Original Manuscript

Breaking barriers for breaking ground: A categorisation of public sector challenges to smart city project implementation

Public Policy and Administration
2024, Vol. 0(0) 1–53

DOI: 10.1177/09520767241263233
journals.sagepub.com/home/ppa
Sage

Emine Zehra Akgün and Paolo Gerli
Business School, Edinburgh Napier University, Edinburgh, UK

Luca Mora
Business School, Edinburgh Napier University, Edinburgh, UK

Academy of Architecture and Urban Studies, Tallinn University of Technology, Tallinn, Estonia

Clare McTigue
Business School, Edinburgh Napier University, Edinburgh, UK

Abstract

Smart city technologies provide promising solutions for local governments to tackling societal challenges and enhancing public service provision. The global embrace of these digital innovations represents a new era in public sector advancements. However, it has also brought to light difficulties that existing public sector innovation (PSI) theories struggle to address. One key issue is the lack of comprehensive knowledge regarding the most critical barriers to implementing smart city projects and their intensity. We address this knowledge gap with a systematic literature review within the smart city domain, focusing on literature reporting on the barriers that local governments commonly encounter. This effort has culminated in the development of a conceptual framework that categorize smart city project barriers, forming a taxonomy that builds on and expand the most recent development in the PSI literature. This study contributes to PSI theory refinement by offering a more nuanced understanding of the barriers that local governments might experience when attempting to sustain digital innovation efforts.

Corresponding author:
Emine Zehra Akgün, Edinburgh Business School, Heriot-Watt University, Gait 11 The Avenue, Currie, Edinburgh EH14 4AS, UK.
Email: E.Akgun@hw.ac.uk

Moreover, this insight into PSI dynamics is a valuable resource for local governments as they seek to devise realistic mitigation strategies tailored to local development needs.

Keywords
Smart city project, public sector innovation, implementation barrier, taxonomy, innovation management, digital transformation

Introduction

Public sector organisations have long been seeking innovative approaches to enhance the quality of public service delivery and improve internal efficiencies (De Vries et al., 2016). These efforts have gained momentum, particularly in the face of austerity measures (Qiu and Chreim, 2022; Salge and Vera, 2012). Moreover, recent technological advancements have further propelled local and national governments towards integrating smart city technologies in their innovation strategies. Some examples include applications leveraging Internet of Things (IoT), machine learning, and artificial intelligence (AI) technologies (Hong et al., 2022).

However, embarking on these innovation projects presents internal and external obstacles. For example, digital transformation projects within the public sector often encounter resistance to change, as they challenge established interests, routines, and administrative structures (Qiu and Chreim, 2022). Financial constraints also loom as a significant issue (Micheli et al., 2015). In addition, these innovation projects are expected to thrive in highly collaborative arenas where citizens (Torfing, 2019) and private sector organisations play crucial roles (Bryson et al., 2015). Managing these partnerships has proven to be complex, given the intricacies arising from power struggles (Hambleton and Howard, 2013) strict policies and regulations (Bjørner, 2021), and the need to harmonise the differing expectations of heterogenous stakeholders (Cinar et al., 2019).

Fragmented in the academic literature is a multidisciplinary knowledge domain reporting on the barriers that local governments might experience while implementing smart city projects. Despite various attempts to tackle this subject, a comprehensive understanding of these barriers and their examination within the context of public administration and management theories is still missing. While current studies offer a comprehensive, cross-sectoral view of the hurdles in smart city project implementation, they tend to neglect the distinct perspective of public sector organisations.

Furthermore, prior research has separately delved into the barriers associated with public sector innovation (PSI) and those associated with smart city projects. Examples of such research include De Vries et al. (2016), Cinar et al. (2019, 2021) and Rana et al. (2019). However, these studies have not been collectively analysed to identify common threads and distinctions. This gap in the literature presents a valuable opportunity to deepen our comprehension of innovation processes within the public sector. However, the focus of these studies has never been analysed in conjunction. This gap presents an opportunity to enhance our understanding of innovation processes within the public sector.

Drawing from this background, we conducted a systematic review addressing the following research question: what barriers do local governments experience when implementing smart city projects? The main output of our study is a comprehensive and systemic overview of these barriers, sourced from a very large set of multi-disciplinary studies and examined though the lens of theories on PSI processes. Drawing on our findings, we develop a conceptual framework that enriches public administration views on innovation management, expanding upon the macro-dimension view of PSIs proposed by Cinar et al. (2019, 2021). Our framework also provides a more granular understanding of the barriers to the implementation of a specific type: smart city solutions. Our findings are also instrumental in providing practical recommendations to policymakers in the public sector, with the objective to facilitate substantial enhancements in their decision-making processes. We expect these recommendations to contribute to the refinement and optimisation of policy implementations in the smart city area, fostering more effective and informed governance approaches.

The reminder of the article is structured as follows. Theoretocal framing discusses the extant literature on barriers to PSI, providing the theoretical background for analysis. Methdology section discusses the methodological approach adopted conduct our systematic review. Next, we discuss the findings of the review in which we present the barriers captured during the analysis and link their observation to public administration theory. Finally, the article is concluded by discussing the theoretical and practical contributions of this review, together with its limitations and potential areas for future research exploration.

Theoretical framing

This section delineates the theoretical framework underpinning our systematic literature review. Initially, we introduce key studies that explore different paradigms of public administration and management and how they have been driving PSI, particularly in the smart city area. Subsequently, we examine the literature that offers valuable perspectives on the obstacles encountered by public sector organisations in their pursuit of PSI.

Public sector innovation and the main paradigms of public administration and management

Public sector organisations strive to fulfil their mission by constantly enhancing the quality of public service delivery in response to external and internal changes occurring across social, economic, and political landscapes. The obligations derived from their mission introduce growing pressures and demands for innovation (Hartley et al., 2013). Examples of factors influencing this imperative to innovate include the following: increasing fiscal pressures (Bartlett and Dibben, 2002), the rising expectations of citizens for improved public services (Borins, 2001; Demircioglu and Audretsch, 2017; Hartley, 2005), and the necessity to develop specialised responses to complex societal challenges like climate change and poverty (Hartley et al., 2013; Sørensen and Torfing, 2012).

Current studies extols the virtues of PSI, underscoring its potential to enhance organisational productivity, problem-solving abilities, and the quality of service delivery (Bloch and Bugge, 2013; De Vries et al., 2016). Moreover, it has been observed that the adoption of innovative practices by public sector organisations is profoundly shaped by shifts in the paradigms of public administration and management. Three major paradigms stand out for their significant impact on how scholars and practitioners understand and apply the principles of public administration and management (Hartley, 2005): Traditional Public Administration (TPA), New Public Management (NPM), and New Public Governance (NPG). Existing evidence shows that these paradigms introduce diversity across nations and among public sector entities in crafting innovation management strategies and in allocating authority to policymakers, innovation managers, and citizens (Arundel et al., 2015; Hartley, 2005).

Traditional Public Administration advocates for a state-as-a-producer model, wherein societal needs are addressed by public professionals through standardised services (Hartley, 2005). In this framework, politicians at various levels of public administration wield significant influence over PSI activities (Hartley, 2005), fostering a top-down management of innovation predominantly steered by political decisions (Arundel et al., 2015; Walker, 2006).

In contrast, NPM shifts these dynamics, advocating for public sector organisations to adopt practices from the private sector, including the introduction of market-based competition (Osborne and Gaebler, 1992) and the application of private sector management techniques (Hartley et al., 2013; Lapuente and Van de Walle, 2020). New Public Management core objectives emphasise outcome control in PSI operations (Sørensen and Torfing, 2012) and typically aims to commercialise government services and the government-citizen relationship (Gonzalez et al., 2013). Within the NPM framework, innovation activities focus on organisational forms and processes, highlighting the importance of decentralised decision-making and granting more autonomy to individual departments (Hartley, 2005). An entrepreneurial strategic outlook is encouraged among PSIs as they seek to identify and capitalise on new service and market opportunities (Andrews and Van de Walle, 2013). Moreover, NPM views the role of citizens in innovation as akin to that of customers, with public managers and policymakers acting as agents of market and efficiency maximisation (Hartley, 2005).

The NPM framework has faced significant criticism regarding its approach to fostering innovation in public service provision. For example, Hartley et al. (2013) have pointed out that NPM may discourage knowledge sharing across organisations, thereby impeding certain types of innovation. While NPM's strong emphasis on performance management and control has been recognised for its positive impact on enhancing the efficiency of service production, Andrews and Van de Walle (2013) contend that an overemphasis on quantifiable performance metrics can limit the flexibility of public sector organisations in adapting services to meet the varied needs of different citizen groups. Furthermore, Hartley (2005) has argued that the "customer focus" inherent in NPM has improved certain services but has simultaneously neglected others that require closer relationships, such as co-design and co-production of services.

Some scholars have also highlighted that the principles of NPM can stifle the adoption of a bottom-up approach that centers services around citizens and involves collective decision-making by key stakeholders (Arundel et al., 2015). This body of research advocates for the adoption of new governance models, like NPG, which emphasises networked governance to facilitate collaboration among various public sector organisations (Christensen and Lægreid, 2007) as well as the development of innovative strategies through leveraging the expertise of policymakers, public managers, private sector entities, and citizens (Sørensen and Torfing, 2012). This shift towards NPG aims to prioritise collaboration and innovation by tapping into a broader range of insights and expertise.

New Public Governance conceptualises public administration and management being shaped by the diverse and evolving needs of citizen groups. It highlights the crucial role of networks and partnerships between local and national public sector organisations in driving the successful delivery of public services (Hartley, 2005), while arguing for the importance of national actors in providing the necessary space for local authorities (Van Duijn et al., 2021). This enables the development of interorganisational collaborative networks that include various stakeholders, thereby fostering innovation through collective effort.

Innovation within the NPG framework is portrayed as a collaborative act that involves a wide array of stakeholders, from different citizen groups to public and private sector organisations. This collaborative environment facilitates the cross-pollination of ideas and the co-creation of new solutions aimed at improving service delivery (Hartley et al., 2013). The networked governance paradigm positions policymakers, public managers, and citizens as co-explorers and co-producers of transformative changes and ongoing improvements in service quality across all levels of public administration (Hartley, 2005). Evidence shows that increased collaboration strengthens PSI management throughout the entire process (Gonzalez et al., 2013; Sørensen and Torfing, 2012). Moreover, organisations engaged in peer networks exhibit enhanced innovation capabilities (Hartley et al., 2013).

Smart city projects serve as a prime example of PSI attempts where an NPG approach to innovation is needed. Smart city technologies are increasingly recognised for their potential to tackle a broad spectrum of social, environmental, and economic challenges that citizens and local governments face (Barrutia et al., 2022). The primary aim of such projects is to deploy digital solutions that make urban systems and services more accessible and create public value (Bjørner, 2021; Martin et al., 2018). The advancements in Information and Communication Technologies (ICTs) over the last two decades have simplified the process for local authorities to collect and analyse large data sets, supporting evidence-based policymaking (Ullah et al., 2021). By engaging multiple stakeholders in smart city projects, local governments can be in a better position to enhance economic prosperity and public management efficiency (Andrea et al., 2013; Meijer, 2018; Nilssen, 2019).

While smart city technologies offer promising advantages and have seen several successful implementations worldwide, these projects are increasingly subjected to scrutiny due to various strategic and operational concerns. Martin et al. (2018) highlighted a notable gap in evidence supporting the achievement of smart and sustainability objectives by smart city projects, suggesting that these initiatives often embody a technocratic and neoliberal vision without providing a coherent, actionable plan for implementing and measuring sustainability metrics. This critique aligns with other studies that point out the predominance of a technocratic approach in the deployment of smart city projects (Arundel et al., 2015; Meijer, 2018), underpinned by managerial philosophies that resonate with the the NPM paradigm (Hartley, 2005; Hartley et al., 2013).

In addition to the challenges rooted in high-level public management paradigms, several other factors impede the successful implementation and long-term financial sustainability of smart city projects. These include the absence of effective governance mechanisms, the high costs of project implementation, difficulties in scaling up, a lack of interoperability among technologies and devices, as well as concerns related to data management and information security (Mora et al., 2023). These issues frequently emerge as critical obstacles, significantly influencing the success of smart city initiatives. However, these barriers have never been examined in the framework of PSI theory.

Categorisation of barriers to public sector innovation

Research examining barriers to PSI has grown rapidly in recent years, and so has its importance; it is widely acknowledged in public administration literature that public sector organisations can better manage their innovation efforts when they possess a clear understanding of what barriers can prevent their projects from being successful (e.g., see (Cinar et al., 2019; Mu and Wang, 2022; Torugsa and Arundel, 2016). Several single case studies have been presented, looking at an array of policy areas where the public sector has crucial obligations to meet, such as education, safety and security, healthcare, waste management, and mobility oversight (Cinar et al., 2019; Qiu and Chreim, 2022; Torvinen and Jansson, 2023). By analysing several exemplary projects, these studies help provide a broader understanding of what barriers can hinder successful implementation of PSI projects in the context of specific policy domains. However, they have a reduced generalisation capability, which results from the limitations imposed by their research design (Tangi et al., 2020), and these limitations have triggered the need for more systematic examinations focused on the framing of taxonomies of barriers.

To address this gap, public administration scholars have conducted several systematic literature reviews. These studies introduced different approaches to the examination and categorisation of barriers experienced by public sector organisation when dealing with innovation projects. Barriers are interpreted as either obstacle to overcome (D'Este et al., 2012; Meijer, 2015) and predictors of outcomes, or antecedents of innovation (De Vries et al., 2016). Research by De Vries et al. (2016), for example, exposes the need for public administration research to further explore barriers to PSI by considering the environmental and organisational contexts in which innovation processes take place. Other studies have focused on categorising barriers as internal versus external (Bloch and

Bugge, 2013) or revealed as opposed to deterring (D'Este et al., 2012). Attempts to address these issues can be observed in some recent review articles. In line with the argument brought about by De Vries et al. (2016), the systematic literature review by Cinar et al. (2019) suggests that conceptualising barriers only as negative or enabling factors reflect a static view that fails to visualise the phased development of innovation processes. Accordingly, the authors create a taxonomy of barriers to PSI that accounts for different project phases, exposing how challenges may emerge and evolve over time.

Mu and Wang (2022) add to these cognitive frameworks with a study that compares barriers to innovation projects in two different types of settings: digital and non-digital transformations in public sector organisations. This distinction is instrumental in emphasising the contextual differences that project types imply when considering different application areas, but also the additional complexities that digital innovation may involve. Mu and Wang (2022) also contribute to proving that research on barriers to digital innovation in the context of local governments is gaining attention; however, no conceptual frameworks have been developed that provide a systematic view of the type of barriers that can emerge when public sectors organisations work on smart city projects. Global-scale data gathered by the United Nations shows that many local governments worldwide are already working on smart city projects (Beckers et al., 2022), and they progress without possessing a holistic understanding of the possible barriers that they might encounter (Ihrke et al., 2003; Queyroi et al., 2022). The complexity of these projects requires public sector organisations to deal with new challenges, such as more advanced technologies, more complex collaborative environments, and changes in existing institutional settings that might lead to conflict and resistance. Thus, we recognise the need for a dedicated inquiry that specifically targets the obstacles in implementing smart city projects.

To set the theoretical foundation for a new conceptual framework in which these barriers can be organised, we build on the abovementioned studies. More specifically, we start from the five macro categories proposed by Cinar et al. (2019, 2021). These categories focus on organisational, contextual, collaborative, technological, and resource-related barriers, respectively.

Organisational barriers refer to internal challenges that public sector organisations experience when dealing with leadership (Arundel et al., 2019; Mergel et al., 2018), the management of core business functions (Cinar et al., 2019), and the formulation of strategic visions and organisational strategies (Addae et al., 2019; De Vries et al., 2016). Organisational barriers also focus on issues that can emerge when the public sector adopts inappropriate approaches to the development and implementation of innovation projects (Anand and Navío-Marco, 2018; Ma and Lam, 2019).

Contextual barriers originate outside the boundaries of public sector organisations; however, they contextual environments shape their actions and affect what smart technologies they would deploy and how they should manage inputs and outputs of these technologies according to existing local policies, and national laws. By influencing structural and cultural features of public sector organisations (Cinar et al., 2019; De Vries et al., 2016), contextual elements impact on project arrangements.

Interaction-specific barriers reflect that the successful implementation of innovation projects depend on a complex network of stakeholders (D'Este et al., 2012), including private and third sector organisations, community groups, and citizens. The relationships between these stakeholders can be complex to coordinate and maintain, hence such interactions can cause frictions, affecting the quality of the implementation process of innovation projects and their outcome (Cinar et al., 2019; De Vries et al., 2016)

Technology has become a core element in many innovation projects, and it has a strong influence on the pace of innovation in public organisations. Technological barriers refer to challenges that originate from the characteristics of a particular technology. Some examples include financial burdens affecting development and deployment, compatibility, and interoperability with existing technological systems (Cinar et al., 2019; Razmjoo et al., 2021), existing regulations and old government structures (Janssen et al., 2017), cybersecurity (Ullah et al., 2021), and physical infrastructure (Merhi, 2021).

Finally, resource-related barriers reflect the internal and external availability of resources that are vital to innovation projects, including infrastructure, human, and financial resources. Resource availability is essential for any innovation project to unfold (De Vries et al., 2016). In the public sector context, for instance, it is widely acknowledged that organisations often struggle with limited budgets and skills gaps, which limit the potential to innovate fast and sustain scale up operations. Moreover, in recent years, the intensive implementation of digital transformation projects escalated the discussion around the state of human resources (Mergel et al., 2019; Paskaleva and Cooper, 2018; Pittaway and Montazemi, 2020), which refers to the lack of digital skills and knowledge in both developing and managing digital technologies in the public sector (Kuhlmann and Heuberger, 2021; Nadkarni and Prügl, 2020).

Methodology

We conducted a systematic literature review to investigate the barriers to the implementation and management of smart city projects from the perspective of local government officials. To conduct our analysis, we applied a five-phase protocol inspired

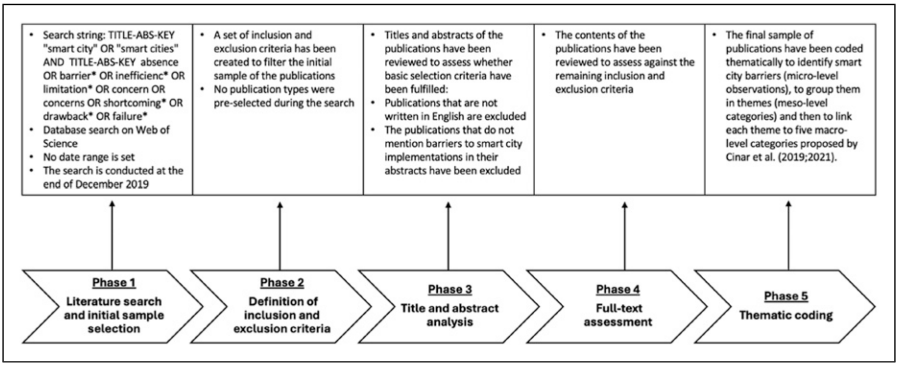

Figure 1. The overview of the systematic review and selection process.

by previous studies (Mora et al., 2019, 2023; Tranfield et al., 2003). This protocol ensured transparency and replicability (Snyder, 2019), while reducing the risk of bias in the selection, appraisal, and synthesis of the selected studies (Tranfield et al., 2003). Figure 1 presents an overview of how articles have been selected for this review study.

Phase 1: Literature search and initial sample selection

We started with the crafting of a search query comprising a list of selected keywords, which were used to gather relevant publications from relevant academic databases. The search query combined the locution '*smart city*' with the term *barrier* and relevant synonyms and expressions that are often used to describe issues making it difficult for a project to be completed: for example, *inefficiency*, *limitation*, *concern*, *shortcoming*, *drawback*, *failure*, and *absence*. When possible, all the words that we selected were added to the search query in their plural and singular forms: (TITLE-ABS-KEY ("smart city" OR "smart cities") AND TITLE-ABS-KEY (absence OR barrier* OR inefficienc* OR limitation* OR concern OR concerns OR shortcoming* OR drawback* OR failure*).

After being assembled, the search query was run in Scopus at the end of December 2019. The SLR has been undertaken as the part of a project, which ended in 2019. Therefore, the sample covers the articles that are published until the end of December 2019. The search was set to look for the selected keywords in titles, abstracts, or keyword lists of Scopus-indexed references. The selection of Scopus as our primary platform for conducting literature searches was driven by its comprehensive coverage, which encompasses a broad range of publication types. No publication types were pre-selected during the search, hence the initial sample included articles in peer-reviewed journals, books, book chapters, and conference papers for a total of 2809 unique records.

Phase 2: Definition of inclusion and exclusion criteria

A set of inclusion and exclusion criteria were formulated to assess the retrieved publications against the objectives of this study and to eliminate those that were not relevant to our investigation. First, all authors of this article concurred that it was essential to consider publications across various disciplines to avoid omitting relevant studies. However, we decided to only focus the review on material presenting empirical evidence to exclude publications that do not explicitly discuss any specific barrier or just mention such barriers without providing any empirical data. Furthermore, we chose to exclude publications written in a language other than English. Table 1 shows all the inclusion and exclusion criteria together with the relevant reasons.

Phase 3: Title and abstract analysis

Upon reaching consensus on the selection criteria, each co-author was assigned the task of reviewing the titles and abstracts of the 2809 publications initially identified

Table 1. The inclusion and exclusion criteria.

	Criteria		
Code	Type	Focus	Reasons for inclusion or exclusion
INC.1	Inclusion	Quantitative and qualitative empirical studies	Inclusion of articles that offer empirical evidence, which is the focus of this review
INC.2	Inclusion	Perspective	Inclusion of articles that make it possible to understand smart city barriers from the perspective of public administration and governance perspectives
INC.3	Inclusion	Publication type	All types of publications are included (i.e., books, book chapters, conference proceeding)
EXC.1	Exclusion	Unit of analysis	Exclusion of publications which do not mention barriers to smarty city implementations in their abstracts
EXC.2	Exclusion	Unit of analysis	Exclusion of publications which do not discuss barriers in detail in the main body of articles
EXC.3	Exclusion	Language	Exclusion of the articles which are written in a language other than English

for inclusion in our study. This was done to exclude any publications that did not align with the scope of our research. To ensure consistency and thorough discussion of the decision-making process, multiple rounds of meetings were convened both prior to and during the analytical phase. Independently, every author examined all publications in the sample, after which the findings were meticulously compared on a pairwise basis to achieve unanimous agreement. This approach to qualitative data analysis, which shares similarities with consensus coding, was lengthy but secured a rigorous standard of selection (Snyder, 2019; Xiao and Watson, 2019). At the end of this phase, the authors have agreed on 398 publications for further examination.

Phase 4: Full-text assessment

The same collaborative approach was adopted when assessing the content of each publication. The 398 publications selected during Phase 3 were distributed among the co-authors, each of whom independently evaluated their alignment with the inclusion criteria. After these independent assessments, the co-authors engaged in thorough discussions to elucidate the reasons for each publication's inclusion or exclusion, with the aim of achieving consensus. Consequently, 154 publications were deemed suitable for the coding phase. The list of selected publications and the journal titles are presented in the Table 2.

Table 2. The list of venues that selected publications are published.

Title of publication venue	Corresponding publication
Journals	
Accounting, Auditing & Accountability Journal	Argento et al. (2019)
ACM SIGSOFT Software Engineering Notes	Vieira and Alvaro (2018)
Annals of the American Association of Geographers	Crampton et al. (2019); Masucci et al. (2019)
Annual Review of Political Science	Brady (2019)
Applied Sciences	Dilawar et al. (2018)
Asia & the Pacific Policy Studies	Yang and Xu (2018)
Cities	Angelidou (2014); Lim et al. (2018); Marek et al. (2017); Mueller et al. (2018); Offenhuber and Schechtner (2018); Ruhlandt (2018); Addae et al. (2019); Bjørner (2021)
City, Culture and Society	Barns (2018); Reed and Keech (2019)
Computer Communications	Rodrigues et al. (2018)
Computer Networks	Ahmed et al. (2017)
Computers & Security	Pan et al. (2019); Vitunskaite et al. (2019)
Computing	Ye et al. (2019)
Data	McKenna (2019)
Energy Policy	Mosannenzadeh et al. (2017)
Environment, Development and Sustainability	Marsal-Llacuna (2019)
Equity & Excellence in Education	Leigh (2017)
European Urban and Regional Studies	Trivellato (2017)
Future Generation Computer Systems	Gianni et al. (2019)
Geo-spatial Information Science	Musakwa (2017)
Government Information Quarterly	Belanche-Gracia et al. (2015); Li and Liao (2018); Maccani et al. (2020); Matheus et al. (2020)
Health Policy and Technology	Bates et al. (2018)
Human-centric Computing and Information Sciences	Park et al. (2019)
IEEE Access	Liborio et al. (2018)
IEEE Internet Things Journal	Nelson et al. (2019)
IEEE Transactions on Industrial Informatics	Xiao et al. (2018)
Information	Lee et al. (2017)
Information Polity	Gil-Garcia (2012); Meijer and Thaens (2018)
Information Systems and e-Business Management	Peng et al. (2017)
Information Systems Frontiers	Gupta et al. (2019); Rana et al. (2019)
Innovation: The European Journal of Social Science Research	De Wijs et al. (2016)
International Journal of Parallel Programming	Alabady et al. (2018)

(continued)

Table 2. (continued)

Title of publication venue	Corresponding publication
International Journal of Sustainable Development and Planning	Praharaj et al. (2018)
International Review of Law, Computers & Technology	Jewell (2018); Rinik (2019)
Internet Research	Janssen et al. (2019)
Journal of Cleaner Production	Almeshaiei et al. (2020); Colding and Barthel (2017); Lin et al. (2015); Lu et al. (2018); Adapa (2018)
Journal of Open Innovation: Technology, Market, and Complexity	Yigitcanlar et al. (2019)
Journal of Reliable Intelligent Environments	Pereira et al. (2018)
Journal of the Knowledge Economy	Tekin Bilbil (2017)
Journal of Transport and Land Use	Faisal et al. (2019)
Journal of Urban Technology	Joss et al. (2017)
Management Decision	Chinnaswamy et al. (2019)
Mobile Networks and Applications	Yao et al. (2017)
Mobilities	Perng (2019)
NEO 2016	Escamilla-Ambrosio et al. (2018)
Personal and Ubiquitous Computing	Kabáč et al. (2017); Qiu et al. (2017)
Pervasive and Mobile Computing	Valerio et al. (2017)
Procedia Computer Science	Patel and Doshi (2019)
R&D Management	Sandulli et al. (2017)
Sensors (Basel)	Garcia-Font et al. (2017)
Social Science Computer Review	Popham et al. (2020)
Sustainability	Expósito López et al. (2019); Lim and Taeihagh (2019); Lombardi et al. (2017); Lytras and Visvizi (2018); Yang (2019)
Sustainable Cities and Society	Cellina et al. (2020); Dagher et al. (2018); Mattoni et al. (2015); Nicolas et al. (2020); Silva et al. (2018)
Sustainable Development	Khan et al. (2020)
Technological Forecasting and Social Change	Corsini et al. (2019); Islam et al. (2020); Kummitha (2018); Trencher (2019); Wang et al. (2019)
Technovation	Paskaleva and Cooper (2018)
Telecommunications Policy	Anand and Navío-Marco (2018); Sangki (2018); Vu and Hartley (2018)
The Electricity Journal	Li and Shahidehpour (2017)
Urban Policy and Research	Barns et al. (2017)
Urban Research & Practice	Cowley et al. (2018)
Urban Studies	Spicer et al. (2019)
Waste Management	Esmaeilian et al. (2018)

(continued)

Table 2. (continued)

Title of publication venue	Corresponding publication
Conference Proceedings	
18th IFAC Conference on Technology, Culture, and International Stability	Kobza and Hermanowicz (2018)
2016 1st International Workshop on Science of Smart City Operations and Platforms Engineering (SCOPE) in partnership with Global City Teams Challenge	Rhee (2016)
2017 27th International Telecommunication Networks and Applications Conference (ITNAC)	Elsaeidy et al. (2017)
2017 9th International Workshop on Resilient Networks Design and Modeling (RNDM)	Sterbenz (2017)
2017 IEEE 19th International Conference on High Performance Computing and Communications; IEEE 15th International Conference on Smart City; IEEE 3rd International Conference on Data Science and Systems (HPCC/SmartCity/DSS)	Marchiori (2017)
2017 IEEE SmartWorld, Ubiquitous Intelligence & Computing, Advanced & Trusted Computed, Scalable Computing & Communications, Cloud & Big Data Computing, Internet of People and Smart City Innovation	Naphade et al. (2017); Sandnes et al. (2017)
2018 14th International Wireless Communications & Mobile Computing Conference (IWCMC)	Vaidya and Mouftah (2018)
2018 21st Saudi Computer Society National Computer Conference (NCC)	Subasi et al. (2018)
2018 3rd Technology Innovation Management and Engineering Science International Conference (TIMES-iCON)	Chen et al. (2018)
2018 4th International Conference on Universal Village (UV)	De Aguiar et al. (2018)
2018 6th International Conference on Future Internet of Things and Cloud Workshops (FiCloudW)	Alromaihi et al. (2018)
2018 IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData)	Desai et al. (2018)

(continued)

Table 2. (continued)

Title of publication venue	Corresponding publication
2018 IEEE International Conference on Smart Computing (SMARTCOMP)	Burns et al. (2018)
2018 IEEE/ACS 15th International Conference on Computer Systems and Applications (AICCSA)	Morrissett and Abdelwahed (2018)
2018 IEEE/ACS 15th International Conference on Computer Systems and Applications (AICCSA)	Morrissett and Abdelwahed (2018)
2018 International Conference and Exposition on Electrical and Power Engineering (EPE)	Picioroagă et al. (2018)
2018 International Conference on Smart Systems and Inventive Technology (ICSSIT)	Mary et al. (2018)
2019 CHI Conference on Human Factors in Computing Systems	Freeman et al. (2019); Heitlinger et al. (2019)
2019 Global IoT Summit (GIoTS)	Frauenberger (2019)
2019 IEEE 21st International Conference on High Performance Computing and Communications; IEEE 17th International Conference on Smart City; IEEE 5th International Conference on Data Science and Systems	Wu et al. (2019)
2019 IEEE/ACM 5th International Workshop on Software Engineering for Smart Cyber-Physical Systems (SEsCPS)	Barnaby (2019)
2019 International Conference on Information Management and Technology (ICIMTech)	Setyowati et al. (2019)
2nd International Conference on Smart Grid and Smart Cities (ICSGSC)	Lesperance et al. (2018)
2nd International Conference on Sustainable Engineering Techniques (ICSET 2019)	Alkanaani and Bahith (2019)
4th MEC International Conference on Big Data and Smart City (ICBDSC)	Guangul and Chala (2019)
CEUR Workshop Proceedings	Grieman (2019)
EVS26 International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium	Beeton (2012)
HCI 2018	Shreepriya et al. (2018)
ICIOT 2018	Tekinerdogan and Köksal (2018)
ICSR 2019	Yin et al. (2019)
IEEE International Smart Cities Conference (ISC2)	Tonekaboni et al. (2018)
Proceedings of the 10th Latin America Networking Conference	Ayora et al. (2018)

(continued)

Table 2. (continued)

Title of publication venue	Corresponding publication
Proceedings of the 12th International Conference on Theory and Practice of Electronic Governance	Ramos and Silva (2019)
Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age	Marzouki et al. (2018)
Proceedings of the 21st International Database Engineering & Applications Symposium on - IDEAS 2017	Costa and Santos (2017)
Proceedings of the 2nd ACM/EIGSCC Symposium on Smart Cities and Communities	Kendrick et al. (2019); Potoczny-Jones et al. (2019)
Proceedings of the 3rd International Conference on Internet of Things, Big Data and Security	Diallo et al. (2018)
Proceedings of the International Conferences ICT, Society, and Human Beings 2019; Connected Smart Cities 2019; and Web Based Communities and Social Media 2019	Mamay (2019)
The 20th World Multi-Conference on Systemics, Cybernetics and Informatics	Lom et al. (2016)
The 4th Conference on Sustainable Urban Mobility	Stefanouli and Economou (2019)
The International Conference on Industrial Engineering and Operations Management	Jayasena et al. (2019)
Books	
Building on Smart Cities Skills and Competences	Panagiotakopoulos et al. (2020)
Climate Change in Cities	Rajasekar et al. (2018)
Green Building in Developing Countries	Hui et al. (2020)
Living in the Internet of Things: Cybersecurity of the IoT	Madaan et al. (2018)
Smart Cities: Technologies and Models of Governance for Citizen Engagement	Manda and Backhouse (2019)
Smart Technologies for Smart Governments	Edelenbos et al. (2018)
Web 2.0 Technologies and Democratic Governance	Anthopoulos and Tougountzoglou (2012)

Phase 5: Thematic coding

The coding methodology employed in this study is based on the study developed by Gerli et al. (2022), drawing inspiration from Gioia et al. (2012). After conducting the full-text assessment, the selected publications were subjected to a rigorous three-level thematic coding process. Initially, all passages that provided empirical evidence on barriers to implementing smart city projects were extracted (first-level coding). This task, undertaken by the lead author, resulted in the identification of 58 distinct barriers. Subsequently, all co-authors devised second-level codes to categorise these barriers into themes and independently matched the identified barriers to their corresponding themes. After this independent analysis, the coders convened to compare their coded data, engaging in thorough discussions to achieve consensus on emerging patterns, themes, and relationships (Richards and Hemphill, 2018).

Upon aligning the first and second-level codes, they were linked to five macro-level categories proposed by Cinar et al. (2019, 2021), which we used as theoretical dimensions. This step was carried out individually by all authors, with the results compared and deliberated upon until unanimous agreement was reached. This coding strategy significantly enhanced the reliability and credibility of the study, enabling the analysis of an extensive dataset. Furthermore, it fostered a collaborative and participatory research environment by involving multiple coders and their cross-disciplinary backgrounds in the analytical process (Cascio et al., 2019).

Discussion of the findings

This section presents a comprehensive overview of the findings of the review process (see Table 3). Drawing on the coding process described in the final phase (Phase 5) of the systematic review, we structured a framework unfolding the aggregated dimensions identified by Cinar et al. (2019, 2021) into more detailed micro-level categories. These micro-level categories expose several challenges that municipalities need to mitigate when implementing smart city projects.

Organisational barriers

Under this category, four categories of barriers have been identified: failures in the strategy and vision, failures in leadership, failures in public procurement, and failures in data management. All these barriers reflect actions leading to the mismanagement of critical organisational issues with an impact on the delivery of individual projects and long-term digital strategies.

Failures in the strategy and vision. These barriers emerge since the early phases of smart city projects, during the development of smart city strategies and implementation plans. The reviewed studies highlighted that municipalities often struggle with the definition of long-term strategic and clear objectives and priorities (Angelidou, 2014; Janssen et al., 2019), as they tend to implement smart city projects without conducting ex-ante evaluation of the local needs that these initiatives should address (Vu and Hartley, 2018). This is exacerbated by the limited engagement of external stakeholders in strategic planning processes (Anand and Navío-Marco, 2018; Trivellato, 2017).

Furthermore, failures in strategy and vision have been associated with a lack of in-depth understanding of both technical and non-technical components in smart city

Table 3. Data structure: barriers to the implementation of smart city projects.

Barriers (first-level coding)	Meso-level categories (second-level coding)	Macro-level categories (third-level coding)	References
The lack of long-term strategic visions of clear objectives and priorities	Failures in the strategy and vision	Organizational barriers	Angelidou (2014); Vu and Hartley (2018); Janssen et al. (2019)
The limited engagement of external stakeholders in strategic planning processes			Trivellato (2017); Anand and Navío-Marco (2018)
The lack of in-depth understanding of both technical and non-technical components in smart city projects			Nicolas et al. (2020); Mamay (2019); Anand and Navío-Marco (2018); Frauenberger (2019)
The limited consideration for ethical and societal values in the planning process			Trivellato (2017); Yigitcanlar et al. (2019)
Prioritising technological advancements over local needs			Joss et al. (2017); Reed and Keech (2019)
The lack of consideration for the local context			Lee et al. (2017)
The lack of effective leadership	Failures in leadership		Wang et al. (2019); Trivellato (2017)
Adopting a top-down and rigid leadership styles			Marek et al. (2017); Crampton et al. (2019); Reed and Keech (2019); Wang et al. (2019); Bjørner (2021)
Unexpected delays in the completion of projects			Khan et al. (2020)
Wrong budget estimations			Mamay (2019)
Excessively complex public procurement frameworks	Failures in public procurement		Lom et al. (2016)
The limited options provided by technology providers			Silva et al. (2018); Lombardi et al. (2017); Almeshaiei et al. (2020)
The lack effective methods to manage the amount of data generated by smart city projects	Failures in data management		Ahmed et al. (2017); Costa and Santos (2017); Kabáč et al. (2017); Valerio et al. (2017); Escamilla-Ambrosio et al. (2018); Kummitha (2018); Park et al. (2019); Setyowati et al. (2019); Nelson et al. (2019); Tonekaboni et al. (2018)
Difficulties in integrating existing datasets in project activities			Ayora et al. (2018); Rodrigues et al. (2018); Ma and Lam (2019)

(continued)

Table 3. (continued)

Barriers (first-level coding)	Meso-level categories (second-level coding)	Macro-level categories (third-level coding)	References
Ineffective collaboration between public and private actors	Failures in stakeholder collaboration	Interaction-specific barriers	Sandulli et al. (2017); Sangki (2018)
The limited coordination amongst project partners			Lu et al. (2018); Manda and Backhouse (2019)
Poor synergies amongst public sector organisations			Gil-Garcia (2012)
The lack of effective collaborative tools			Paskaleva and Cooper (2018); Cellina et al. (2020)
Tensions amongst project partners			Manda and Backhouse (2019); Gil-Garcia (2012); Ruhlandt (2018)
The unwillingness of private organisations to participate in project activities			Rana et al. (2019); Sangki (2018); Sandulli et al. (2017); Spicer et al. (2019)
The lack of adequate protocols sharing of data between projects partners			Sangki (2018); Desai et al. (2018)
The unwillingness of project partners to collaborate with end-users			Ma and Lam (2019); Marsal-Llacuna (2019); Heitlinger et al. (2019); Gupta et al. (2019)
The low responsiveness of end-users to engagement efforts			Marzouki et al. (2018); Mueller et al. (2018); Corsini et al. (2019); McKenna (2019); Freeman et al. (2019)
The limited trust and accountability in the public sector			Manda and Backhouse (2019); Potoczny-Jones et al. (2019); Rana et al. (2019); Rinik (2019); Matheus et al. (2020)
The use of unsuitable project management practices	Failures in project implementation		Alkanaani and Bahith (2019); De Aguiar et al. (2018)
The lack of adequate benchmarking tools and metrics to evaluate the long-term viability of smart city projects			Anthopoulos and Tougountzoglou (2012); Lombardi et al. (2017); Pereira et al. (2018); Nelson et al. (2019); Yin et al. (2019); Wang et al. (2019)

(continued)

Table 3. (continued)

Barriers (first-level coding)	Meso-level categories (second-level coding)	Macro-level categories (third-level coding)	References
The lack of coordination in the supply chain of the technological components for smart city projects	Failures in the market structure	Contextual barriers	Rhee (2016)
The high concentration of technology markets, which remain dominated by few large providers			Anand and Navío-Marco (2018)
The limited capability of technology suppliers to provide tailored solutions			Beeton (2012)
The lack of political support	Failures in the political system		Musakwa (2017); Addae et al. (2019); Mosannenzadeh et al. (2017)
Unsuitable or missing national and local policies and guidelines to support the implementation of local projects			Tekin Bilbil (2017); Barns et al. (2017); Praharaj et al. (2018); Faisal et al. (2019); Trencher (2019); Maccani et al. (2020)
Authoritarian governmental practices			Cowley et al. (2018); Leigh (2017)
The insufficient consideration for inequalities and social inclusion			Shreepriya et al. (2018); Rajasekar et al. (2018)
The excessive privatisation of public services			Frauenberger (2019); Perng (2019)
Political instability			Addae et al. (2019)
Regulatory uncertainty stemming from the lack of clear regulatory frameworks	Shortcomings of the public administration		Cowley et al. (2018); Addae et al. (2019); Marsal-Llacuna (2019); Rana et al. (2019)
Existing regulations hindering technological development			Setyowati et al. (2019)
Funding requirements setting conditions that negatively affect smart city projects			Jayasena et al. (2019)
Organisational silos within public sector organisations			Rajasekar et al. (2018); Argento et al. (2019)

(continued)

Table 3. (continued)

Barriers (first-level coding)	Meso-level categories (second-level coding)	Macro-level categories (third-level coding)	References
The limited availability or quality of adequate infrastructures	Shortcomings in the enabling infrastructure	Resource-related barriers	Addae et al. (2019); Spicer et al. (2019); Von Wielligh et al. (2018); Chen et al. (2018); Morrissett and Abdelwahed (2018)
The limited resilience of the IT infrastructure to the natural and man-made disasters			Colding and Barthel (2017); Diallo et al. (2018); Alabady et al. (2018); Sterbenz (2017); Garcia-Font et al. (2017); Elsaeidy et al. (2017); Mylrea (2017); Alromaihi et al. (2018); Pan et al. (2019); Li and Shahidehpour (2017); Subasi et al. (2018)
The limited availability of advanced skills and expertise within the workforce in public organisations	The lack of skills and knowledge		Panagiotakopoulos et al. (2020); Musakwa (2017); Adapa (2018); Gianni et al. (2019); Alkanaani and Bahith (2019); Rana et al. (2019); Ma and Lam (2019); Expósito López et al. (2019); Nicolas et al. (2020); Popham et al. (2020)
The insufficient digital literacy of end-users			Lytras and Visvizi (2018); Masucci et al. (2019); Musakwa (2017); Popham et al. (2020)
Ineffective coordination procedures	Shortcomings of supportive tools		Lin et al. (2015); Paskaleva and Cooper (2018); Ruhlandt (2018); Frauenberger (2019)
The use of ineffective risk and performance management instruments			Mattoni et al. (2015); Picioroagă et al. (2018); Nicolas et al. (2020)
Insufficient funding	Lack of funding		Adapa (2018); Meijer and Thaens (2018)
The limited financial capacity of partner organizations			Von Wielligh et al. (2018)
Insufficient private sector investments in smart city projects			Liborio et al. (2018)
High acquisition and maintenance costs of smart city technologies deployed as part of projects	Financial burdens of technology		Marchiori (2017); Yao et al. (2017); Lesperance et al. (2018); Liborio et al. (2018); Mary et al. (2018); Vieira and Alvaro (2018); Chinnaswamy et al. (2019); Guangul and Chala (2019); Hui et al. (2020); Yang (2019)
High cost to acquire, run and maintain open datasets			Vaidya and Mouftah (2018); Gupta et al. (2019); Kendrick et al. (2019); Matheus et al. (2020)

(continued)

Table 3. (continued)

Barriers (first-level coding)	Meso-level categories (second-level coding)	Macro-level categories (third-level coding)	References
The limited interoperability and user friendliness of digital technologies	Shortcomings in the design of technology	Technology-specific barriers	Ma and Lam (2019); Sandnes et al. (2017); Tekinerdogan and Köksal (2018); Burns et al. (2018); Barnaby (2019)
The high energy consumption of smart technologies and the lack of automation in data processing			Naphade et al. (2017); Wu et al. (2019); Ye et al. (2019); Xiao et al. (2018)
Inefficient regulations and guidelines on smart city technologies (including data privacy regulations)	Shortcomings in the regulation of technology		Jewell (2018); Patel and Doshi (2019); Edelenbos et al. (2018); Mylrea (2017); Ramos and Silva (2019); Vitunskaite et al. (2019); Ruhlandt (2018); Stefanouli and Economou (2019); De Wijs et al. (2016); Yang and Xu (2018); Grieman (2019); Ma et al. (2018); Qiu et al. (2017); Dagher et al. (2018)
The lack of ad hoc regulations to address ethical concerns in the use of algorithmic decision-making			Lim and Taeihagh (2019); Brady (2019)
The lack of holistic data regulations			Mylrea (2017); Qiu et al. (2017); Dagher et al. (2018); Madaan et al. (2018); Desai et al. (2018); Bates et al. (2018)
The lack of full rounded business models and viable scale-up strategies	Gaps in the business models		Esmaeilian et al. (2018); Belanche-Gracia et al. (2015); Li and Liao (2018); Lim et al. (2018)
Difficulties in responding to end-users' needs			Dilawar et al. (2018); Rajasekar et al. (2018); Kobza and Hermanowicz (2018)
Technical and functional difficulties disincentivising end-users to adopt smart technologies introduced in smart city projects			Peng et al. (2017)

projects (Nicolas et al., 2020), owing to the absence of appropriate data and metrics to evaluate the outcomes of these initiatives and map potential obstacles to their implementation (Anand and Navío-Marco, 2018; Mamay, 2019). This is again aggravated by the limited involvement of external stakeholders in strategic planning processes, due to the lack of negotiation spaces for local governments, industry partners, and other local actors to shape together the design of smart cities (Frauenberger, 2019).

Several studies have also evidenced the limited consideration for ethical and societal values in the planning process (Trivellato, 2017; Yigitcanlar et al., 2019), as local institutions driving deployment of smart city technologies tend to prioritise technological advancements over local needs (Joss et al., 2017; Reed and Keech, 2019). According to Joss et al. (2017) this reflects a lack of clarity in strategic plans and guidelines regarding the role citizens should play in smart city development. Conversely, Lee et al. (2017) related this lack of consideration for the local context to land use aspects, suggesting that urban transformations induced by industrial activities, infrastructural projects, and migration should be better reflected in technological choices embedded in smart city plans.

Failures in leadership. The reviewed literature discussed several barriers emerging when local governments fail to effectively exert their leadership over smart city projects, as they tend to adopt top-down and rigid leadership styles that discourage the participation of local stakeholders to smart city developments and constrain the application of collaborative methods for the design of smart city solutions (Trivellato, 2017; Wang et al., 2019). Scholars have also linked this barrier to the techno-centric views dominating smart city narratives, which push local governments to implement smart technologies with little consideration for the needs of local communities (Bjørner, 2021; Crampton et al., 2019; Reed and Keech, 2019), thereby causing a misalignment between the expectations of local stakeholders and the outcomes of smart city projects (Marek et al., 2017).

Additionally, from the review it emerged that leadership failures may result in unexpected delays in the completion of smart city projects due to the inability of local leaders to deal with financial constraints (Khan et al., 2020), red tape and corruption (Adapa, 2018). Even when leaders manage to secure sufficient financial resources, the literature evidenced that smart city projects may suffer from wrong budget estimations stemming from the lack of robust metrics and tools to pre-assess the capital requirements of these initiatives and to track their ongoing expenditure (Mamay, 2019).

Failures in public procurement. Smart city developments are also affected by failures in public procurement processes. The revised publications highlighted that many municipalities struggle to comply with public procurement frameworks, which have become excessively complex (Lom et al., 2016). Moreover, the limited options provided by technology providers are augmenting the risks associated with the procurement of smart city technologies (Almeshaiei et al., 2020; Silva et al., 2018). As a result, public sector organisations often fail to procure the technological solutions that are more suitable for their local projects; this is more likely to happen when municipalities are not equipped with a clear criteria and decision-making processes for technology selection (Lombardi et al., 2017).

Failures in data management. Likewise, the literature shows that local governments often lack effective methods to manage the data generated by smart city projects, due to the absence of adequate information systems and advanced technical skills (Kummitha, 2018; Setyowati et al., 2019) to manage the storage and analysis of big data collected through sensors and other sources (Ahmed et al., 2017; Costa and Santos, 2017; Kabáč et al., 2017; Park et al., 2019). Furthermore, the effective management of data is also compromised by the limited capacity and technical faults of data infrastructures and sensing devices in use within municipal governments (Escamilla-Ambrosio et al., 2018; Nelson et al., 2019; Tonekaboni et al., 2018; Valerio et al., 2017).

Municipalities also encounter difficulties in integrating existing datasets because of legacy systems that are vendor-specific and not designed to collect and integrate data from multiple subjects (Ayora et al., 2018; Rodrigues et al., 2018). This is exacerbated by the lack of technical standards for the interoperability of data originating from different sources (Ma and Lam, 2019).

Interaction-specific barriers

Under this category, two types of barriers have been identified: Failures in stakeholder collaboration and failures in project implementation. Both barriers reflect ineffective actions (or inactions) by municipal governments, resulting in the mismanagement of multi-stakeholder collaborations (that are vital for the completion of smart city projects and to boost their acceptance among local communities).

Failures in stakeholder collaboration. The reviewed literature has widely documented that municipal governments and their partners often struggle to successfully collaborate in smart city projects. While more emphasis has been placed on ineffective collaborations between public and private actors (Sandulli et al., 2017; Sangki, 2018), poor synergies amongst public sector organisations have also been reported (Gil-Garcia, 2012).

One major challenge faced in the context of smart city developments is the limited coordination amongst project partners. This may reflect the inadequacies of the contracts in place between the parties (Lu et al., 2018; Manda and Backhouse, 2019) but can also be associated with the lack of effective collaborative tools to sustain smart city projects (Paskaleva and Cooper, 2018). The review clarified that municipalities are either unfamiliar with such tools or unaware of their potential (Cellina et al., 2020). The studies in the sample also evidenced the existence of specific barriers to data-sharing between projects partners, as municipal governments and their counterparts grapple with the definition of protocols achieving fairness, integrity and security in data sharing practices (Desai et al., 2018; Sangki, 2018).

Moreover, failures in stakeholder collaboration have been linked to existing tensions amongst project partners, which in turn derive from power asymmetries and the conflicting interests existing between different stakeholders (Gil-Garcia, 2012; Manda and Backhouse, 2019; Ruhlandt, 2018). Some studies have also reported the unwillingness of private organisations to participate in smart city projects (Rana et al., 2019; Sangki, 2018) when public sector organisations lack advanced technical, managerial and infrastructural capabilities or there is limited political support for long-term partnerships (Sandulli et al., 2017; Spicer et al., 2019). Likewise, the revised studies have identified several constraints to the participation of end-users in smart city projects. From the analysis it emerged that the main obstacles to their engagement are the unwillingness of project partners to collaborate with end-users and the low responsiveness of end-users to engagement efforts. The former has been observed in public sector organisations with a risk-averse culture (Ma and Lam, 2019) or in the contexts dominated by the top-down delivery of international and local agendas for urban sustainable developments (Gupta et al., 2019; Heitlinger et al., 2019; Marsal-Llacuna, 2019).

Increasing efforts to boost the participation of residents in smart city projects are being made by municipal governments worldwide, yet the empirical research examined in this paper shows a limited interest of end-users to engage with these initiatives (Corsini et al., 2019; Marzouki et al., 2018; Mueller et al., 2018). Such behaviour has been associated with a lack of awareness on participatory methods among local communities, a more generic fear of technology and the limited trialability of smart city solutions (Freeman et al., 2019; McKenna, 2019). Furthermore, the revised literature has evidenced how the willingness of local communities to engage in smart city projects is affected by their limited trust and accountability in the public sector which, in turn, reflect widespread concerns of residents on the risks that smart cities pose to data privacy and security (Potoczny-Jones et al., 2019; Rana et al., 2019; Rinik, 2019). Additionally, the trust of citizens was found to decrease when public organisations "cannot deliver a proper level of public services" (Matheus et al., 2020: 6) and fail to fulfil their promises (Manda and Backhouse, 2019).

Failures in project implementation. Alongside collaborative tensions between municipal governments and their partners, failures can also occur in the implementation of smart city projects because of poor managerial practices and tools. In particular, the review highlighted that the use of unsuitable project management practices is still common. Municipal governments frequently apply traditional management practices that are unsuitable for the implementation of complex socio-technical projects, such as smart city developments (Alkaani and Bahith, 2019). However, even when innovative methods are adopted, public managers were found to rush the prototyping of smart city solutions without fully considering critical concerns regarding their usability, security, and efficiency (De Aguiar et al., 2018).

Moreover, implementation failures have been associated with the lack of adequate benchmarking tools and metrics to evaluate the long-term viability of smart city projects (Anthopoulos and Tougountzoglou, 2012; Pereira et al., 2018). Existing frameworks have emerged as ineffective to handle the complex and multifaceted nature of smart city developments (Lombardi et al., 2017). Plus, there is lack of consensus on how smart city developments should be monitored and evaluated (Nelson et al., 2019). This lack of comprehensive benchmarking and assessment frameworks undermine the efficient management of ongoing projects (Yin et al., 2019) but also compromise the ability of municipal governments to learn from past experiences and boost effectiveness of future decision-making processes (Wang et al., 2019).

Contextual barriers

The review revealed that contextual barriers to smart city developments can be associated with failures in markets and political systems, as well as shortcomings of the public administration. While much emphasis has been placed on contextual barriers related to the structure and functioning of the public sector, market failures were less frequently debated and analysed in the revised publications.

Failures in the market structure. The few papers discussing these barriers highlighted the lack of coordination in the supply chain of the technological components for smart city projects (Rhee, 2016). The absence of coordination between supply chain parties happens due to several reasons and scalability and replicability of smart city projects are constrained as a result. Rhee (2016) argued that the tailored nature of smart city projects limits the scalability of successful project being implemented in multiple locations due to the lack of collaborative approach to learning from existing examples and adopting similar technologies in new smart city initiatives. Next, existing physical infrastructure that facilitates the implementation of smart city technologies differs in the degree of availability and quality. This is another reason for not being able to coordinate in producing and implementing scalable and replicable smart city technologies. On the other hand, our review also evidenced the limited capability of technology suppliers to provide tailored solutions as a barrier. Beeton (2012) argued that it is mainly because of the high costs associated with developing place-based smart city applications. It must be noted, however, that Rhee (2016) argued against placing excessive emphasis on tailored digital solutions, as this contributes to the fragmentation of smart city technologies and undermine their scalability.

Our review identified that the high concentration of technology markets, which remain dominated by few large providers also restrains the scalability and economic viability of smart city projects. According to Anand and Navíco-Marco (2018), few players that dominate the market cause monopolistic competition. This diminishes the power of local authorities in negotiating for affordable and yet effective technologies to be implemented, especially in the Global South.

Failures in the political system. More frequently than market failures, the literature has discussed how failures in the political system can directly affect smart city development. First, smart city projects are severely affected by a lack of political support from elected officials and political figures, which results in suboptimal levels of investment (Addae et al., 2019), and a misalignment between local initiatives and national policies or standards (Faisal et al., 2019; Musakwa, 2017). Mosannenzadeh et al. (2017) identified two main reasons that cause the lack of political support. First, it may occur due to changes in local authorities as they may not be re-elected once their terms are over, and second, the authors highlighted that the involvement of relevant policy makers in local and regional levels may reduce the likelihood of the support coming from political actors. Political support may be influenced by political instability, another major barrier often discussed in the smart city literature, which remarked that frequent changes in the political leadership drive private investors away from smart city projects and undermine the continuity and sustainability of these initiatives (Addae et al., 2019). Also, political instability indicates the absence of the ability of authorities in establishing long-term policies which will help to promote and scale up smart city projects (Addae et al., 2019).

Furthermore, scholars have highlighted that smart city initiatives often suffer from unsuitable or missing national and local policies and guidelines to support the implementation of local projects. According to Faisal et al. (2019), the complexity of urban digital transformations partially explains why national and local governments struggle to develop adequate policies to govern smart city transitions. As a result, policy interventions are often fragmented, failing to provide a comprehensive regulatory oversight while procurement policies tend to negatively affect the participation of external stakeholders by setting requirements that are not suitable for innovative projects (Barns et al., 2017; Maccani et al., 2020). The findings of Maccani et al. (2020) show that long tendering processes arising from rigid public procurement framework where long bureaucratic processes need to be followed, restricts full implementation of projects and these projects often do not continue after piloting stages are completed. Moreover, in contexts characterised by authoritarian governmental practices, smart city policies and regulations tend to neglect the potential contribution of external stakeholders, especially citizens and community groups (Cowley et al., 2018; Leigh, 2017; Trencher, 2019). In general, the reviewed publications highlighted that national governments are more likely to follow top-down approaches when developing smart city policies (Praharaj et al., 2018; Tekin Bilbil, 2017). Conversely, scholars have stressed that participatory approaches to smart city planning and implementation could help address the insufficient consideration for inequalities and social inclusion currently observed in both national and local initiatives (Rajasekar et al., 2018; Shreepriya et al., 2018). Participatory approaches should not only consider local communities as part of the bottom-up development and implementation processes but also need to involve technology providers and all relevant public sector organisations beginning from the earliest development phases of smart city projects (Trencher, 2019). This can enable policy makers to address potential venues that require policy interventions as well as a common set of policies for design, testing, and implementation of smart city technologies (Faisal et al., 2019). Some authors have also argued that the excessive privatisation of public services is negatively affecting the extent to which smart city projects are inclusive, democratic, and responsive to the needs of local communities (Frauenberger, 2019; Perng, 2019).

Shortcomings of the public administration. Additional contextual barriers emerging from the literature can be classified as shortcomings in the organisational structures and decision-making processes of public sector organisations. Several studies highlighted the consequences of regulatory uncertainty, stemming from the lack of clear and stable regulatory frameworks. The limited coordination and integration of complementary policies and regulations results in ambiguous policy directions undermining both the political and financial support for smart city projects (Addae et al., 2019; Cowley et al., 2018; Marsal-Llacuna, 2019; Rana et al., 2019).

The reviewed publications also highlighted that existing regulations may hinder technological development because of their stringent, onerous, and obsolete requirements (Setyowati et al., 2019). Similarly, funding schemes in support of smart city developments were often found to set timeframes or financial thresholds that force municipal governments to exclude peripheral and deprived neighbourhoods from the perimeter of smart city projects (Jayasena et al., 2019). Finally, the organisational silos existing within public sector organisations were regularly cited among the barriers compromising the cooperation between government departments and agencies involved in digital transformations processes (Argento et al., 2019; Rajasekar et al., 2018).

Resource-related barriers

Four categories belong to this category: shortcomings in the enabling infrastructures, lack of skills and knowledge, shortcomings of supportive tools, and lack of funding. All these barriers have critical implications for the long-term viability and scalability of smart city projects, and are affected by economic, cultural, and political contingencies specific to urban contexts.

Shortcomings in the enabling infrastructures. Scholars agreed that robust infrastructures need to be in place for smart city deployments to succeed (Islam et al., 2020). However, many cities were found to suffer from the limited availability or quality of adequate infrastructures, especially in economically deprived areas (Addae et al., 2019; Spicer et al., 2019; Von Wielligh et al., 2018). These include both digital and non-digital infrastructures: for instance, Chen et al. (2018) showed that the adoption of smart and sustainable mobility services is constrained by the insufficient capacity of existing energy networks. Likewise, it was noted that smart city projects are often developed without fully considering the capacity of existing digital infrastructures to cope with increasing amounts of data sources and connected devices (Ma and Lam, 2019; Morrissett and Abdelwahed, 2018).

Another issue emerging from the literature is the limited resilience of urban infrastructures to both natural and man-made disasters, such as cyberattacks and civil disorders (Alabady et al., 2018; Colding and Barthel, 2017; Diallo et al., 2018). By interconnecting different infrastructures together, smart city systems may increase their vulnerability (Colding and Barthel, 2017; Garcia-Font et al., 2017; Sterbenz, 2017). Such risks are exacerbated by the lack of sophisticated detection and defensive mechanisms (Alromaihi et al., 2018; Elsaeidy et al., 2017; Mylrea, 2017; Pan et al., 2019), leaving smart infrastructures more exposed to cyber threats (Li and Shahidehpour, 2017; Pan et al., 2019; Subasi et al., 2018).

Lack of skills and knowledge. Alongside the integration of multiple physical infrastructures, smart city developments also rely on the combination of alternative skillsets and competencies, whose scarcity has emerged as a major resource-related barrier in the revised literature. First, researchers evidenced the limited availability of advanced skills and expertise within the workforce in public organisations, caused by gaps in the curricula

Table 4. Further research questions identified per macro level of barriers.

Framework component	Summary of the findings	Relevant areas for future research enquiries
Organisational Barriers (Failures in the strategy and vision, failures in leadership, failures in public procurement, and failures in data management.)	Local authorities lack understanding of both the technical and non-technical components in smart city projects; therefore, they tend to follow a technocratic approach and are unable to innovate their existing processes (e.g. for procurement and data government), as well as leadership practices.	• What are the most effective approaches for developing cohesive and dynamic strategies that encompass both technical and non-technical aspects of digital transformation in smarty city projects? • How can the monitoring and execution of smart city strategies be performed, considering both technical and non-technical factors? • What leadership styles are more effective in the context of smart city projects? • How can public leadership be nurtured to foster more sustainable, inclusive, and resilient smart city projects? • What methods can be employed to enhance agility and innovation in public procurement, while still preserving market competition and ensuring efficient use of public funds? • How can public procurement be harnessed as a platform for value co-creation? • What data governance practices work best in for smart city projects within the public sector? • How can data governance and procurement practices be updated to more effectively manage the forthcoming challenges associated with emerging technologies, such as AI?

(continued)

Table 4. (continued)

Framework component	Summary of the findings	Relevant areas for future research enquiries
Interaction-specific Barriers (Failures in stakeholder collaboration; failures in project implementation).	Local authorities struggle to form effective partnerships, encompassing all stakeholders affected by digital transformation projects. Existing project management practices are not suitable to deal with specific issues emerging in digital transformation projects (e.g., data sharing).	• What formal and informal agreements are more suitable to foster successful partnerships in the context of smart city projects? • How can local actors, including residents and community members, be encouraged to participate in the implementation of smart city initiatives? • What strategies can be employed to effectively promote collaboration among stakeholders across different sectors (including but not limited to public organisations and private companies)? • Why are project management practices ineffective when applied to smart city projects in the public sector? • What methodologies and tools can be leveraged to improve the implementation and evaluation of smart city projects within the public sector?

(continued)

Table 4. (continued)

Framework component	Summary of the findings	Relevant areas for future research enquiries
Contextual Barriers (failures in markets, failures in political shortcomings of the public administration)	Whereas much emphasis has been placed on contextual barriers related to the structure and functioning of the public sector, market failures were less frequently debated and analysed in the revised publications.	• What strategies can be employed to mitigate the impacts that failures in global supply chains have on local smart city projects? • How can public procurement boost competition among technology suppliers? • What approaches can be adopted to promote the development of scalable digital solutions tailored to the specific needs of different public organisations? • How can public administration at multiple administrative levels prevent and/or mitigate the widening of socio-economic inequalities and the exacerbation of discriminations following the diffusion of emerging technologies? • How can the administrative structure of the public sector be reformed to enhance coordination among public organisations across different geographical levels? • How can smart city strategies be integrated in the political agendas of public leaders at different administrative levels? • How can alignment be ensured between the smart city project strategies devised by different public organisations? • In what ways do the impacts of existing contextual barriers differ among smart city projects based on their size, geographic scale, and focus?

(continued)

Table 4. (continued)

Framework component	Summary of the findings	Relevant areas for future research enquiries
Resource-related Barriers (shortcomings in the enabling infrastructures, lack of skills and knowledge, shortcomings of supportive tools, lack of funding).	These barriers have critical implications for the long-term viability and scalability of smart city projects, and are affected by economic, cultural, and political contingencies specific to urban contexts.	• What technical and non-technical skills are needed within public sector organisations to successfully manage smart city projects? • What are the most appropriate methods to bridge skills gaps within the public sector? • How can technological path dependencies within the public sector be addressed and their impact on smart city projects mitigated? • What management practices and tools can help public sector organisations to better manage the risk of smart city projects? • How can these tools and practices be developed and disseminated? • What financing models are available to fund smart city projects in the public sector? What are their socio-economic and political implications?

(continued)

Table 4. (continued)

Framework component	Summary of the findings	Relevant areas for future research enquiries
Technology-specific Barriers (financial burden of technology, shortcomings in the design of digital technologies, shortcomings in existing regulations, gaps in existing business models).	These barriers are associated with idiosyncrasies in the development and policymaking of digital technologies, issues that are not specific to public sector organisations but disproportionately affect them over other parties involved in digital transformation projects.	• How can public procurement be leveraged to enhance the user-friendliness and sustainability of digital technologies? • What financial and operational models are more suitable for the development and acquisition of emerging technologies by public sector organisations? • What strategic and operational tools can help to better plan and implement maintenance activities associated with smart city projects? • In what ways can and should public sector organisations contribute to the design of AI-enabled systems and other emerging technologies? • How can smart city projects in the public sector create value for all the stakeholders involved? How can this value be captured? • What strategies can be employed to enhance the technical and data interoperability of the digital technologies implemented within the public sector? • What regulatory approaches are more suitable to address the ethical concerns associated with emerging technologies? • What regulatory approaches are more likely to foster data access and sharing while simultaneously ensuring data protection and cybersecurity?

currently taught in higher education and the high cost of IT-related training (Expósito López et al., 2019; Musakwa, 2017; Rana et al., 2019). In contexts characterised by political instability, this may pose further constraints to the ability of local administrations to attract and retain professional profiles with advanced skills (Alkanaani and Bahith, 2019).

Outside the public sector, the insufficient digital literacy of end-users was often discussed as a barrier to the effective development of smart cities, as it affects the extent to which residents, businesses and other end-users can engage with and benefit from smart technologies (Lytras and Visvizi, 2018; Masucci et al., 2019). Some authors however contested that promoting digital skills does necessarily enhance the participation of residents to smart city projects (Masucci et al., 2019), rather they emphasised the importance of regular communications to boost the acceptance and engagement of residents (Masucci et al., 2019; Musakwa, 2017; Popham et al., 2020).

Both within and outside the public sector, the reviewed literature placed much emphasis on the shortage of digital skills. Yet gaps in managerial and legal competencies were also acknowledged and discussed (Nicolas et al., 2020; Panagiotakopoulos et al., 2020; Popham et al., 2020). For example, some studies reported that local administrations often struggle to comply with privacy regulations (Matheus et al., 2020) and to leverage the potential of open data initiatives (Ma and Lam, 2019) because of their low levels of data literacy.

Shortcomings of supportive tools. Another type of resource-related barriers concerns the supportive tools employed in smart city development, that is any tool and mechanism employed to facilitate the implementation of smart city projects. Limitations were first discussed in relation to coordination procedures and other tools utilised to orchestrate all involved parties, facilitate decision-making and transfer knowledge amongst them (Ruhlandt, 2018). Earlier studies shows that ineffective coordination procedures result from a lack of appropriate governance models and competences to manage the codesign and coproduction of smart city services (Frauenberger, 2019; Paskaleva and Cooper, 2018). Furthermore, the effectiveness of coordination mechanisms and participatory practices may be hindered by rigid hierarchies and bureaucratic controls (Lin et al., 2015).

Less frequently, the literature has explored the use of ineffective risk and performance management instruments. Scholars have highlighted the limited adoption, among municipal governments, of dedicated systems to assess either risks or the outcomes of smart city projects (Picioroagă et al., 2018). When monitoring whether effective performance measures are in place, the existing evidence suggests that the performance indicators and metrics applied are not sufficiently comprehensive and robust, hence providing only a partial and superficial overview of the impact of smart city developments (Mattoni et al., 2015; Nicolas et al., 2020).

Lack of funding. Insufficient funding recurred as a significant barrier across the different stages of smart city projects (Adapa, 2018). Municipal governments often struggle to source the start-up capital required for these initiatives as well as to establish viable sources of revenue that can guarantee their continuity in the long-term (Adapa, 2018; Meijer and Thaens, 2018). Limited financial capacity of partner organisations may pose additional constraints, especially in emerging economies (Von Wielligh et al., 2018). The reviewed publications also highlighted that private sector investments are often insufficient for infrastructural projects because of uncertainties regarding the sustainability of their financial and business models (Liborio et al., 2018).

Technology-specific barriers

Finally, some barriers experienced by smart city projects reflects idiosyncrasies in the design and economics of smart city technologies. These barriers also include shortcomings and gaps in the existing regulations and business models, specific to these technologies.

Financial burdens of technology. Deploying and maintaining smart city technologies entails a financial burden for municipal governments, which emerged as a major threat to the long-term sustainability of smart city initiatives (Chinnaswamy et al., 2019; Hui et al., 2020; Yao et al., 2017). High costs have been associated with both the acquisition and maintenance of smart city technologies (Guangul and Chala, 2019; Lesperance et al., 2018; Vieira and Alvaro, 2018; Yang, 2019), representing a major obstacle to their adoption and deployment in urban contexts (Marchiori, 2017). Uncertainties on the economic sustainability of these technologies could further increase the costs and risks of smart city deployment (Liborio et al., 2018; Mary et al., 2018).

Furthermore, scholars remarked the high cost to acquire, run and maintain open datasets (Gupta et al., 2019; Matheus et al., 2020). Trade-offs emerged between the cost and quality of sensors, whose costs is also affected by interoperability issues (Kendrick et al., 2019). Accordingly, open-source standards have been advocated for to cut the cost of smart city developments (Vaidya and Mouftah, 2018).

Shortcomings in the design of technology. The review also highlighted a series of barriers reflecting shortcomings in how smart city technologies are designed and manufactured. These include the limited interoperability and user friendliness of digital technologies, which depend on the accessibility of their interfaces (Ma and Lam, 2019; Sandnes et al., 2017) and extent to which they integrate with and adapt to existing devices already in use within the population (Barnaby, 2019; Tekinerdogan and Köksal, 2018)Not only do these issues affect the adoption and usage of digital solutions: they also have an impact on the security of smart city infrastructures (Burns et al., 2018).

Other design shortcomings frequently discussed are the high energy consumption of smart technologies and the lack of automation in data processing. The former echoes growing concerns on the energy efficiency of sensors and IOT networks (Wu et al., 2019; Ye et al., 2019). The latter refers to the lack of autonomous systems for data cleansing and labelling (Xiao et al., 2018), as well as the limited diffusion of trained models and machine learning techniques for the real-time analysis of urban data (Naphade et al., 2017).

Shortcomings in the regulation of technology. Additional shortcomings were discussed in relation to how smart city technologies are (or are not) regulated (Jewell, 2018; Patel and Doshi, 2019). In the reviewed literature, existing regulations and guidelines on smart city technologies (including data privacy regulations) have been depicted as inefficient or patchy, because they fail to define clear roles and responsibilities within and across different organisations (Edelenbos et al., 2018; Mylrea, 2017; Ramos and Silva, 2019; Ruhlandt, 2018; Stefanouli and Economou, 2019; Vitunskaite et al., 2019). Furthermore, they have been criticised for offering ineffective and incomplete responses to the threats and risks associated with citywide deployments of digital technologies (De Wijs et al., 2016; Grieman, 2019; Yang and Xu, 2018), for example, in the context of autonomous vehicles (Mylrea, 2017) and wireless sensor networks (Dagher et al., 2018; Ma et al., 2018; Qiu et al., 2017).

Earlier studies have also denounced the lack of ad hoc regulations to address ethical concerns in the use of algorithmic decision-making (Brady, 2019; Lim and Taeihagh, 2019). The lack of holistic data regulations has equally been discussed as a disincentive to data sharing (Bates et al., 2018; Dagher et al., 2018; Desai et al., 2018; Madaan et al., 2018).

Gaps in the business models. Finally, the review evidenced a lack of fully rounded business models and viable scale-up strategies for smart city projects (Esmaeilian et al., 2018), which compromises the development of long-lasting partnerships and results in the early discontinuation of many of these initiatives (Belanche-Gracia et al., 2015; Li and Liao, 2018; Lim et al., 2018).

Moreover, the publications analysed in this paper showed that the business models currently adopted in smart city projects often struggle with responding to end-users' needs because of budget constraints and a lack of flexibility (Dilawar et al., 2018; Rajasekar et al., 2018). The predominance of market-driven and top-down approaches further push municipal governments to implement smart city solutions without understanding the specific problems of different groups of users living in their areas (Kobza and Hermanowicz, 2018). In some cases, technical and functional difficulties experienced by end-users were also found to disincentivise the adoption of smart technologies (Peng et al., 2017), thereby compromising the sustainability of their business models.

Discussion and conclusions

Our findings provide additional insights into the barriers experienced by municipal governments promoting smart city development. Within each of the categories outlined by Cinar et al. (2019, 2021) we identified three typologies (failures, gaps, and shortcomings), reflecting the composite nature of the barriers hindering innovation in public sector. Drawing on these findings, we articulate a set of theoretical and practical implications, presented in the following subsections. These are followed by a series of recommendations for future research on PSI.

Theoretical contributions

Cinar et al. (2019: 284) state that "*the nature of barriers is complicated and not well understood, although there has been a general perception that the barriers to public sector innovation are well studied*". Our review builds on this observation; it contributes to bridging this gap by offering a more nuanced and comprehensive framing of the barriers to innovation that public sector organisations might experience, with a focus on the fast-growing domain of smart city projects. The theoretical implications of this study are likely to benefit scholars across different domains, adding to the literature on PSI and smart city transitions.

The existing systematic literature reviews that investigate barriers to PSI focus on public sector as a whole and they present barriers without focusing on a specific administration level (Cinar et al., 2019, 2021). In this study, we only consider the perspective of local governments, using smart city project development as our empirical setting. Several studies stressed the importance of studying barriers to digital transformations at the level of local governments. This call is structured upon three interrelated reasons, which highlight the growing centrality of local governments in smart city development practices. First, local governments act as *"the pivot of the network of actors that can take a role in implementing smart cities projects"* (Sancino and Hudson, 2020: 716) and have the autonomy to implement technological innovation policies and administrative reforms (Weißmüller et al., 2023). Second, local governments often represent the initiator of smart city projects (De Vries et al., 2016). Third, local governments have become more entrepreneurial, with innovation that has become a means to fight poor fiscal health in the face of a growing demand for services (Andrews et al., 2021), to manage New Public Management reforms (Cinar et al., 2022; De Vries et al., 2016), and to adapt nationally developed digital transformation programmes to local-context conditions (De Vries, 2018; Nicolas et al., 2020).

Focusing on the smart city literature enabled us to gain additional insights into the barriers that public sector organisations face when developing these initiatives. Our findings support some of the findings of Mora et al. (2023), in which the authors highlighted the strengths and weaknesses in the current approaches to the governance of smart city transitions. The authors identified several challenges in relation with administrative structures, internal capabilities, technological innovation policies, implementation strategies, collaborative tools and spaces, cross-sector partnerships, technical regulations and standards, and business models (Mora et al., 2023). These findings are aligned with several barriers we identified in this systematic literature review regarding the failures in strategy and vision, the shortcomings of the public administration, the failures in data management, the lack of skills and knowledge, the shortcomings in the supporting tools, the shortcomings in the regulation of technologies, and the gaps in business models.

Finally, our analysis provides a granular and nuanced categorisation of the barriers that local governments experience when implementing smart city projects. Through a systematic review of the literature, we identified 58 barriers (micro-level), which we grouped under the five macro categories presented by Cinar et al. (2019, 2021) in their studies on barriers to PSI. Generally, our analysis highlight that, within these macro categories, there coexists different types of barriers, which can be classified in failures, shortcomings, and gaps. Failures stem from actions that do not lead to the intended outcomes because of the mismanagement of existing tools and resources, or ineffective decision-making. Shortcomings result from faults and flaws in existing institutions or tools that should instead support PSI. Lacks reflect the absence of such resources, tools, and mechanisms. By distinguishing between these three typologies of barriers (failures, lacks and shortcomings), we respond to Criado et al. (2023: 12) call for "*a rigorous classification of the* *enablers and inhibitors of implementation*". These three typologies also help us understand the relative intensity of the barriers, which the existing taxonomies do not provide an indication about, and this understanding makes possible to configure appropriate mitigation strategies based on barriers' severity and strength (Rjab et al., 2023). The intensity of the barriers arises from the fact that whether capabilities, conditions and tools exist, or whether they are appropriate for initiating smart city projects or can nestle the required properties to initiate viable projects. In the case of the failures, it is a combination of non-existing capabilities and inappropriate actions, as well as tools. For the shortcomings, we observed that regulations, institutions, physical infrastructure, and technological capabilities are in place; however, they are either not sufficient to enable a smooth transition to smart city technologies or they do not address (issues arising due to the implementation of a new technology. Therefore, current regulations, institutional practices and infrastructure need to be reviewed and changed wherever is necessary. The lacks (or gaps) point to resources that do not exist but essential for starting smart city projects and being able to scale-up in the long term. Also, we focused on identifying the barriers that appear in the initial stages of smart city projects. Wang (2023: 2) highlighted that "*firms learn more effectively from early-stage failure experiences than from late-stage failure experiences*".

Practical contributions

Our findings also offer practical contributions for public sector officials and other stakeholders that work with local governments to initiate smart city projects. The practical contributions are enabled by implementing meso-level categories to capture the root causes of the identified barriers. We realised some of these barriers arise from the absence of required resources, expertise, or stakeholders to implement and operationalise smart city technologies, whilst other barriers arise from the mismanagement of existing resources, tools, and practices. Making this differentiation between problems will help local governments to create mitigation strategies and timelines that are realistic for solving these emerging issues identified through these barriers. Local authorities need realistic timelines more than ever because they work under immense resource pressures. It will help them to realise they will need more time to build resources and knowledge from scratch when they are not in place. Also, they will realise the timeline is different to building mitigation strategies when it comes to the barriers that focus on shortcomings, which may require a shorter period of time and resources to change/mitigate the existing practices. Smart city projects are complex and the identification of barriers will enable public sector officials to understand the complexities of their existing environments and to set-up the right conditions for a smooth implementation of smart city technologies (Criado et al., 2023). Although changing established and complex operational practices is difficult and requires the right skills, experience and cultural conditions, the results of the review can help critique, pause, and reset practice. This will be instrumental in offering cognitive resources for sustaining transformative learning and deep transitions driven by innovation efforts (Cole and Hagen, 2023).

Considering the findings of this review, several action plans can be developed in the following domains: (1) community-based problem-solving strategies, (2) risk management strategies, and (3) expertise development programs. These areas are identified as the most critical subjects that will help local authorities to re-focus their actions for predicting barriers as early as possible and mitigating any negative consequences of these barriers. Global trends in smart city implementations points in the direction towards adopting people-centred and inclusive approaches as a critical part of national policies and digital transformation agendas. However, Beckers et al. (2022) argued in the Global Smart City Governance Framework help local authorities that have difficulties in ensuring the active involvement of citizens in the initiation of smart city projects and one third or local authorities worldwide fall behind responding feedback they receive from their residents. The interaction-specific barriers along with the findings of Beckers et al. (2022) indicate that local authorities need to develop community-based problem solving strategies. Whilst it is crucial that citizens should participate in the design of smart city projects for a successful final product (Zarei and Nik-Bakht, 2021), local authorities, as well as national policy guidelines, need to acknowledge that cities have their own individual features (i.e., cultures, norms, challenges, lifestyles) that need to be considered when community based problem strategies are developed (Simonofski et al., 2021). It is inevitable that community based strategies and problem-solving mechanisms will be affected by various modes of governance (whether it is based on TPA, NPM or NPG) (Przeybilovicz et al., 2020); however, local authorities need to work on several topics that will become the essential pillars of community based problem solving strategies. This approach will also enable local authorities to embrace a structured approach towards managing their innovation which can reduce risk and uncertainty caused by implementation of new technologies. Local authorities need to identify and document engagement domains (i.e., environmental, social, political, or economic challenges), engagement goals (i.e., citizens' needs and priorities), engagement platforms (i.e., social media, games), and finally engagement incentives to attract the attention of citizens and to maximise value proposition for them (i.e., entertainment, community interaction, learning) (Zarei and Nik-Bakht, 2021).

Next, local authorities need effective risk management strategies because risk-averse nature of public sector organisations appear as one of the strongest barriers in the design and implementation of innovation projects (Cinar et al., 2019). Ideally, risk management strategies should provide local authorities with appropriate tools and knowledge for making situational analysis to continuously increase their awareness on current and future challenges that their projects need to endure. Such analysis needs to be supported through information sharing, active cooperation between stakeholders, and building necessary capacities. However, the findings of this systematic literature review showed that local authorities either do not have structured risk management strategies specifically for smart city projects or they do use their existing tools and techniques, which do not necessarily work for radical innovations and new technologies that smart city project require. Ullah et al. (2021) argued that the existing knowledge and practices provide no comprehensive risk taxonomy or methods specifically for understanding the risk exposure in smart city projects and it makes projects more prone to failures. There is a need for developing comprehensive risk management strategies that suit the nature of complex innovations. These strategies need to provide step-by-step guidelines for local authorities to identify and assess risks that stakeholders, especially public sector organisations, may come across throughout different stages of smart city projects. A multi-layered strategy that considers organisational, technological, and environmental elements of smart city projects will provide local authorities with required knowledge and tools to identify, analyse, act upon, and monitor several factors that may hinder the implementation of viable projects (Ullah et al., 2021).

The final recommendation that policy makers and practitioners can take on board is about initiating programs which specifically focus on developing necessary skills and expertise within public sector organisations, particularly in local authorities, for managing smart city projects and digital transformations. A lack of skills and expertise in managing smart city projects and digital transformation overall within public sector organisations appear as one of the most challenging organisational barriers (Beckers et al., 2022; Cinar et al., 2019), and yet individual level skills are highly critical for enabling innovation, as well as managing smart city projects with minimum friction possible (Bartlett and Dibben, 2002; De Vries et al., 2016). Therefore, local authorities need to pay attention in enabling effective acquisition and building of required talents. Building up teams and acquiring individuals that are equipped with required managerial as well as technical skills will have an impact on several other domains within local authorities such as managing complex innovation projects, analysing, and interpreting a vast amount of data for better decision making to support policy development, and managing risks under high uncertainties. Developing training and hiring programmes for expanding internal skillsets will enable local authorities to have the expertise required to manage smart city projects and services (Beckers et al., 2022).

Limitations and agenda for future research

This review comes with limitations. We ran our search terms only on Scopus and although the database is comprehensive; some studies may be omitted. We only considered a single type of PSI while identifying implementation barriers, therefore, future studies can expand the findings of this review by considering other types of innovation such as projects focusing on the digital transformation of public service provisions and organisations' internal IT processes. Another limitation for this review arises from the heterogeneity of the studies included in terms of areas of research, methods, outcomes, and cases/samples used, which makes it challenging to synthesise the results. Finally, the selection bias can sometimes be a limitation for systematic literature reviews as the quality of these reviews heavily relies on the selection of studies. To tackle this limitation, the search terms, the inclusion and exclusion criteria, and the database were evaluated by each author and the search strategy was built based on a consensus among the authors of this review.

The barriers identified in this review provide a comprehensive understanding of several domains that public sector organisations need to deal with when implementing smart city technologies. The review showed that some of these domains and some of the barriers have been studied more extensively than others. Three areas stand out while analysing barriers: limiting nature of public procurement, lack of skills and knowledge needed to implement and manage smart city projects, and the need for comprehensive business models. First, future studies can identify the role of public procurement as a key policy instrument for fostering innovation through attracting more investments from private sector organisations (Pihlajamaa and Merisalo, 2021), and as an engagement platform for value co-creation and value destruction by various stakeholders involved in smart city projects (Torvinen and Haukipuro, 2018). Second, the discussion concerning the lack of skills and knowledge has recently emerged as a topic in the context of smart city literature and public management literature. Further research is needed to understand what skills and knowledge is required to upskill the existing workforce and equip new graduates with necessary skills throughout their studies (Mora et al., 2023). Further studies should investigate the required skills and knowledge beyond building digital skills and there is a need for understanding what business and management skills are needed for initiating viable smart city projects. Finally, we identified issues raised around the use of unsuitable business models that do not acknowledge the multifaceted nature of smart city projects (Mora et al., 2023) and assumes that local governments are at the centre of smart city projects (Timeus et al., 2020). Further studies should investigate how smart cities can become an integral part of city management and how business models can correspond to this need. There is also a need for understanding how value proposition can be constructed for a wide variety of stakeholders and how citizens can influence the design and development of smart city projects (Grossi et al., 2020). Table 4 shows further areas of research which are categorised based on each macro level components.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work has been supported by the European Commission through the Horizon 2020 project FinEst Twins (Grant No. 856602).

ORCID iD

Emine Zehra Akgun https://orcid.org/0009-0008-5637-0314

References

Adapa S (2018) Indian smart cities and cleaner production initiatives – integrated framework and recommendations. *Journal of Cleaner Production* 172: 3351–3366.

Addae BA, Zhang L, Zhou P, et al. (2019) Analyzing barriers of Smart Energy City in Accra with two-step fuzzy DEMATEL. *Cities* 89: 218–227.

Ahmed E, Yaqoob I, Hashem IAT, et al. (2017) The role of big data analytics in Internet of Things. *Computer Networks* 129: 459–471.

Alabady SA, Al-Turjman F and Din S (2018) A novel security model for cooperative virtual networks in the IoT era. *International Journal of Parallel Programming* 48(2): 280–295.

Alkanaani HA and Bahith KH (2019) Evaluate the efficiency of the Iraqi city to overcome the challenges of sustainable smart cities. In: 2nd International Conference on Sustainable Engineering Techniques (ICSET 2019), Baghdad, 6–7 March 2019. IOP Publishing.

Almeshaiei E, Al-Habaibeh A and Shakmak B (2020) Rapid evaluation of micro-scale photovoltaic solar energy systems using empirical methods combined with deep learning neural networks to support systems' manufacturers. *Journal of Cleaner Production* 244: 118788.

Alromaihi S, Elmedany W and Balakrishna C (2018) Cyber security challenges of deploying IoT in smart cities for healthcare applications. In: 2018 6th International Conference on Future Internet of Things and Cloud Workshops (FiCloudW), Barcelona, Spain, 6–8 August 2018, pp. 140–145.

Anand PB and Navío-Marco J (2018) Governance and economics of smart cities: opportunities and challenges. *Telecommunications Policy* 42(10): 795–799.

Andrea C, Del Bo C and Nijkamp P (2013) Smart cities in Europe. In: Deakin M (ed). *Creating Smarter Cities*. London: Routledge, 65–82.

Andrews R and Van de Walle S (2013) New public management and citizens' perceptions of local service efficiency, responsiveness, equity and effectiveness. *Public Management Review* 15(5): 762–783.

Andrews R, Bellò B, Downe J, et al. (2021) The motivations for the adoption of management innovation by local governments and its performance effects. *Public Administration Review* 81(4): 625–637.

Angelidou M (2014) Smart city policies: a spatial approach. *Cities* 41: S3–S11.

Anthopoulos LG and Tougountzoglou TE (2012) A viability model for digital cities: economic and acceptability factors. In: Reddick C and Aikins S (eds) *Web 2.0 Technologies and Democratic Governance*. New York, NY: Springer.

Argento D, Grossi G, Jääskeläinen A, et al. (2019) Governmentality and performance for the smart city. *Accounting, Auditing & Accountability Journal* 33(1): 204–232.

Arundel A, Casali L and Hollanders H (2015) How European public sector agencies innovate: the use of bottom-up, policy-dependent and knowledge-scanning innovation methods. *Research Policy* 44(7): 1271–1282.

Arundel A, Bloch C and Ferguson B (2019) Advancing innovation in the public sector: aligning innovation measurement with policy goals. *Research Policy* 48(3): 789–798.

Ayora V, Horita F and Kamienski C (2018) Social networks as real-time data distribution platforms for smart cities. In: Proceedings of the 10th Latin America Networking Conference, São Paulo, Brazil, 3–4 October 2018, pp. 2–9.

Barnaby C (2019) A just culture is fundamental: extending security ergonomics by design. In: 2019 IEEE/ACM 5th International Workshop on Software Engineering for Smart Cyber-Physical Systems (SEsCPS), Montreal, QC, Canada, 28 May 2019, pp. 46–49. IEEE.

Barns S (2018) Smart cities and urban data platforms: designing interfaces for smart governance. *City, Culture and Society* 12: 5–12.

Barns S, Cosgrave E, Acuto M, et al. (2017) Digital infrastructures and urban governance. *Urban Policy and Research* 35(1): 20–31.

Barrutia JM, Echebarria C, Aguado-Moralejo I, et al. (2022) Leading smart city projects: government dynamic capabilities and public value creation. *Technological Forecasting and Social Change* 179: 121679.

Bartlett D and Dibben P (2002) Public sector innovation and entrepreneurship: case studies from local government. *Local Government Studies* 28(4): 107–121.

Bates DW, Heitmueller A, Kakad M, et al. (2018) Why policymakers should care about "big data" in healthcare. *Health Policy and Technology* 7(2): 211–216.

Beckers D, Gerli P, Mora L, et al. (2022) Global review of smart city governance practices. Reportno. Report Number|, Date. Place Published|: Institution|.

Beeton D (2012) Electric vehicle cities of the future: a policy framework for electric vehicle ecosystems. In: EVS26 International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium. Los Angeles, California, 2012.

Belanche-Gracia D, Casaló-Ariño LV and Pérez-Rueda A (2015) Determinants of multi-service smartcard success for smart cities development: a study based on citizens' privacy and security perceptions. *Government Information Quarterly* 32(2): 154–163.

Bjørner T (2021) The advantages of and barriers to being smart in a smart city: the perceptions of project managers within a smart city cluster project in Greater Copenhagen. *Cities* 114: 103187.

Bloch C and Bugge MM (2013) Public sector innovation—from theory to measurement. *Structural Change and Economic Dynamics* 27: 133–145.

Borins S (2001) Encouraging innovation in the public sector. *Journal of Intellectual Capital* 2(3): 310–319.

Brady HE (2019) The challenge of big data and data science. *Annual Review of Political Science* 22(1): 297–323.

Bryson JM, Crosby BC and Stone MM (2015) Designing and implementing cross-sector collaborations: needed and challenging. *Public Administration Review* 75(5): 647–663.

Burns M, Griffor E, Balduccini M, et al. (2018) Reasoning about smart city. In: 2018 IEEE International Conference on Smart Computing (SMARTCOMP), Taormina, Italy, 18–20 June 2018, pp. 381–386.

Cascio MA, Lee E, Vaudrin N, et al. (2019) A team-based approach to open coding: considerations for creating intercoder consensus. *Field Methods* 31(2): 116–130.

Cellina F, Castri R, Simão JV, et al. (2020) Co-creating app-based policy measures for mobility behavior change: a trigger for novel governance practices at the urban level. *Sustainable Cities and Society* 53: 101911.

Chen H, Zhao C and Shen Z (2018) Analysis of the problems of current smart city and countermeasures in China. In: 2018 3rd Technology Innovation Management and Engineering Science International Conference (TIMES-iCON), Bangkok, Thailand, 12–14 December 2018, pp. 1–4. IEEE.

Chinnaswamy A, Papa A, Dezi L, et al. (2019) Big data visualisation, geographic information systems and decision making in healthcare management. *Management Decision* 57(8): 1937–1959.

Christensen T and Lægreid P (2007) The whole-of-government approach to public sector reform. *Public Administration Review* 67(6): 1059–1066.

Cinar E, Trott P and Simms C (2019) A systematic review of barriers to public sector innovation process. *Public Management Review* 21(2): 264–290.

Cinar E, Trott P and Simms C (2021) An international exploration of barriers and tactics in the public sector innovation process. *Public Management Review* 23(3): 326–353.

Cinar E, Simms C, Trott P, et al. (2022) Public sector innovation in context: a comparative study of innovation types. *Public Management Review* 26: 265–292. DOI: 10.1080/14719037.2022.2080860.

Colding J and Barthel S (2017) An urban ecology critique on the "Smart City" model. *Journal of Cleaner Production* 164: 95–101.

Cole L and Hagen P (2023) Scaling deep through transformative learning in public sector innovation labs – experiences from Vancouver and Auckland. *Public Management Review* 26: 2094–2121. DOI: 10.1080/14719037.2023.2254776.

Corsini F, Certomà C, Dyer M, et al. (2019) Participatory energy: research, imaginaries and practices on people' contribute to energy systems in the smart city. *Technological Forecasting and Social Change* 142: 322–332.

Costa C and Santos MY (2017) The SusCity big data warehousing approach for smart cities. In: Proceedings of the 21st International Database Engineering & Applications Symposium on - IDEAS 2017, Bristol, UK, 12–14 July 2017, pp. 264–273.

Cowley R, Joss S and Dayot Y (2018) The smart city and its publics: insights from across six UK cities. *Urban Research & Practice* 11(1): 53–77.

Crampton JW, Hoover KC, Smith H, et al. (2019) Smart festivals? security and freedom for well-being in urban smart spaces. *Annals of the American Association of Geographers* 110(2): 360–370.

Criado JI, Alcaide-Muñoz L and Liarte I (2023) Two decades of public sector innovation: building an analytical framework from a systematic literature review of types, strategies, conditions, and results. *Public Management Review* 1–30. DOI: 10.1080/14719037.2023.2254310.

Dagher GG, Mohler J, Milojkovic M, et al. (2018) Ancile: privacy-preserving framework for access control and interoperability of electronic health records using blockchain technology. *Sustainable Cities and Society* 39: 283–297.

De Aguiar CA, Leshed G, Bernard A, et al. (2018) CoDAS, a method for envisioning larger-scaled computational artifacts connecting communities. In: 2018 4th International Conference on Universal Village (UV), Boston, MA, USA, 21–24 October 2018, pp. 1–6. IEEE.

De Vries H (2018) *Unrevalling Public Sector Innoavtion: Towards a Stakeholder and Leadership Approach in a Teleworking Context*. Rotterdam: The Erasmus University Rotterdam.

De Vries H, Bekkers V and Tummers L (2016) Innovation in the public sector: a systematic review and future research agenda. *Public Administration* 94(1): 146–166.

de Wijs L, Witte P and Geertman S (2016) How smart is smart? Theoretical and empirical considerations on implementing smart city objectives – a case study of Dutch railway station areas. *Innovation: The European Journal of Social Science Research* 29(4): 424–441.

Demircioglu MA and Audretsch DB (2017) Conditions for innovation in public sector organizations. *Research Policy* 46(9): 1681–1691.

Desai H, Liu K, Kantarcioglu M, et al. (2018) Adjudicating violations in data sharing agreements using smart contracts. In: 2018 IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData), Halifax, NS, Canada, 30 July–03 August 2018, pp. 1553–1560.

Diallo MH, Panwar N, Yus R, et al (2018) Trustworthy Privacy policy translation in untrusted IoT environments. In: Proceedings of the 3rd International Conference on Internet of Things, Big Data and Security, Funchal, Madeira, Portugal, pp. 132–143.

Dilawar N, Majeed H, Beg MO, et al. (2018) Understanding citizen issues through reviews: a step towards data informed planning in smart cities. *Applied Sciences* 8(9): 1589.

D'Este P, Iammarino S, Savona M, et al. (2012) What hampers innovation? Revealed barriers versus deterring barriers. *Research Policy* 41(2): 482–488.

Edelenbos J, Hirzalla F, van Zoonen L, et al. (2018) Governing the complexity of smart data cities: setting a research agenda. In: Rodríguez Bolívar M (ed) *Smart Technologies for Smart Governments*. Cham: Springer.

Elsaeidy A, Elgendi I, Munasinghe KS, et al. (2017) A smart city cyber security platform for narrowband networks. In: 2017 27th International Telecommunication Networks and Applications Conference (ITNAC), Melbourne, VIC, Australia, 22–24 November 2017, pp. 1–6.

Escamilla-Ambrosio PJ, Rodríguez-Mota A, Aguirre-Anaya E, et al. (2018) Distributing computing in the internet of things: cloud, fog and edge computing overview. *Studies in Computational Intelligence* 731: 87–115.

Esmaeilian B, Wang B, Lewis K, et al. (2018) The future of waste management in smart and sustainable cities: a review and concept paper. *Waste Management* 81: 177–195.

Expósito López J, Romero-Díaz de la Guardia JJ, Olmos-Gómez MdC, et al. (2019) Enhancing skills for employment in the workplace of the future 2020 using the theory of connectivity: shared and adaptive personal learning environments in a Spanish context. *Sustainability* 11(15): 4219.

Faisal A, Yigitcanlar T, Kamruzzaman M, et al. (2019) Understanding autonomous vehicles: a systematic literature review on capability, impact, planning and policy. *Journal of Transport and Land Use* 12(1): 45–72.

Frauenberger C (2019) Smart everythings agency, power, responsibility and participation In: 2019 Global IoT Summit (GIoTS), Aarhus, Denmark, 17–21 June 2019, pp. 1–6.

Freeman G, Bardzell J, Bardzell S, et al. (2019) Smart and fermented cities. In: Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, Glasgow, Scotland, UK, 4–9 May 2019, pp. 1–13.

Garcia-Font V, Garrigues C and Rifa-Pous H (2017) Attack classification schema for smart city WSNs. *Sensors (Basel)* 17(4): 771.

Gerli P, Clement J, Esposito G, et al. (2022) The hidden power of emotions: how psychological factors influence skill development in smart technology adoption. *Technological Forecasting and Social Change* 180: 121721.

Gianni F, Mora S and Divitini M (2019) RapIoT toolkit: rapid prototyping of collaborative Internet of Things applications. *Future Generation Computer Systems* 95: 867–879.

Gil-Garcia JR (2012) Towards a smart State? Inter-agency collaboration, information integration, and beyond. *Information Polity* 17(3–4): 269–280.

Gioia DA, Corley KG and Hamilton AL (2012) Seeking qualitative rigor in inductive research. *Organizational Research Methods* 16(1): 15–31.

Gonzalez R, Llopis J and Gasco J (2013) Innovation in public services: the case of Spanish local government. *Journal of Business Research* 66(10): 2024–2033.

Grieman K (2019) Pedestrian curiosity: a brief examination of consent and privacy in swath section smart city spaces. CEUR Workshop Proceedings. Spatial Knowledge and Information Canada, 1–5.

Grossi G, Meijer A and Sargiacomo M (2020) A public management perspective on smart cities: 'urban auditing' for management, governance and accountability. *Public Management Review* 22(5): 633–647.

Guangul FM and Chala GT (2019) SWOT analysis of wind energy as a promising conventional fuels substitute. In: 4th MEC International Conference on Big Data and Smart City (ICBDSC), Muscat, Oman, 15–16 January 2019, pp. 1–6. IEEE.

Gupta P, Chauhan S and Jaiswal MP (2019) Classification of smart city research - a descriptive literature review and future research agenda. *Information Systems Frontiers* 21(3): 661–685.

Hambleton R and Howard J (2013) Place-based leadership and public service innovation. *Local Government Studies* 39(1): 47–70.

Hartley J (2005) Innovation in governance and public services past and present. *Public Money & Management* 25(1): 27–34.

Hartley J, Sørensen E and Torfing J (2013) Collaborative innovation: a viable alternative to market competition and organizational entrepreneurship. *Public Administration Review* 73(6): 821–830.

Heitlinger S, Bryan-Kinns N and Comber R (2019) The right to the sustainable smart city. In: Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, Scotland, UK, May 4–9 2019, pp. 1–13.

Hong S, Kim SH and Kwon M (2022) Determinants of digital innovation in the public sector. *Government Information Quarterly* 39(4): 101723.

Hui FKP, Ulya PF, Wilson S, et al. (2020) Green buildings in Makassar, Indonesia. In: Gou Z (ed) *Green Building in Developing Countries*. Cham: Springer, 109–127.

Ihrke D, Proctor R and Gabris J (2003) Understanding innovation in municipal government: city council member perspectives. *Journal of Urban Affairs* 25(1): 79–90.

Islam N, Marinakis Y, Majadillas MA, et al. (2020) Here there be dragons, a pre-roadmap construct for IoT service infrastructure. *Technological Forecasting and Social Change* 155: 119073.

Janssen M, Konopnicki D, Snowdon JL, et al. (2017) Driving public sector innovation using big and open linked data (BOLD). *Information Systems Frontiers* 19(2): 189–195.

Janssen M, Luthra S, Mangla S, et al. (2019) Challenges for adopting and implementing IoT in smart cities. *Internet Research* 29(6): 1589–1616.

Jayasena NS, Mallawaarachchi H and Waidyasekara KGAS (2019) A critical review on the drivers and barriers for enabling smart cities. In: *The International Conference on Industrial Engineering and Operations Management*. Bangkok, Thailand: IEOM Society International, 2405–2413.

Jewell M (2018) Contesting the decision: living in (and living with) the smart city. *International Review of Law, Computers & Technology* 32(2–3): 210–229.

Joss S, Cook M and Dayot Y (2017) Smart cities: towards a new citizenship regime? A discourse analysis of the British Smart City standard. *Journal of Urban Technology* 24(4): 29–49.

Kabáč M, Consel C and Volanschi N (2017) Designing parallel data processing for enabling large-scale sensor applications. *Personal and Ubiquitous Computing* 21(3): 457–473.

Kendrick C, Wilde D, Martin K, et al. (2019) Developing best practices for air quality sensor deployments through testing. In: Proceedings of the 2nd ACM/EIGSCC Symposium on Smart Cities and Communities, Portland, OR, USA, pp. 1–9.

Khan HH, Malik MN, Zafar R, et al. (2020) Challenges for sustainable smart city development: a conceptual framework. *Sustainable Development* 28(5): 1507–1518.

Kobza N and Hermanowicz M (2018) Sustainable development in the city how to use technology in the service of mankind? In: Kopacek P and Ibrahimov B (eds) *18th IFAC Conference on Technology, Culture and International Stability*. Baku, Azerbaijan: Elsevier, 340–345.

Kuhlmann S and Heuberger M (2021) Digital transformation going local: implementation, impacts and constraints from a German perspective. *Public Money & Management* 43(2): 147–155.

Kummitha RKR (2018) Entrepreneurial urbanism and technological panacea: why smart city planning needs to go beyond corporate visioning? *Technological Forecasting and Social Change* 137: 330–339.

Lapuente V and Van de Walle S (2020) The effects of new public management on the quality of public services. *Governance* 33(3): 461–475.

Lee TH, Hong S-G and Jeong H (2017) A study on design thinking-based co-creation planning applying for the sasang smart city development project. *Information* 20(6(B)): 4281–4293.

Leigh EW (2017) An exploration of “hyper-local” community-university engagement in the development of smart cities. *Equity & Excellence in Education* 50(4): 421–433.

Lesperance W, Kamdem JS, Linguet L, et al. (2018) Renewable energy in French Guiana: prospects towards a sustainable development scenario. In: 2018 2nd International Conference on Smart Grid and Smart Cities (ICSGSC), Kuala Lumpur, Malaysia, 12–14 August 2018, pp. 133–136. IEEE.

Li Z and Liao Q (2018) Economic solutions to improve cybersecurity of governments and smart cities via vulnerability markets. *Government Information Quarterly* 35(1): 151–160.

Li Z and Shahidehpour M (2017) Deployment of cybersecurity for managing traffic efficiency and safety in smart cities. *The Electricity Journal* 30(4): 52–61.

Liborio MP, Machado-Coelho TM, Bernardes P, et al. (2018) Forecasting internet demand using public data: a case study in Brazil. *IEEE Access* 6: 65974–65980.

Lim HSM and Taeihagh A (2019) Algorithmic decision-making in AVs: understanding ethical and technical concerns for smart cities. *Sustainability* 11(20): 5791.

Lim C, Kim K-J and Maglio PP (2018) Smart cities with big data: reference models, challenges, and considerations. *Cities* 82: 86–99.

Lin Y, Zhang X and Geertman S (2015) Toward smart governance and social sustainability for Chinese migrant communities. *Journal of Cleaner Production* 107: 389–399.

Lom M, Pribyl O and Zelinka T (2016) Systems engineering for smart cities - hybrid-agile approach in smart cities procurement. In: The 20th World Multi-Conference on Systemics, Cybernetics and Informatics (WMSCI 2016), Orlando, Florida, USA, 5–8 July 2016, pp. 50–55.

Lombardi P, Abastante F, Torabi Moghadam S, et al. (2017) Multicriteria spatial decision support systems for future urban energy retrofitting scenarios. *Sustainability* 9(7): 1252.

Lu H, de Jong M and ten Heuvelhof E (2018) Explaining the variety in smart eco city development in China-what policy network theory can teach us about overcoming barriers in implementation? *Journal of Cleaner Production* 196: 135–149.

Lytras M and Visvizi A (2018) Who uses smart city services and what to make of it: toward interdisciplinary smart cities research. *Sustainability* 10(6): 1998.

Ma R and Lam PTI (2019) Investigating the barriers faced by stakeholders in open data development: a study on Hong Kong as a "smart city". *Cities* 92: 36–46.

Ma R, Lam PTI and Leung CK (2018) Potential pitfalls of smart city development: a study on parking mobile applications (apps) in Hong Kong. *Telematics and Informatics* 35(6): 1580–1592.

Maccani G, Connolly N, McLoughlin S, et al. (2020) An emerging typology of IT governance structural mechanisms in smart cities. *Government Information Quarterly* 37(4): 101499.

Madaan A, Wang X, Hall W, et al. (2018) Observing data in IoT worlds: what and how to observe? In: Living in the Internet of Things: Cybersecurity of the IoT - 2018, London, 28–29 March 2018, pp. 1–7.

Mamay EA (2019) Digitization of public services in Russia: how a "man-made" reform goes ahead and sets back again. In: Proceedings of the International Conferences ICT, Society, and Human Beings 2019; Connected Smart Cities 2019; and Web Based Communities and Social Media 2019, Porto, Portugal, 17–19 July 2019, pp. 177–183.

Manda MI and Backhouse J (2019) Smart governance for inclusive socio-economic transformation in South Africa: are we there yet? In: *E-Participation in Smart Cities: Technologies and Models of Governance for Citizen Engagement*. Cham: Springer, 179–201.

Marchiori M (2017) The smart cheap city: efficient waste management on a budget. In: 2017 IEEE 19th International Conference on High Performance Computing and Communications; IEEE 15th International Conference on Smart City; IEEE 3rd International Conference on Data Science and Systems (HPCC/SmartCity/DSS), Bangkok, Thailand, 18–20 December 2017, pp. 192–199.

Marek L, Campbell M and Bui L (2017) Shaking for innovation: the (re)building of a (smart) city in a post disaster environment. *Cities* 63: 41–50.

Marsal-Llacuna M-L (2019) How to succeed in implementing (smart) sustainable urban agendas: "keep cities smart, make communities intelligent". *Environment, Development and Sustainability* 21(4): 1977–1998.

Martin CJ, Evans J and Karvonen A (2018) Smart and sustainable? Five tensions in the visions and practices of the smart-sustainable city in Europe and North America. *Technological Forecasting and Social Change* 133: 269–278.

Mary MCVS, Devaraj GP, Theepak TA, et al. (2018) Intelligent energy efficient street light controlling system based on IoT for smart city. In: 2018 International Conference on Smart Systems and Inventive Technology (ICSSIT), Tirunelveli, India, 13-14 December 2018, pp. 551–554. IEEE.

Marzouki A, Mellouli S and Daniel S (2018) Spatial, temporal and semantic contextualization of citizen participation. In: Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age, Delft, The Netherlands, 30 May–1 June 2018, pp. 1–8.

Masucci M, Pearsall H and Wiig A (2019) The smart city conundrum for social justice: youth perspectives on digital technologies and urban transformations. *Annals of the American Association of Geographers* 110(2): 476–484.

Matheus R, Janssen M and Maheshwari D (2020) Data science empowering the public: data-driven dashboards for transparent and accountable decision-making in smart cities. *Government Information Quarterly* 37(3): 101284.

Mattoni B, Gugliermetti F and Bisegna F (2015) A multilevel method to assess and design the renovation and integration of Smart Cities. *Sustainable Cities and Society* 15: 105–119.

McKenna HP (2019) Innovating metrics for smarter, responsive cities. *Data* 4(1): 25.

Meijer A (2015) E-governance innovation: barriers and strategies. *Government Information Quarterly* 32(2): 198–206.

Meijer A (2018) Datapolis: a public governance perspective on "smart cities". *Perspectives on Public Management and Governance* 1(3): 195–206.

Meijer A and Thaens M (2018) Quantified street: smart governance of urban safety. *Information Polity* 23(1): 29–41.

Mergel I, Kleibrink A and Sörvik J (2018) Open data outcomes: U.S. cities between product and process innovation. *Government Information Quarterly* 35(4): 622–632.

Mergel I, Edelmann N and Haug N (2019) Defining digital transformation: results from expert interviews. *Government Information Quarterly* 36(4): 101385.

Merhi MI (2021) Evaluating the critical success factors of data intelligence implementation in the public sector using analytical hierarchy process. *Technological Forecasting and Social Change* 173: 121180.

Micheli P, Schoeman M, Baxter D, et al. (2015) New business models for public-sector innovation: successful technological innovation for government. *Research-Technology Management* 55(5): 51–57.

Mora L, Deakin M and Reid A (2019) Combining co-citation clustering and text-based analysis to reveal the main development paths of smart cities. *Technological Forecasting and Social Change* 142: 56–69.

Mora L, Gerli P, Ardito L, et al. (2023) Smart city governance from an innovation management perspective: theoretical framing, review of current practices, and future research agenda. *Technovation* 123: 102717.

Morrissett A and Abdelwahed S (2018) A physical testbed for smart city research. In: 2018 IEEE/ACS 15th International Conference on Computer Systems and Applications (AICCSA), Aqaba, Jordan, 28 October–01 November 2018, pp. 1–2. IEEE.

Mosannenzadeh F, Di Nucci MR and Vettorato D (2017) Identifying and prioritizing barriers to implementation of smart energy city projects in Europe: an empirical approach. *Energy Policy* 105: 191–201.

Mu R and Wang H (2022) A systematic literature review of open innovation in the public sector: comparing barriers and governance strategies of digital and non-digital open innovation. *Public Management Review* 24(4): 489–511.

Mueller J, Lu H, Chirkin A, et al. (2018) Citizen design science: a strategy for crowd-creative urban design. *Cities* 72: 181–188.

Musakwa W (2017) Perspectives on geospatial information science education: an example of urban planners in Southern Africa. *Geo-spatial Information Science* 20(2): 201–208.

Mylrea M (2017) Smart energy-internet-of-things opportunities require smart treatment of legal, privacy and cybersecurity challenges. *Journal of World Energy Law & Business* 10(2): 147–158.

Nadkarni S and Prügl R (2020) Digital transformation: a review, synthesis and opportunities for future research. *Management Review Quarterly* 71(2): 233–341.

Naphade M, Anastasiu DC, Sharma A, et al. (2017) The NVIDIA AI city challenge. In: 2017 IEEE SmartWorld, Ubiquitous Intelligence & Computing, Advanced & Trusted Computed, Scalable Computing & Communications, Cloud & Big Data Computing, Internet of People and Smart City Innovation (SmartWorld/SCALCOM/UIC/ATC/CBDCom/IOP/SCI), San Francisco, CA, USA, 04–08 August 2017, pp. 1–6.

Nelson A, Toth G, Linders D, et al. (2019) Replication of smart-city, internet of things assets in a municipal deployment. *IEEE Internet of Things Journal* 6: 6715.

Nicolas C, Kim J and Chi S (2020) Quantifying the dynamic effects of smart city development enablers using structural equation modeling. *Sustainable Cities and Society* 53: 101916.

Nilssen M (2019) To the smart city and beyond? Developing a typology of smart urban innovation. *Technological Forecasting and Social Change* 142: 98–104.

Offenhuber D and Schechtner K (2018) Improstructure - an improvisational perspective on smart infrastructure governance. *Cities* 72: 329–338.

Osborne D and Gaebler T (1992) *Reinventing Government: How the Entrepreneurial Spirit is Transforming the Public Sector*. New York: Penguin Publishing Group.

Pan Z, Hariri S and Pacheco J (2019) Context aware intrusion detection for building automation systems. *Computers & Security* 85: 181–201.

Panagiotakopoulos T, Iatrellis O and Kameas A (2020) Emerging smart city job roles and skills for smart urban governance. In: Fitsilis P (ed) *Building on Smart Cities Skills and Competences. Internet of Things*. Cham: Springer, 3–20.

Park J-H, Salim MM, Jo JH, et al. (2019) CIoT-Net: a scalable cognitive IoT based smart city network architecture. *Human-centric Computing and Information Sciences* 9(1): 29.

Paskaleva K and Cooper I (2018) Open innovation and the evaluation of internet-enabled public services in smart cities. *Technovation* 78: 4–14.

Patel Y and Doshi N (2019) Social implications of smart cities. *Procedia Computer Science* 155: 692–697.

Peng GCA, Nunes MB and Zheng L (2017) Impacts of low citizen awareness and usage in smart city services: the case of London's smart parking system. *Information Systems and e-Business Management* 15(4): 845–876.

Pereira C, Cardoso J, Aguiar A, et al. (2018) Benchmarking Pub/Sub IoT middleware platforms for smart services. *Journal of Reliable Intelligent Environments* 4(1): 25–37.

Perng S-Y (2019) Anticipating digital futures: ruins, entanglements and the possibilities of shared technology making. *Mobilities* 14(4): 418–434.

Picioroagă I-I, Eremia M and Sănduleac M (2018) SMART CITY: definition and evaluation of key performance indicators. In: 2018 International Conference and Exposition on Electrical And Power Engineering (EPE), Iasi, Romania, 18–19 October 2018, pp. 217–222. IEEE.

Pihlajamaa M and Merisalo M (2021) Organizing innovation contests for public procurement of innovation – a case study of smart city hackathons in Tampere, Finland. *European Planning Studies* 29(10): 1906–1924.

Pittaway JJ and Montazemi AR (2020) Know-how to lead digital transformation: the case of local governments. *Government Information Quarterly* 37(4): 101474.

Popham J, Lavoie J and Coomber N (2020) Constructing a public narrative of regulations for big data and analytics: results from a community-driven discussion. *Social Science Computer Review* 38(1): 75–90.

Potoczny-Jones I, Kenneally E, Ruffing J, et al. (2019) Encrypted dataset collaboration. In: Proceedings of the 2nd ACM/EIGSCC Symposium on Smart Cities and Communities, Portland, OR, USA, 10–12 September 2019, pp. 1–8.

Praharaj S, Hoon Han J and Hawken S (2018) Towards the right model of smart city governance in India. *International Journal of Sustainable Development and Planning* 13(02): 171–186.

Przeybilovicz E, Cunha MA, Geertman S, et al. (2020) Citizen participation in the smart city: findings from an international comparative study. *Local Government Studies* 48(1): 23–47.

Qiu H and Chreim S (2022) A tension lens for understanding public innovation diffusion processes. *Public Management Review* 24(12): 1873–1893.

Qiu L, Liu Z, Pereira GC, et al. (2017) Implementing RSA for sensor nodes in smart cities. *Personal and Ubiquitous Computing* 21(5): 807–813.

Queyroi Y, Carassus D, Maurel C, et al. (2022) Local public innovation: an analysis of its perceived impacts on public performance. *International Review of Administrative Sciences* 88(2): 493–510.

Rajasekar U, Chakraborty S and Bhat G (2018) Climate resilient smart cities: opportunities for innovative solutions in India. In: Hughes S, Chu EK and Mason SG (eds) *Climate Change in Cities*. Cham: Springer, 203–228.

Ramos LFM and Silva JMC (2019) Privacy and data protection concerns regarding the use of blockchains in smart cities. In: Proceedings of the 12th International Conference on Theory and Practice of Electronic Governance, Melbourne, VIC, Australia, 3–5 April 2019, pp. 342–347.

Rana NP, Luthra S, Mangla SK, et al. (2019) Barriers to the development of smart cities in Indian context. *Information Systems Frontiers* 21(3): 503–525.

Razmjoo A, Østergaard PA, Denaï M, et al. (2021) Effective policies to overcome barriers in the development of smart cities. *Energy Research & Social Science* 79: 102175.

Reed M and Keech D (2019) Making the city smart from the grassroots up: the sustainable food networks of Bristol. *City, Culture and Society* 16: 45–51.

Rhee S (2016) Catalyzing the internet of things and smart cities: global city teams challenge. In: 2016 1st International Workshop on Science of Smart City Operations and Platforms Engineering (SCOPE) in partnership with Global City Teams Challenge (GCTC) (SCOPE - GCTC), Vienna, Austria, 11 April 2016, pp. 1–4. IEEE.

Richards K, Andrew R and Hemphill Michael A (2018) A Practical Guide to Collaborative Qualitative Data Analysis. *Journal of Teaching in Physical Education* 37(2): 225–231. DOI: 10.1123/jtpe.2017-0084.

Rinik C (2019) Data trusts: more data than trust? The perspective of the data subject in the face of a growing problem. *International Review of Law, Computers & Technology* 34(3): 342–363.

Rjab AB, Mellouli S and Corbett J (2023) Barriers to artificial intelligence adoption in smart cities: a systematic literature review and research agenda. *Government Information Quarterly* 40(3): 101814.

Rodrigues DO, Boukerche A, Silva TH, et al. (2018) Combining taxi and social media data to explore urban mobility issues. *Computer Communications* 132: 111–125.
Ruhlandt RWS (2018) The governance of smart cities: a systematic literature review. *Cities* 81: 1–23.
Salge TO and Vera A (2012) Benefiting from public sector innovation: the moderating role of customer and learning orientation. *Public Administration Review* 72(4): 550–559.
Sancino A and Hudson L (2020) Leadership in, of, and for smart cities – case studies from Europe, America, and Australia. *Public Management Review* 22(5): 701–725.
Sandnes FE, Herstad J, Stangeland AM, et al. (2017) UbiWheel: a simple context-aware universal control concept for smart home appliances that encourages active living. In: 2017 IEEE SmartWorld, Ubiquitous Intelligence & Computing, Advanced & Trusted Computed, Scalable Computing & Communications, Cloud & Big Data Computing, Internet of People and Smart City Innovation (SmartWorld/SCALCOM/UIC/ATC/CBDCom/IOP/SCI), San Francisco, CA, USA, 04–08 August 2017.
Sandulli FD, Ferraris A and Bresciani S (2017) How to select the right public partner in smart city projects. *R&D Management* 47(4): 607–619.
Sangki J (2018) Vision of future e-government via new e-government maturity model: based on Korea's e-government practices. *Telecommunications Policy* 42(10): 860–871.
Setyowati R, Sutoto SNA, Ishlahuddin A, et al. (2019) Improving capabilities and creating values in public services through extended organization concept: case study of Jakarta Smart City. In: 2019 International Conference on Information Management and Technology (ICIMTech), Jakarta/Bali, Indonesia, 19–20 August 2019, pp. 192–197. IEEE.
Shreepriya S, Bottia A and Du Y (2018) We care: integrated helping system for people with physical limitations. In: Stephanidis C (ed) *HCI 2018*. Cham: Springer.
Silva BN, Khan M and Han K (2018) Towards sustainable smart cities: a review of trends, architectures, components, and open challenges in smart cities. *Sustainable Cities and Society* 38: 697–713.
Simonofski A, Vallé T, Serral E, et al. (2021) Investigating context factors in citizen participation strategies: a comparative analysis of Swedish and Belgian smart cities. *International Journal of Information Management* 56: 102011.
Snyder H (2019) Literature review as a research methodology: an overview and guidelines. *Journal of Business Research* 104: 333–339.
Sørensen E and Torfing J (2012) Collaborative innovation in the public sector. *The Innovation Journal: The Public Sector Innovation Journal* 17(1): 115–138.
Spicer Z, Goodman N and Olmstead N (2019) The frontier of digital opportunity: smart city implementation in small, rural and remote communities in Canada. *Urban Studies* 58(3): 535–558.
Stefanouli M and Economou C (2019) Data protection in smart cities: application of the EU GDPR. In: Nathanail E and Karakikes I (eds) *4th Conference on Sustainable Urban Mobility*. Skiathos Island, Greece: Springer, Cham, 748–755.
Sterbenz JPG (2017) Smart city and iot resilience, survivability, and disruption tolerance: challenges, modelling, and a survey of research opportunities. In: 2017 9th International Workshop on Resilient Networks Design and Modeling (RNDM), Alghero, Italy, 04–06 September 2017, pp. 1–6. IEEE.

Subasi A, Al-Marwani K, Alghamdi R, et al. (2018) Intrusion detection in smart grid using data mining techniques. In: 2018 21st Saudi Computer Society National Computer Conference (NCC), Riyadh, Saudi Arabia, 25–26 April 2018, pp. 1–6. IEEE.

Tangi L, Janssen M, Benedetti M, et al. (2020) Barriers and drivers of digital transformation in public organizations: results from a survey in The Netherlands. In: Pereira GV, Janssen M, Lee H, et al. (eds) *19th IFIP WG 8.5 International Conference, EGOV 2020*. Linkoping, Sweden: Springer, 42–56.

Tekin Bilbil E (2017) The operationalizing aspects of smart cities: the case of Turkey's smart strategies. *Journal of the Knowledge Economy* 8(3): 1032–1048.

Tekinerdogan B and Köksal Ö (2018) Pattern based integration of internet of things systems. In: Georgakopoulos D and Zhang L (eds) Internet of Things – ICIOT 2018, Seattle, WA, USA, 25–30 June 2018. Springer.

Timeus K, Vinaixa J and Pardo-Bosch F (2020) Creating business models for smart cities: a practical framework. *Public Management Review* 22(5): 726–745.

Tonekaboni NH, Kulkarni S and Ramaswamy L (2018) Edge-based anomalous sensor placement detection for participatory sensing of urban heat Islands. In: 2018 IEEE International Smart Cities Conference (ISC2), Kansas City, MO, USA, 16–19 September 2018, pp. 1–8. IEEE.

Torfing J (2019) Collaborative innovation in the public sector: the argument. *Public Management Review* 21(1): 1–11.

Torugsa N and Arundel A (2016) Complexity of Innovation in the public sector: a workgroup-level analysis of related factors and outcomes. *Public Management Review* 18(3): 392–416.

Torvinen H and Haukipuro L (2018) New roles for end-users in innovative public procurement: case study on user engaging property procurement. *Public Management Review* 20(10): 1444–1464.

Torvinen H and Jansson K (2023) Public health care innovation lab tackling the barriers of public sector innovation. *Public Management Review* 25(8): 1539–1561.

Tranfield D, Denyer D and Smart P (2003) Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British Journal of Management* 14(3): 207–222.

Trencher G (2019) Towards the smart city 2.0: empirical evidence of using smartness as a tool for tackling social challenges. *Technological Forecasting and Social Change* 142: 117–128.

Trivellato B (2017) How can 'smart' also be socially sustainable? Insights from the case of Milan. *European Urban and Regional Studies* 24(4): 337–351.

Ullah F, Qayyum S, Thaheem MJ, et al. (2021) Risk management in sustainable smart cities governance: a TOE framework. *Technological Forecasting and Social Change* 167: 120743.

Vaidya B and Mouftah HT (2018) Deployment of secure EV charging system using open charge point protocol. In: 2018 14th International Wireless Communications & Mobile Computing Conference (IWCMC), Limassol, Cyprus, 25–29 June 2018, pp. 922–927. IEEE.

Valerio L, Passarella A and Conti M (2017) A communication efficient distributed learning framework for smart environments. *Pervasive and Mobile Computing* 41: 46–68.

van Duijn S, Bannink D and Ybema S (2021) Working toward network governance: local actors' strategies for navigating tensions in localized health care governance. *Administration & Society* 54(4): 660–689.

Vieira I and Alvaro A (2018) A centralized platform of open government data as support to applications in the smart cities context. *ACM SIGSOFT Software Engineering* 42(4): 1–13.

Vitunskaite M, He Y, Brandstetter T, et al. (2019) Smart cities and cyber security: are we there yet? A comparative study on the role of standards, third party risk management and security ownership. *Computers & Security* 83: 313–331.

von Wielligh RJ, Grobler MJ and Marais H-J (2018) Cellular IoT capacity estimation for African smart cities. In: 2018 IEEE Global Conference on Internet of Things (GCIoT), Alexandria, Egypt, 05–07 December 2018, pp. 1–6. IEEE.

Vu K and Hartley K (2018) Promoting smart cities in developing countries: policy insights from Vietnam. *Telecommunications Policy* 42(10): 845–859.

Walker RM (2006) Innovation type and diffusion: an empirical analysis of local government. *Public Administration* 84(2): 311–335.

Wang T (2023) Toward an understanding of innovation failure: the timing of failure experience. *Technovation* 125: 102787.

Wang Y, Ren H, Dong L, et al. (2019) Smart solutions shape for sustainable low-carbon future: a review on smart cities and industrial parks in China. *Technological Forecasting and Social Change* 144: 103–117.

Weißmüller KS, Ritz A and Yerramsetti S (2023) Collaborating and co-creating the digital transformation: empirical evidence on the crucial role of stakeholder demand from Swiss municipalities. *Public Policy and Administration*. OnlineFirst. DOI: 10.1177/09520767231170100.

Wu H, Shang Z and Wolter K (2019) Performance prediction for the Apache Kafka messaging system. In: 2019 IEEE 21st International Conference on High Performance Computing and Communications; IEEE 17th International Conference on Smart City; IEEE 5th International Conference on Data Science and Systems (HPCC/SmartCity/DSS), Zhangjiajie, China, 10–12 August 2019, pp. 154–161.

Xiao Y and Watson M (2019) Guidance on conducting a systematic literature review. *Journal of Planning Education and Research* 39(1): 93–112.

Xiao Z, Fu X and Goh RSM (2018) Data privacy-preserving automation architecture for industrial data exchange in smart cities. *IEEE Transactions on Industrial Informatics* 14(6): 2780–2791.

Yang B (2019) Developing a mobile mapping system for 3D GIS and smart city planning. *Sustainability* 11(13): 3713.

Yang F and Xu J (2018) Privacy concerns in China's smart city campaign: the deficit of China's Cybersecurity Law. *Asia & the Pacific Policy Studies* 5(3): 533–543.

Yao H, Xiong M, Liu C, et al. (2017) Encounter probability aware task assignment in mobile crowdsensing. *Mobile Networks and Applications* 22(2): 275–286.

Ye H, Li F, Liu Z, et al. (2019) A green energy consumption policy of Bluetooth mobile devices for smart cities. *Computing* 102(4): 1077–1091.

Yigitcanlar T, Wilson M and Kamruzzaman M (2019) Disruptive impacts of automated driving systems on the built environment and land use: an urban planner's perspective. *Journal of Open Innovation: Technology, Market, and Complexity* 5(2): 24.

Yin Q, Niu K, Li N, et al. (2019) ACO-RR: ant colony optimization ridge regression in reuse of smart city system. In: Peng X, Ampatzoglou A and Bhowmik T (eds) *ICSR 2019*, Madrid, Spain, 26–29 November 2019. Springer.

Zarei F and Nik-Bakht M (2021) Citizen engagement body of knowledge – a fuzzy decision maker for index-term selection in built environment projects. *Cities* 112: 103137.