectation or under-expectation of efficiencies.

However, the limitations of this study are that the research is based only on literature reviews on recent FM-related and published ISO standards and the viewpoints of the researchers. The existing outcome is rather limited. To have more generalised results or outcomes, it is recommended to conduct a large-scale research study on this topic of modernised digitalisation and implementation of the new FM international ISO standards.

Recommendations

The significance of sustainable digitalisation and ISO FM standards to the built environment is on the financial perspective. One potential demand driver for organisations towards the adoption of ISO 41001 could be the possibility of objectively benchmarking FM organisations. Standards can also aid in avoiding unnecessary effort/costs (waste) for both the demand and FM organisation when

trying to have IT systems communicate with one another. Especially when a demand organisation has multiple service providers in multiple geographical locations and/or a FM organisation has multiple clients. Standards can also provide ways to make interfaces effective and lean.

The link between FM Key Performance Indicators (KPIs), sustainable digitalisation and ISO FM standards is still unclear on the physical perspective. Risks could be a perceived lack of power or influence by IT if FM goes this way, another could be the lack of technical knowledge and insight by FM professionals and lack of long-term or strategic thinking abilities in FM. The risks encountered relate to 1) the new strategic role for FM (ISO41001) and 2) bringing new digital, data and technology within the realm of FM (ISO41016) and use of these standards could help to mitigate the risks.

The aim of ISO FM standards is to ensure consistency of essential features of goods and services, such as quality, ecology, safety, economy, reliability, compatibility, interoperability, efficiency and effectiveness (ISO/TC 267). Implementation of standards is different to implementation of a FMS - Facility Management System. No matter what kind of profession, IT applications can further improve the efficiency and productivity of the profession. The introduction of new standards for FM digitalisation must be beneficial to the international FM industry. However, the success of the ISO standard should not only depend on the efforts of the FM ISO committee members but also most importantly on the application of the new standards by the international FM community. Without the use of the standard on daily FM services, the power of the ISO standard cannot be developed and the FM services cannot be comprehensively improved.

The challenges in developing sustainable digitalisation and implementation of ISO standards for facilities management are the two perspectives of function and user satisfaction. The new FM ISO standards are useful and beneficial to the FM community for their reference and use. The ISO FM standards can be utilised not only to maintain the quality but also to improve the FM services in the built environment systematically if risks can be managed. It is understood that the ISO standards are not adopted as quickly and widely as expected. The barriers that are considered are at the fringe of FM, where FM can make further horizontal managerial connections with other business columns such as IT and HR, especially when discussing sustainable digitalisation. Sustainable digitalisation and implementation of ISO standards for facilities management are necessary to the industry.

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Table I - Schedule of working activities of International Organization of Standards (ISO/TC 267 "Facility management")

Year	ISO Standard	Description	Leadership	Group	Function	Under development " ** "	Published " ** "	Incidents happened in the year
2012	ISO 41000	Start of ISO/TC 267						- ISO/TC 267 is established. - Chairman Stan Mitchell leads ISO TC 267 for Facility Management.
2017	ISO 41011	Facility management | Vocabulary	Casey Martin	WG 1	Concepts and context		**	- ISO 41001 is shortly to become the world's first international management systems standard for Facilities Management (FM) - Final Countdown to ISO 41001: Malaysia Update. The plenary meeting took place in Kuala Lumpur. It followed on from the 3rd Malaysia Europe FM Conference. - The Committee warmly welcomed three new participating members, Russia, Colombia and Poland. - The goal is to launch this revolutionary standard ISO 41001 in the first quarter of 2018. - ISO 41001 is FM's first global management systems standard and is due for launch early 2018. - The first International Facility Management Standards: An Overview - The ISO 267 Facility Management committee published its first two international facility management standards. A third followed
	ISO 41012	Facility management | Guidance on strategic sourcing and the development of agreements	Jay Drew	WG	Strategic sourcing		**	
	ISO TR 41013	Facility management | Scope, key concepts and benefits	Olav Egil Sæbøe	WG	Concepts and benefits		**	
		Start of Advisory Group 1 - Roadmap	Ian van der Pool / Laverne Deckert	AG1	Roadmap			
2018	ISO 41001	Facility management | Management system – Requirements with guidance for use	Jim Whittaker	WG 3	Management System		**	- Approval of the ISO 41001 Management Systems Standard for Facility Management
	ISO/IEC TS 17021-11	Conformity Assessment - Requirements for bodies providing audit and certification of	David O'Brien	CASCO	Conformity assessment		**	

		management systems. Part 11: Competence requirements for auditing and certification of facility management (FM) management systems						
2019			Stephen Ballesty	AG 2	Communication			- Advisory Group 2 was formed and tasked with developing ISO/TC 267 messaging - Raising FM standards worldwide with ISO 41014
2020	ISO 41014	Facility management | Development of a facility management strategy	Helgard Pienaar	WG	Management strategy		**	- Committee recently announced their intention to map the ISO 41000 series of standards to the UN Sustainable Development goals – Number 3 being "Health and Wellbeing" - China is one of the 32 countries currently registered as participating members of ISO/TC 267, further evidence of their will to drive forward professional standards in the FM sector
2021	ISO TR 41016	Technology in facility management | Scope, key concepts and benefits	Gordon Mitchell	WG 6	Digital, data and technology	**		- Pending
2022	ISO 41015	Facility management | Influencing organizational behaviors for improved facility outcomes and user experience	Ted Weidner	WG 5	Human experience	**		- Pending
	ISO/TR 41019	Facility management | The role of FM in sustainability and resilience	Casey Martin	WG 1	Concepts and context	**		
2023	ISO 41017	Facility management | Guidance on emergency management of epidemic prevention in the workplace	Xiaolu Zhang	WG 7	Emergency management	**		- Pending
	ISO 41018	Facility management | Development of a facility management policy	Helgard Pienaar	WG 4	Strategy and policy		**	
20XX	ISO 41020	Facility management | Performance measurement and management for improved facility outcomes	Eric Dillinger	WG 8	Performance measurement and improvement	**		- Pending

Remarks: 1) AG – Advisory Group; WG – Working Group; CASCO - ISO's Committee on Conformity Assessment 2) Within the family of ISO management system standards alone, there are at least seven requirement standards related to FM functions. There is a technical committee behind each of these standards responsible for standardization in their domain. Including ISO 9001, Quality; ISO 14001, Environmental management; ISO 22301, Business continuity; ISO 45001, Health and Safety; ISO 46001, Water efficiency; ISO 50001, Energy management and ISO 55001, Asset management.

Table II. Factors affecting the productivity in modern offices.

	Factors That Affect Productivity
Personal	Career achievement home/work interface intrinsic to the job
Social	Relationship with others
Organisational	Managerial role, Organisational structure
Environment	Indoor climate, workplace, indoor air quality

Source: Clements-Croome, and Kaluarachchi, (2000, p. 11); Reprinted with permission from Copyright 2000 Clements-Croome, and Kaluarachchi.

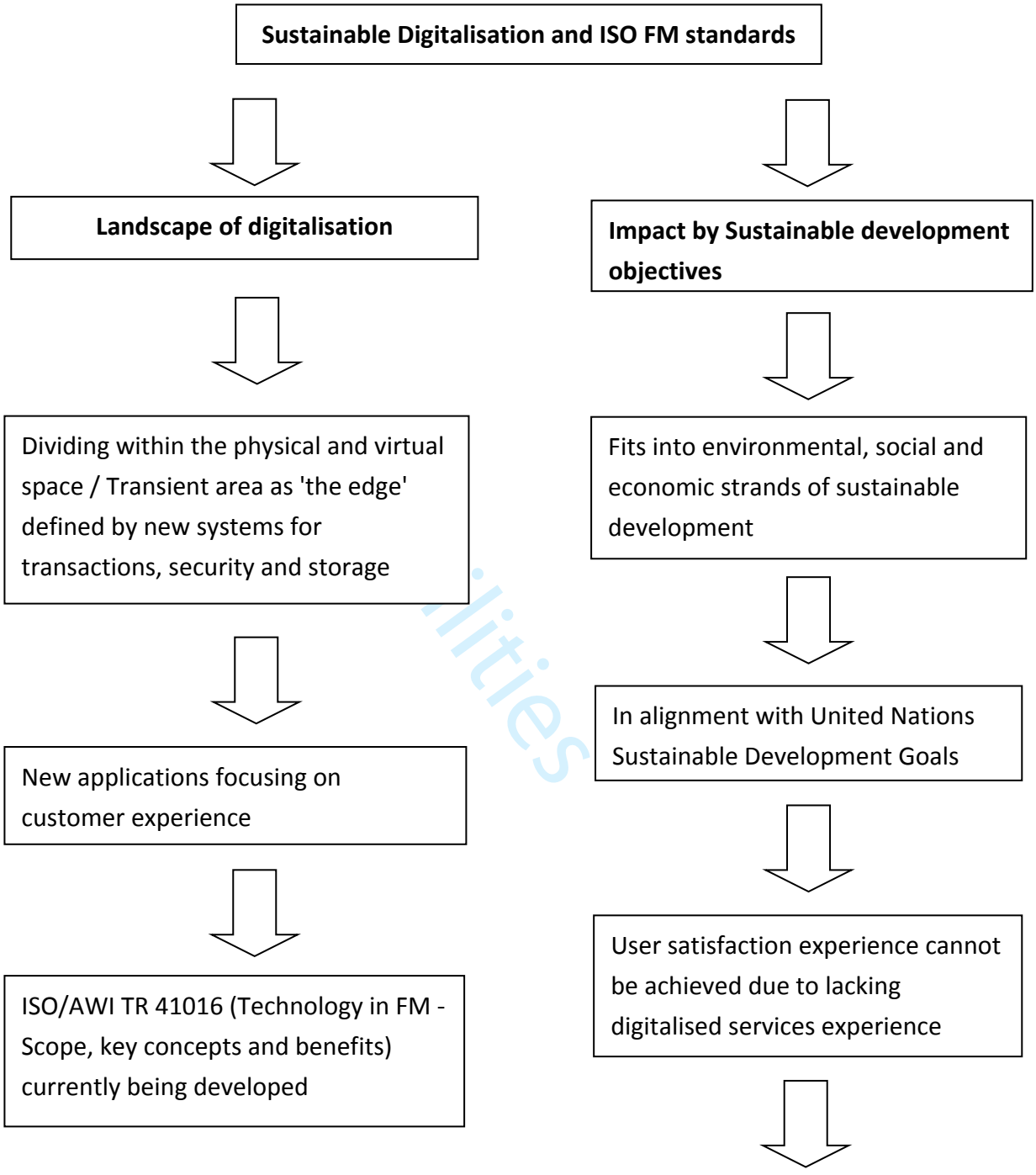
Table III. Linking ISO 41001 standard series to Sustainable Development Goals with Key performance indicators

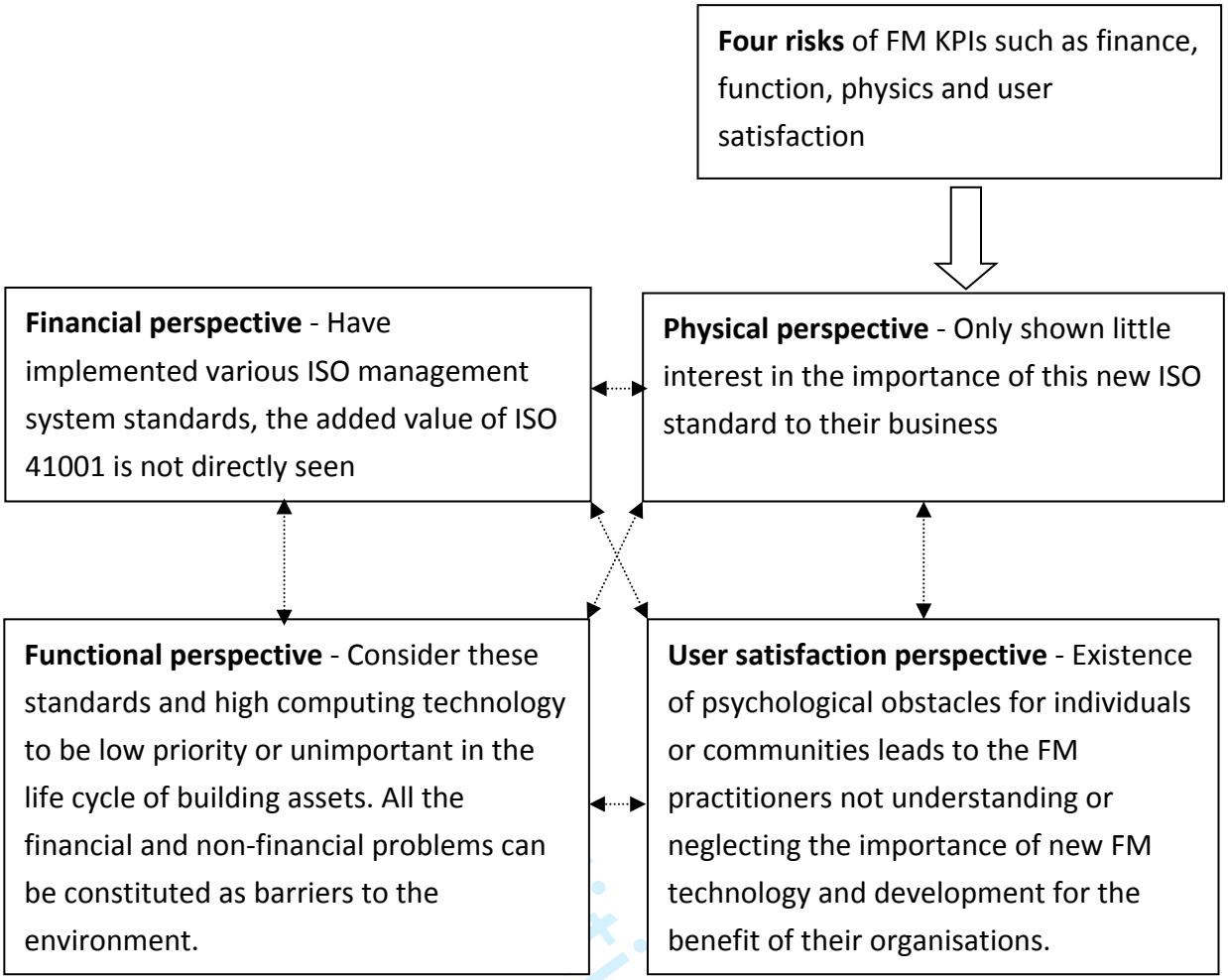
	FM Key Performance Indicators	**United Nations Sustainable Development Goals (SDGs)**
Facility Management / TC 267/ ISO 41001	Financial: Sustainable Economic Development Functional: Sustainable Environmental Development Physical: Sustainable Environmental Development User satisfaction: Sustainable Social Development	No. 4 Quality Education No. 9 Industry, innovation and infrastructure No. 10 Reduced Inequalities No. 11 Sustainable Cities and Communities No. 12 Responsible Production & Consumption No. 13 Climate Action No. 14 Life Below Water No. 15 Life on Land

Remarks:

1. Facility Management / TC 267 in alignment with United Nations Sustainable Development Goals (SDGs) (High Level Structure (HLS) core text, common terms and definitions) including No. 4; No. 9; No. 10; No. 11; No. 12; No. 13; No. 14 and No. 15.
2. Four categories of FM Key Performance Indicators including i) Financial category; ii) Functional category; iii) Physical category; iv) User satisfaction category.

Figure I. Understanding the Sustainable Digitalisation and ISO FM standards




Four risks of FM KPIs such as finance, function, physics and user satisfaction
Financial perspective - Have implemented various ISO management system standards, the added value of ISO 41001 is not directly seen
Physical perspective - Only shown little interest in the importance of this new ISO standard to their business
Functional perspective - Consider these standards and high computing technology to be low priority or unimportant in the life cycle of building assets. All the financial and non-financial problems can be constituted as barriers to the environment.
User satisfaction perspective - Existence of psychological obstacles for individuals or communities leads to the FM practitioners not understanding or neglecting the importance of new FM technology and development for the benefit of their organisations.

Title: Sustainable digitalisation and implementation of ISO standards for facilities management

Authors Response

The success of this paper is because of the support and guidance by the reviewers. Million thanks to the reviewers' important comments and suggestions. We have implemented the reviewers' comments for further improvement of the paper with blue lines in the manuscript.

Reviewer #1	Comments	Authors' Response	Page Nr.
1	Please accept, but the authors should merge the recommendations with the conclusion. The recommendations should form the second part of the conclusion.	The new manuscript has been merged the recommendations with the conclusion. The recommendations form the second part of the conclusion.	14, 15
Reviewer #2	**Comments**	**Authors' Response**	**Page Nr.**
1	The content and the structure content and the structure, in my viewpoint, should be improved to improve readability and understanding. The framework of the text must be carefully revised to improve the logic of the paper construction. The quality of communication can be improved with a review of the framework / structure of the whole work.	Revised. The current format of this manuscript has been prepared and followed the requirements of standard research paper though this is a "viewpoint" paper. The content and the structure of this current format includes research problem/ gap, aim, questions, objective, literature review, methodology, findings, discussion, conclusion, and recommendations. The framework of the text has been carefully revised to improve the logic of the paper construction.	Whole paper
2	It seems that all titles are at same level and it should be adapted to the standards of this Emerald publication.	Revised. All titles are revised to the suitable levels and are adapted to the standards of this Emerald publication.	Whole paper
3	There is an item, Introduction, without any text, and if there is an introduction, we need to know where it starts and where it is finishing.	Revised	2,3
4	Author(s) also must consider the introduction of one or more diagrams to support the discussed ideas.	Figure 1 is added	11
5	Some affirmatives are not supported by data. This is an opinion paper and the results	In general, the current viewpoint paper is more objective with the support of appropriate literature review and	5 - 15

	should better supported by references. If authors explore the several aspects considered along the text linked to a better structure with clearer purposes, a better result will be obtained.	discussion with relevant literatures. The findings of this viewpoint paper are mainly based on the discussion of viewpoints of the authors and supporting literatures.	
6	Author(s) must include ISO 41018 as a published standard.	Revised	2
7	What is the implementation of the ISO standards?	Stated	3, 15
8	Implementation of standards is the the same of implementation of a FMS - Facility Management System. Is it true? Facility Management is not the same of Facility Services and. ISO 41000 is not about standardization of services it should be cleared. The standards focus on the requirements!	Stated	2, 3
9	Sustainable digitalisation in the context of FM and the requirements of standards.	Stated	5
10	Improve conclusion with a better connection of the content and the recommendations, results, etc...	The new manuscript has been merged the recommendations with the conclusion. The recommendations form the second part of the conclusion.	13, 14, 15
11	Facility Management is complex and the Facility Management Systems should follow the requirements of ISO 41001 to be certifiable.	Stated	13
12	Brackertz discuss a view of FM by 6 different perspectives and can complement the view of Sarel Lavy. My personal experience has showed that these 6 aspects are very useful when analyzing FM systems. It is an old papered technology is not considered in appropriate way. But it can bring some light.	Stated	11 – 13, 16
Reviewer #3	**Comments**	**Authors' Response**	**Page Nr.**
1	This is a very interesting paper. It is well written and presents clear arguments. My only suggestion for improvement would be to make a more explicit link between	In the definition of sustainable digitalization, we have made a more explicit link between digitalisation and sustainability by specific reference to the	5

	digitalisation and sustainability by specific reference to the sections in ISO 41019. My only minor concern is the link between the digitalisation arguments and sustainability. Whilst this is discussed in general, I think the links should be more clearly articulated in the discussion section. It would be good to understand how the author's claims that digitalisation will lead to more sustainable FM through direct reference to the different sections of ISO 41019 (whose actual title is sustainability and resilience, and not resilience, as stated in the paper).	sections in ISO 41019 which is still under development.	