frontiers | Frontiers in Sustainable Cities

TYPE Systematic Review
PUBLISHED 11 December 2024
DOI 10.3389/frsc.2024.1449983

OPEN ACCESS

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RECEIVED 16 June 2024
ACCEPTED 28 November 2024
PUBLISHED 11 December 2024

CITATION
Mupfumira P, Mutingi M and Sony M (2024) Smart city frameworks SWOT analysis: a systematic literature review.
Front. Sustain. Cities 6:1449983.
doi: 10.3389/frsc.2024.1449983

Smart city frameworks SWOT analysis: a systematic literature review

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In the past decade, the concept of "smart cities" has gained popularity as a way to address and manage challenges and complexities in urban areas. Different smart city frameworks have been proposed and the term "framework" has been defined, examined and proposed in various ways, with each interpretation taking a distinct approach. From a different angle, some frameworks highlight how the smart city concept is implemented, while others concentrate on assessing the initiatives' level of success. An additional collection of frameworks concentrated on the essential elements needed to make up a smart city. This research explicitly analyses frameworks concentrating on fundamental components to identify and suggest essential elements for developing an adaptable, sustainable smart city structure. Using a methodological approach that focused on the core elements of smart city structure, the research comprised of conducting a systematic literature review (SLR), and carrying out an analysis of the strengths, weaknesses, opportunities, and threats (SWOT) of existing frameworks. Based on the area of focus, the analysed frameworks were grouped into four categories: human-centric, techno-centric, integrated human-techno-centric and environmental-focus frameworks for easy SWOT analysis. The findings revealed that cyber-security issues pose threats to all frameworks and there are technological dependency vulnerabilities. This shows that technology is the driver/enabler of achieving smart city status. In addition, with the help of proper governance and effective management, involving citizens is key to releasing the potential for sustainable smart forms. Hence, the authors believe that technology, good governance, environmental concerns and citizens are essential components of an adaptable, sustainable smart city framework. A framework built on these crucial components is unique because it can be customised to fit any city. Management, infrastructural development and degree of public participation depend on different city configurations.

KEYWORDS

smart city framework, conceptual framework, SWOT analysis, smart city components, smart city drivers

1 Introduction

The term "smart city," which has gained significant traction globally over the last 10 years, has emerged as a pivotal element in urban strategic planning. The concept of the smart city has garnered widespread acceptance and has been extensively deliberated from a multitude of perspectives, resulting in a substantial corpus of literature concerning frameworks and implementation that permeates the global dialogue. The smart city paradigm leverages information and communication technology (ICT) alongside Internet of Things (IoT) networks to enhance municipal operations, services, and the interaction between governmental

officials and the citizenry, thereby striving to attain sustainability without detrimentally affecting the environment, societal welfare, or economic systems (Gowda et al., 2023). This concept has recently been proposed to encapsulate and address pressing urban challenges (Dameri et al., 2018). According to Chatterjee and Kar (2015), the characterization of a smart city may vary significantly based on the particular context and viewpoint from which it is conceptualized and operationalized. For the purposes of this investigation, the definition of a smart city adopted is that articulated by Yin et al. (2015), which posits that "A smart city is a system that integrates technology infrastructure and relies on advanced data processing aiming to improve city governance efficiency, increase citizen happiness, enhance economic prosperity and promote environmental stability" through a comprehensive review of existing literature. This definition is predicated on the dimensions of technical infrastructure, application domains, system integration, and data processing (Mupfumira and Mutingi, 2023). Smart cities are instrumental in advancing urban sustainability and facilitating economic growth. The concept of urban sustainability is contingent upon a myriad of interrelated factors, including natural resources, human capital, technology, social frameworks, and cultural influences. These interrelations encompass economic development, social equity, and environmental challenges. Fernández-Güell and López (2016) discerned that the complex and diverse characteristics of contemporary urban environments present significant impediments to effective long-term urban planning, with numerous concerns regarding complexity stemming from the operational dynamics and heterogeneity of the city. Given the disparities inherent among cities across various nations, the concept of the smart city has engendered a considerable corpus of literature, investigating an array of frameworks pertinent to the advancement of smart city initiatives. The selection of appropriate components to prioritize is imperative for the establishment of a sustainable smart city. Mosannenzadeh and Vettorato (2014) identified these components as the fundamental urban dimensions warranting focus during the development of smart cities. These dimensions constitute the cornerstone of a smart city framework. A smart city framework encompasses a multitude of components, including technology, governance, citizen engagement, and sustainability, aimed at addressing the multifaceted challenges posed by urbanization while enhancing the quality of life for its residents (Gowda et al., 2023).

1.1 Problem background and statement

Several smart city frameworks have been developed since the inception of the smart city idea. A significant amount of research on what components to include has been done with no consensus being reached. Some researchers focus on technology as the core of smart city development (Tan and Taeihagh, 2020), others have social and human capital as the core center of their approach, and some on environmental issues (Ouni and Saleem, 2022; Sharif and Rahman, 2022). Recently, there has been an emergency of research integrating human-centered and techno-centric approaches focusing on both user and technology (Al-Masri et al., 2019). However, the main challenges with these frameworks are that some of them focus on the implementation/transformation part (Theodoridis et al., 2013; Azizalrahman, 2019; Panchanathan et al., 2020), others on evaluating and assessing the success of the implemented frameworks (Al-Rimawi and Nadler, 2023; Karadağ, 2013; Khatibi et al., 2021; Picioroagă et al., 2018; Roman, 2018), while the majority do not consider the climate resilience. Additionally, the contextualization of the term "framework" significantly influences the development of various forms of frameworks. According to the Cambridge Business English dictionary, a framework can be a structure that something can be built on or an idea, information and principle that form the structure of an organization or plan for future use. Frameworks referred to in this research are those that formulate the basis of smart city structure, focusing on the determinants of a sustainable smart city. These determinants are sometimes referred to as components, dimensions or elements. These may be rooted in technology, environment, user-centric or integrated to formulate the conceptual framework. According to Greco and Bencardino (2014), the systematic integrated approach defines a smart city as one that possesses both technological advancements and a strong human and social capital foundation. This integration is necessary to create an environment conducive to continuous growth and innovation. While, the human-centered/user-centered approach focuses on prioritizing human needs as the core drivers of a smart city, placing significant emphasis on social and human capital in defining the smart city (Maccani et al., 2013). Most of these frameworks are based on an extensive literature review methodology (Achmad et al., 2018; Sourav et al., 2020; Yigitcanlar et al., 2018). Despite the availability of extensive literature-based frameworks, there is still no consensus on a smart city framework that suits all cities worldwide.

Yigitcanlar et al. (2018) elaborated on what a smart city is, the key drivers and desired outcomes and how the paradigm can be conceptualized. Li et al. (2019) proposed a generic shareable smart city framework, but it does not suit one- size-fit-all paradigm, especially focusing on the developing world. To develop a one-size-fits-all framework that can also be applied in the developing world, the framework has to contain basic elements that are common in both developed and developing setups. However, the existing frameworks include some elements that are far-fetched to implement in a developing nation setup. Some of these will be addressed if common elements such as technological advancement and user education are addressed. The proposed framework emphasizes integrated applications to promote information sharing and interconnection, however, there are data and technological barriers between various smart city systems that need to be addressed for this framework to work. In addition, the emphasis is on the application integration without user participation and empowerment consideration, there is a high risk of providing a framework that does not address actual needs, priorities, and preferences, and poses social exclusion due to social disparities. This may result in a lack of transparency and trust, public confidence is key to acceptance of the initiatives. Overreliance on technology may seem intrusive if there is no awareness on the user end, hence citizen involvement plays a major role in the potential success of smart city development. Despite the proposal of the shareable framework and availability of many frameworks, concepts and definitions (Batmetan and Quido, 2022) in their analysis of understanding smart city strategies in developing nations noted that the implementation of the smart city concept in the developing world is still a far-fetched dream. This is because the level of technological advancement and user awareness is still very low. More work needs to be done in terms of technological advancement and citizen education. Numerous challenges arise from the difficulty in formulating the best

strategy starting with limited budgets and policies. Since there are numerous challenges due to the dynamic complexity of the cities, management of urbanization through smart city implementation requires one to know elements to improve, especially in the developing world where resources are scarce. Hence, the question is "What can be included as the essential common elements to focus on for developing an adaptable sustainable smart city conceptual framework applicable to any city?" How are these elements being chosen for those cities that have implemented the smart city concept? This creates an opportunity to critically analyze existing smart city frameworks, focusing on the key elements included in their implementation to identify the main drivers of the city's smartness. This would help with the development of an adaptable sustainable smart city conceptual framework applicable to both the developed and developing world and reduce the experimentation with the real city.

1.2 Aim and objectives

In light of the above, this research wishes to (i) explore existing literature for possible smart city key components general to any city through SLR and SWOT analysis (ii) establish the smart city key components and (iii) propose areas of further studies. Evaluating the strengths, weaknesses, opportunities and threats of the existing frameworks would uncover the weaknesses and threats lying ahead of the existing frameworks highlighting their strengths and achievable opportunities. This helps identify common components to prioritize when developing an adaptable sustainable smart city conceptual framework.

2 Systematic literature review methodology

A systematic literature review (SLR) can be defined as a type of evidence based synthesis where authors do establish explicit eligibility criteria, gather all available studies that meet these criteria and summarizes the results using reproducible methods (Brignardello-Petersen et al., 2024). SLR is a structured comprehensive approach to identifying and synthesising the existing literature relevant to a particular topic, used to identify literature gaps and to provide evidence-based recommendations (Tranfield et al., 2003). Its primary purpose is the provision of a comprehensive overview of existing research on a particular topic allowing researchers to identify patterns, gaps and inconsistencies in the literature (Sharif and Rahman, 2022). This method is distinct from other types of reviews due to its rigorous methodology aimed at minimizing bias and errors. However, its quality is dependent upon the quality of included studies that varies significantly.

Summarised in Figure 1, systematic literature review (SLR) approach adopted by Sony and Naik (2020) was used. Firstly, scoping of the research through the definition of the frameworks under consideration was done. This was to streamline and guide the type of framework to be analyzed. In this case, those frameworks focusing on providing smart city components regardless of their bias towards technology, human or environmental centeredness were targeted. Keywords or search terms were established as outlined in the Figure 1 flow chart. Following these outlined steps, electronic data sources with smart city-related literature were established and searched providing a plethora of literature that required screening to suit the scope of the study. Figure 2 outlines the screening process used to get the final frameworks analyzed in this research.

2.1 Data sources

The first step to identifying target journals is to define the keywords and search terms based on the outlined research scoping (Tranfield et al., 2003). Electronic databases were searched for various smart city framework literature with the following keywords: *smart city/cities frameworks, conceptual smart city/cities models, frameworks for smart city/cities development, and smart city implementation frameworks.* Data source engines searched for these keywords included: Emerald, JSTOR, Science Direct, Taylor & Francis, EBSCOHOST, Google Scholar, Springer, Wiley, IEEE Xplore, Scopus, ProQuest Digital Library as well as peer-reviewed conference proceedings.

2.2 Screening

Figure 2 summarizes the literature review protocol used for the screening processes on the literature on hand. Coined by Popay et al. (2006), the screening process was adopted from Sony et al. (2020). The process involved outlining objectives and conceptual boundaries followed by a broad search of abstracts that meet the screening criteria to obtain the final sample of articles. This was to determine articles to be included in the review, and they must satisfy all inclusion requirements outlined in the protocol showing no evidence of meeting any exclusion requirements (Tranfield et al., 2003). Following the outlined screening process protocol, three screening phases were done. First, the research articles were picked due to the research title, then researchers went through abstracts of the selected literature for the second screening phase. The last phase was to go through the whole article, which yielded 22 research articles used in this research.

2.3 Analysis

The primary goal of this research is to unearth essential components to develop an adaptable smart city framework. Researchers sought to find articles proposing and developing smart city frameworks/models, smart city implementation, and components built/based on, compare, and contrast each framework and group them according to areas of focus. Description and critiquing of each framework in each area of focus, highlighting their shortcomings and strengths, the researchers were able to conduct the SWOT analysis and discover essential frameworks. As method for data collection, no interviews were done however, public documents, literature review and case study analysis on smart city implementation in Europe, Asia and Africa was looked at. Cities like Barcelona Spain, Seoul in South Korea and Bloomfontein in South Africa were looked at.

2.3.1 Studies descriptive analysis

The main goal of this research was to identify critical elements/parameters core to the development or implementation of smart city

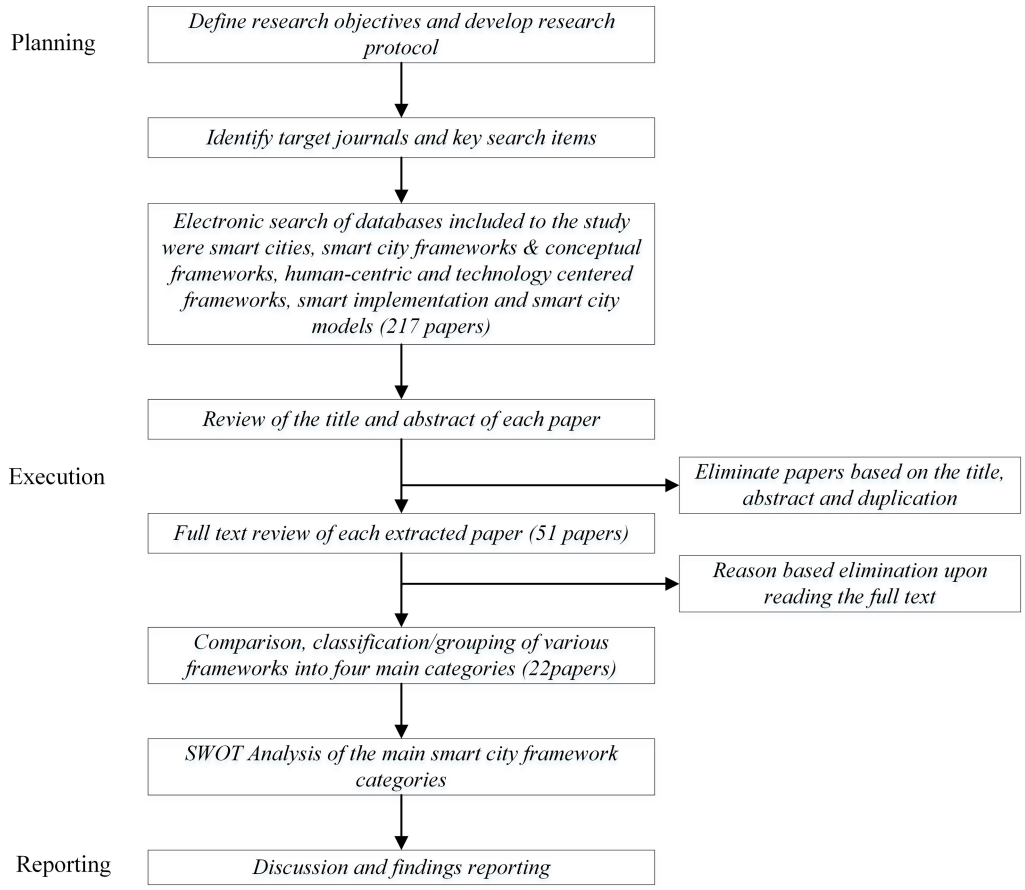

FIGURE 1
Systematic literature review (SLR) (adopted from Brignardello-Petersen et al., 2024).

concept. As part of the analysis process to remove bias on the SLR, a series of analysis was done. Figure 3 shows the database-wise article distribution. The distribution shows a popular response from reputed publishers on the smart city concept. The timeline distribution of the framework articles is explicated in Figure 4 shows an interest in the core elements of the smart city development. Since the inception of the concept, there is still interest on what to include and how explore the notion. Figure 5 highlights the distribution of the smart city key components in the reviewed articles. Majority of the articles contain six elements as the key components and ranges from a minimum of three to a maximum of nine. Lastly an analysis on composition of the each framework was done. This helped in getting the common elements used and most researchers have focused on and how they fared in implementation of the smart city concept. Figure 6 expedite these elements and of note is that some used infrastructure and others used the term technology. The infrastructure here is based on the technology hence it can be noted that technology, governance and environment took centre stage in the studied frameworks.

3 Smart city frameworks

Smart city frameworks integrate ICT to enhance urban environments, improve quality of life indicators by 10 to 30%, and promote sustainable urbanisation by meeting the needs of growing populations (Khan and Labonté, 2021). They leverage existing environments to impact social and management aspects sustainably, emphasising resource efficiency, security, and inclusive growth (Joshi et al., 2016). These smart cities are characterised by common components identified from the literature and fall into different categories depending on the area of focus as outlined in the following sections.

3.1 Technology-centered frameworks

Technology-focused smart city frameworks are pivotal in addressing the multifaceted challenges of urbanisation, leveraging advancement in ICT, IoT and other digital innovations to enhance city operations, sustainability and quality of life. El Hendy et al. (2022) emphasised the need for a holistic ICT framework to ensure interoperability and effective adoption of smart city technologies, highlighting the importance of strategic planning and integrating various ICT infrastructures to achieve smart city goals. As highlighted by the concept of smart cities that connect residents and improve sustainability in Falconer and Mitchell (2012), ICTs and IoT devices integration is crucial for improving city operations and services. Guan and Pei (2022) applied this integration of ICT and IoT in their suggested social-technical integrated framework based on IoT and cloud computing covering dimensions like smart economy,

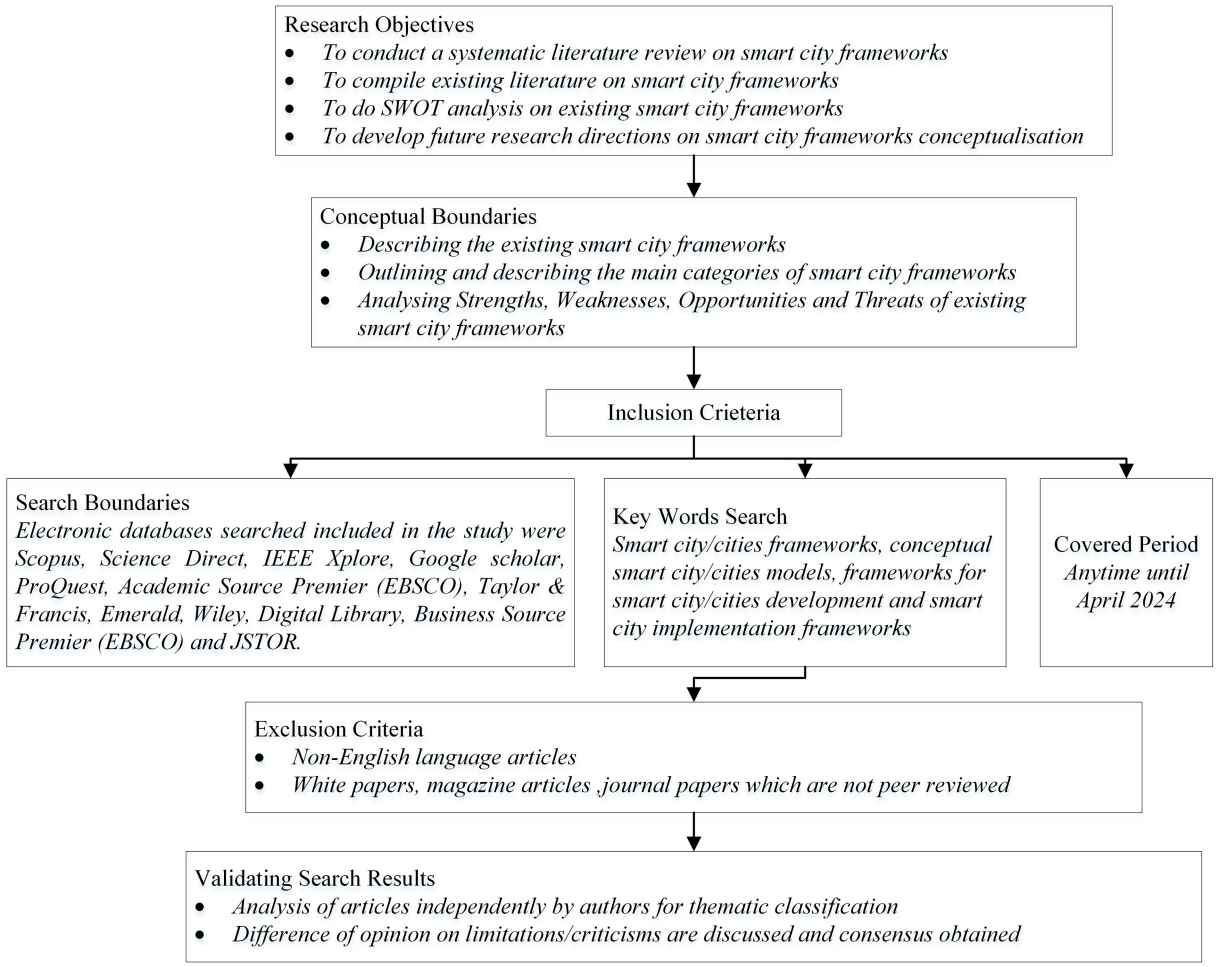

FIGURE 2
Literature review protocol (adopted from Popay et al., 2006).

environment, governance, living, mobility and people. Gowda et al. (2023) discussed the role of IoT in city-wide and home-level automation highlighting the importance of communication channels and protocols whilst Dirsehan and van Zoonen (2022) discussed the dynamics of citizens' acceptance of these smart city technologies emphasizing technology visibility importance and citizen interaction. These frameworks collectively highlight the crucial role of technology in developing smart cities, focusing on interoperability, citizen engagement, sustainability and integration of advanced digital solutions to address urban challenges effectively.

3.2 People/user-centered frameworks

People-centred smart city frameworks prioritise the integration of technology with the needs, values and participation of citizens to enhance urban living. Emphasis is on designing cities that not only leverage technological advancements but also focus on improving the quality of life for their inhabitants, ensuring inclusivity, sustainability and participatory governance. The smart city concept has evolved from a purely technologically oriented urban development framework to one that is intelligent, creative and sustainable with a strong emphasis on people-centeredness, participation and inclusion (Jakonen, 2023). This shift acknowledges the critical role of citizens in shaping smart urban environments, where participatory design and the consideration of space-specific complexities become essential (Wei, 2023). For instance, the use of sustainable big data analytics assists in optimising urbanisation efforts with minimal environmental implications, demonstrating a move towards user-centred design (Founoun et al., 2022). Moreover, integrating human sensitivities with technical data management enables better decision-making and governance, putting citizens at the heart of smart city initiatives (Founoun et al., 2022; Di Bernardo et al., 2023). The approach is further exemplified by efforts to understand and incorporate citizens' perceptions and experiences through innovative platforms, such as mobile applications that validate weather data based on user feedback (Andreasyan et al., 2021; Tomitsch and Ellison, 2023). The involvement of citizens in city improvement projects through co-production mechanisms emphasises a balanced and transparent relationship between the public sector and citizens, showcasing a practical application of human-centred frameworks (Calzada et al., 2023). Furthermore, cultural and spiritual aspects of smart cities argue that identity, values and the common good should be integral to smart city planning, advocating for a broader definition of smartness that includes cultural transmission and well-being.

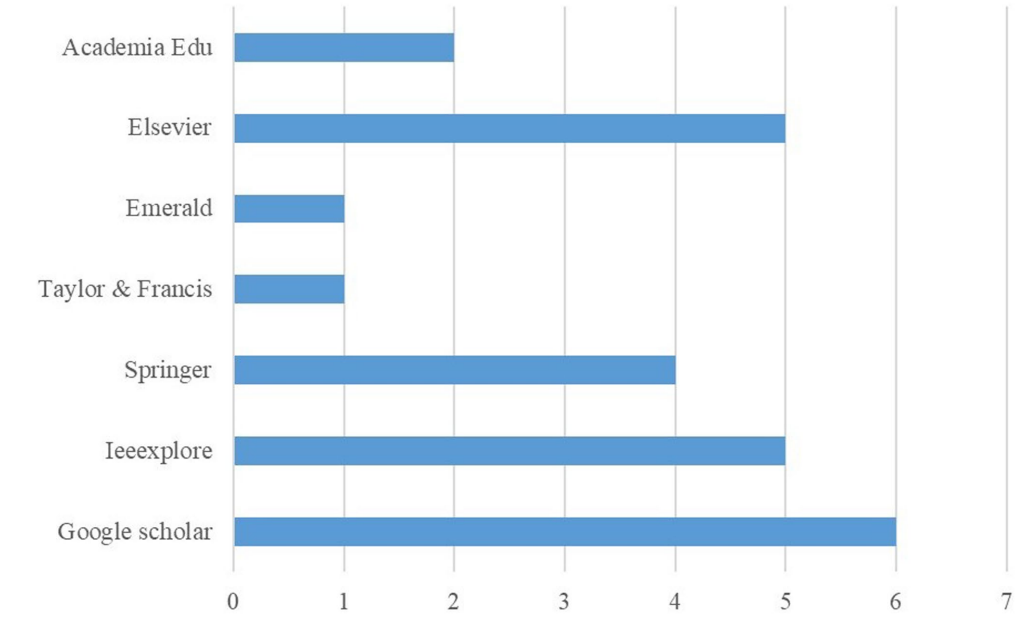

FIGURE 3
Database-wise articles distribution.

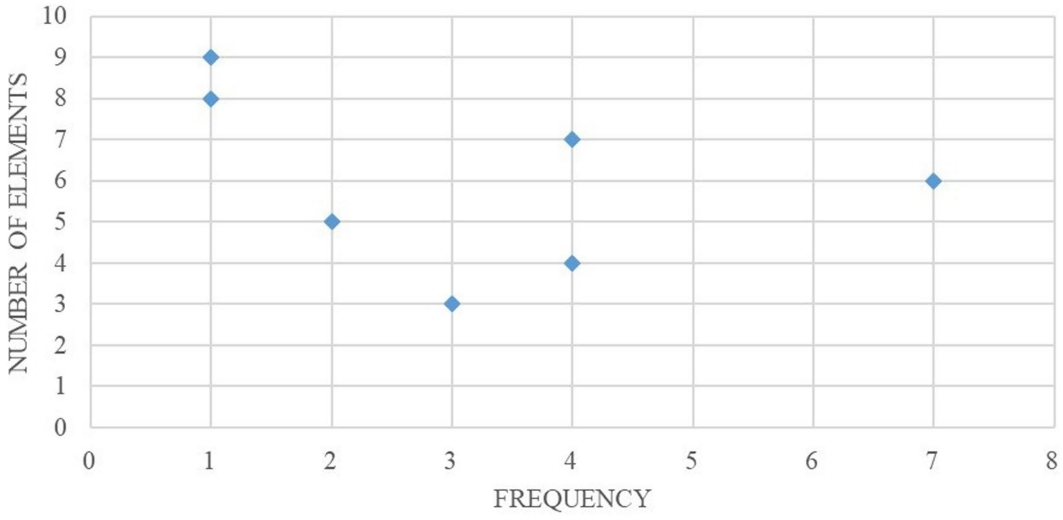

FIGURE 4
Smart city core elements interest-wise distribution.

3.3 Environmental-centered frameworks

Environmental-centred smart city frameworks focus on integrating sustainable practices with advanced technologies to enhance urban living while minimising ecological footprints. They emphasise the importance of smart mobility, transit-oriented development (TOD) and the integration of information and communication technologies (ICTs) to improve the quality of life, productivity, and competitiveness in urban areas. Sharif and Rahman (2022) developed a conceptual framework which highlighted the necessity of combining smart mobility and TOD performance indicators for eco-friendly urban living, identifying key indicators such as utilisation of transit nodes, walkability, and environmental stewardship. Supported by Wei (2023), research demonstrates how sustainable big data analytics can optimise the urbanisation process with minimal environmental implications, achieving high efficiency and energy savings. Wireless sensor networks (WSNs) and the Internet of Things (IoT) are foundational to these frameworks, enabling real-time environmental monitoring and data collection for better decision-making and resource management (Ouni and Saleem, 2022). Husein and Mudhafar (2023) proposed the SenSquare architecture further illustrating the potential integration of diverse data sources

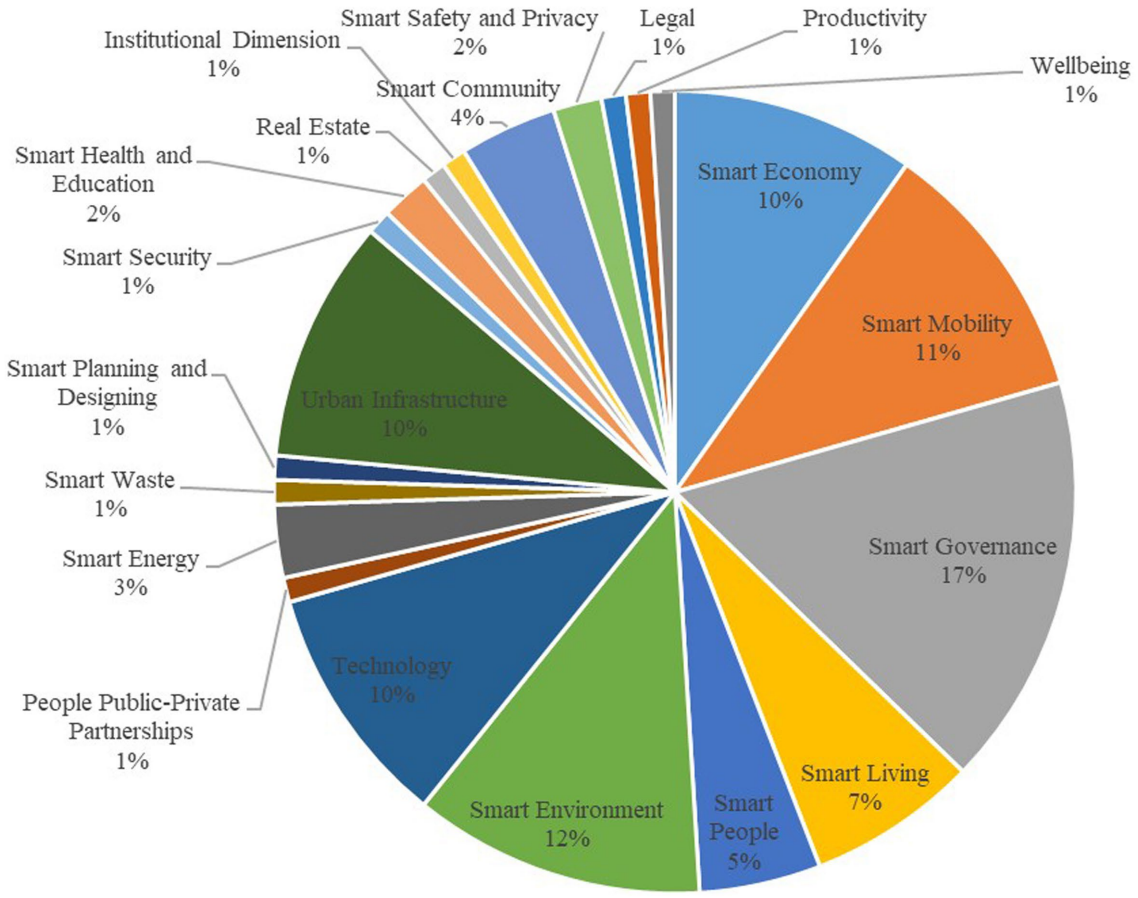

FIGURE 5
Smart city key elements distribution.

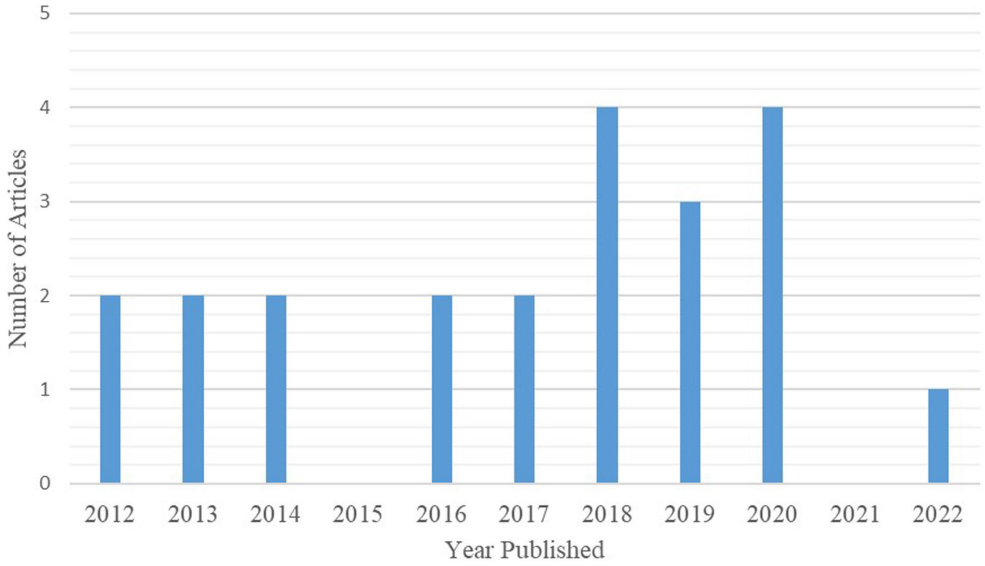

FIGURE 6
Article year-wise distribution.

through IoT for urban-scale environment monitoring. Tiwari et al. (2022) emphasised six pillars crucial for developing smart and green cities, including renewable energy and sustainable infrastructures, highlighting the role of ICT in achieving long-term urban sustainability.

3.4 People-techno-centric integrated frameworks

People-techno-centric smart city frameworks emphasise the integration of technological advancements with a strong focus on human needs, aimed at creating efficient urban environments that are inclusive and responsive to the citizens' lifestyles and preferences. By allowing citizens to actively participate in urban development using digital tools, these frameworks advocate for a participatory design to ensure the growth of smart people-centric cities (Jakonen, 2023). This approach is further enriched by combining the technical aspects of data management with human sensitivities, allowing for a governance framework that places citizens at the heart of smart city initiatives (Founoun et al., 2022). Incorporating human-computer interaction research and human-centred methods, these frameworks seek to improve urban living, exemplified by efforts to enhance pedestrian safety through smart technology interventions informed by people's lived experiences (Tomitsch and Ellison, 2023). The integration of the Internet of Things (IoT) and cloud computing technologies by Guan and Pei (2022) supports the multidimensional aspects of smart cities, including economy, environment, governance living, mobility and people, highlighting the importance of a social-technical framework. Despite the technological focus, there is a growing recognition of the need to prioritise the human element within smart cities. This involves viewing cities as evolving ecosystems where innovation and better services emerge from the interactions among various stakeholders, emphasising the role of citizens in making cities smart (Di Bernardo et al., 2023). Sustained by the notion that smart city technology should facilitate direct communication between city officials and the public, fostering a more sustainable and responsive urban environment (Falconer and Mitchell, 2012). To sum up, human-techno-centric smart city frameworks are a comprehensive approach to urban development that uses technology to improve human well-being, participation and cultural identity. This ensures the smart city's efficiency, sustainability, inclusiveness and residents' needs and values representation.

4 Comparison of smart city framework

To facilitate a clear and concise comparison of the various extracted smart city frameworks, Table 1 presents a detailed overview of each framework focusing on the author, the unique key components included and the number of components each framework has. This comparison illustrates the commonalities and differences among the frameworks and aids in gaining valuable insights into the differing priorities, areas of focus and outcomes. As part of the comparison, some common names have been adopted combining components such as smart built environment, smart environment and smart natural environment into a single component. In a case where a framework has both a smart built environment and a smart natural environment, the framework would have a single component representing all. From the table, it can be noted that the frameworks have different total numbers of components that range from as low as three to as many as nine, this shows that we are still a long way in achieving a universally accepted standard framework for smart city development. This variability may suggest several insights that may include:

- Diverse priorities: Having different goals such as sustainability, governance, social equality and technology.
- Interdisciplinary approaches: Variations may arise from integrating elements from urban planning, environmental science, social sciences and information technology. It is known that all smart cities have to solve urbanisation challenges, hence understanding these differences can help select a framework that best suits their objectives and circumstances.
- Context-specific needs: Specific needs, challenges and contexts of different cities vary highlighting the importance of tailoring frameworks to local conditions
- Complexity and comprehensiveness: More components may aim to be more comprehensive, covering a wide range of factors, while those with fewer components might focus on core elements deemed most critical

4.1 Grouping of various smart city frameworks

Various existing frameworks were grouped based on their primary focus areas to enable SWOT analysis on the set of frameworks focusing on the fundamental components. This grouping helped in understanding the diverse approaches to smart city development. These focus areas are: Group A, the group comprised of frameworks that focus on human or people-centric approaches, Group B is for techno-centric frameworks while Group C is for combined human-centric and techno-centric approaches, Lastly, Group D has frameworks that focus on environmental issues. Section three describes each group of frameworks. The SWOT analysis results are presented in tables under each group in section 4.3. Table 2 has the smart city framework groups.

4.1.1 Group A

According to Yigitcanlar et al. (2018), this type of framework has community, technology and policy as the main drivers of smart cities. These are linked to the desired outcomes such as sustainability, productivity, accessibility, well-being, livability and governance for guidance in the development of sustainable smart cities as a balanced and sustainable approach. The uniqueness is that drivers and outcomes are brought under one roof to improve the conceptualization and practice of smart cities by focusing beyond technology. In the same vein, Mosannenzadeh and Vettorato (2014) had earlier pointed out the importance of governance and stakeholder involvement for a holistic view beyond technology, suggesting a causal connection between smart city drivers and sustainable urban development focusing on achieving the desired outcomes such as productivity and governance. In the framework, smart communities were identified as critical drivers emphasizing access to technology, services and platforms and engaging in local communities for sustainable urban development. On the other hand, Achmad et al. (2018) added the emphasis on good governance in meeting government objectives and citizen needs. In their framework, the researchers proposed integration of existing

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TABLE 1 Smart city frameworks comparison.

Author		Govada et al. (2017)	Bibri (2018)	Allam (2017)	Falconer and Mitchell (2012)	Maccani et al. (2013)	Veldhuis et al. (2014)	Das (2013)	Keswani and Kumar (2018)	Chourabi et al. (2012)	Kuru and Ansell (2020)	Joshi et al. (2016)	Bakry et al. (2019)	Naqvi et al. (2020)	Yadav et al. (2019)	Yigitcanlar et al. (2018)	Achmad et al. (2018)	Budhiputra and Putra (2016)	Tiwari et al. (2022)	Al-Masri et al. (2019)	Kumar et al. (2020)	Sourav et al. (2020)	Mosannenzadeh and Vettorato (2014)
Name of components	Smart economy	✓	✓			✓	✓	✓	✓			✓				✓				✓	✓		✓
	Smart mobility/smart transport	✓	✓		✓		✓	✓		✓	✓			✓	✓				✓		✓		✓
	Smart governance	✓	✓			✓	✓	✓		✓	✓					✓					✓		✓
	Smart living	✓					✓	✓	✓												✓		
	Smart people/citizens			✓			✓	✓					✓					✓		✓	✓	✓	
	Smart environment (built & natural)	✓	✓				✓	✓		✓	✓		✓	✓	✓	✓				✓	✓		✓
	Information/city services/ technology				✓	✓						✓	✓	✓	✓	✓	✓		✓	✓		✓	✓
	Infrastructure (social, urban)/utilities/resources/ real estate	✓	✓	✓	✓	✓						✓		✓	✓		✓	✓	✓				
	Smart agriculture																		✓				
	Smart energy		✓							✓	✓				✓								
	Smart waste		✓																				
	Smart planning and designing		✓																			✓	
	City goals and strategy												✓		✓		✓						
	Smart health and education		✓							✓	✓								✓				
	Community									✓	✓					✓		✓		✓			✓
	Legal/policy											✓				✓				✓			
	Smart safety and privacy								✓	✓	✓			✓									
	Organisation/management			✓								✓	✓					✓		✓			
	People-private-partnership					✓																	
	Sustainability											✓										✓	
Total Number of Components		6	9	3	4	5	6	6	3	7	7	6	5	6	6	7	4	3	4	8	6	4	7

TABLE 2 Smart city frameworks grouping.

Group	Frameworks	Approach
A	Mosannenzadeh and Vettorato, Achmad, Al-Masri et al., and Yigitcanlar et al.	People-centric (human-centered approach)
B	Allam, Naqvi et al., Budhiputra and Putra, Das, Tiwari et al., Kesswani and Kumar, Sourav et al., Chourabi et al., Joshi et al., and Kumar et al.	Technology-centred approach
C	Kuru and Ansell, Macani et al., Govada, Falconer and Mitchell, Yadav et al., Veldhuis et al., Chourabi et al. and Yigitcanlar et al.	Integrated human-technology approach
D	Kuru and Ansell, Bibri, Yadav et al., Achmad et al., Bakry, Kumar et al., and Sourav et al.	Environmental approach

smart city concept with focus on livability, workability and sustainability. The goal was to meet citizen needs through ICT capabilities. This notion is in sync with Al-Masri et al. (2019) whose framework emphasizes the importance of structured governance and operational efficiency of government service delivery and citizens' easy access facilitation. The framework has people and communities at heart focusing on improving quality of life and citizen engagement in the urban development, using economy as the critical dimension for economic growth. The goal for all these frameworks is centered on improving livelihood of the citizens.

4.1.2 Group B

The focus of the frameworks in this group is on smart city ecosystem enhancement through integration of technology, human and institutional aspects. Furthermore, they seek to address the key questions on the necessity, components, actors, locations, timing and methodologies for creating smart cities. In their proposed framework, Allam (2017) addressed the need for smart infrastructure for the support of various urban dimensions with a global perspective to incorporate diverse criteria for smart city development across different countries. On the other hand, Kesswani and Kumar (2018) integrated technology, human and institutional aspects for enhancing the smart city ecosystem focusing on quantitative and qualitative values. The emphasis was on the importance of data acquisition, networking and analytics in the development of smart cities and adaptability with learning and technology utilisation among people for the enhancement of the city's potential efficient resource management by Das (2013). The use of technology is the centre of this resource management (Naqvi et al., 2020), whilst the smart infrastructure in various dimensions such as energy, industry and healthcare support were addressed in Kesswani and Kumar (2018). According to Chourabi et al. (2012) emphasis should be on the importance of communication technologies (ICTs) and information integration with development projects to enhance city management and functioning. This integrative approach suggested that successful smart city initiatives require balancing technological advancement with human, organizational and environmental considerations.

The SMELTS, by Joshi et al. (2016) provided a holistic approach that leveraged on the existing legal, economic and technical environment to impact the social and management aspects sustainably, the framework explains the interrelationships between its components indicating that some factors have a more significant impact on the context with technology as the foundation and sustainability as the basis for development. These technological factors included a structured model development utilizing tree maps to organize data into categories and highlight relationships between different aspects of smart cities by Kumar et al. (2020). This aimed at introducing smart cities' security and privacy, addressing daily challenges and digitalization issues through services and architectural framework portfolio, the framework included an application relationship diagram illustrating fundamental building blocks of smart city applications focusing on privacy enabling technologies, Internet of Things (IoT) ontologies and security techniques. It sought to establish a trust framework for privacy-protected data sharing within smart cities, identifying best practices and standards necessary for reliable and adaptable emerging technologies (Naqvi et al., 2020). Other researchers, such as Tiwari et al. (2022) provided a structured approach to smart city development emphasizing the importance of clear objectives and integration of ICT solutions for operational efficiency and transparency whilst Kumar et al. (2020) developed a business process re-engineering (BPR) integration that enhanced city management and services to address daily urban challenges through BPR and ICT implementation. Emphasis was put on tools standardization and business processes for effective problem identification, assessment and solution implementation utilizing service-oriented architecture (Budhiputra and Putra, 2016). Providing green smart cities realization through the Internet of Things and the quality of life and urban environments enhancement achieved through integration of technology with social dynamics (Kumar et al., 2020). Rounding of these frameworks was a framework that focused on sustainability and technological integration by its applicability was aimed at developing nations addressing challenges of urban lifestyle through technological improvement (Sourav et al., 2020). In the framework, technology and city services play a crucial role, focusing on ICT and other technologies earmarked for the delivery of effective service utilization. It incorporates a regulation-guided working environment to ensure service delivery is governed by rules and regulations with awareness of the importance of public use and professionals delivering the services (Bakry et al., 2019).

4.1.3 Group C

The framework has people, place and planet as the core values and emphasises sustainable urban development beyond technological advancement, the framework integrates smart thinking, planning and design principles for comprehensive urban and rural development. Technology is embedded in the urban infrastructure to enable smart people to utilise digital data to enhance smart city life. The framework promotes non-motorised transportation, high-quality public spaces and urban designs that consider human scale and environmental sustainability. This aims to reduce over-reliance on technology, focusing instead on good planning and design for progressive smart city development (Govada et al., 2017). Falconer and Mitchell (2012) added the dimension of multidisciplinary approach, were combination of insights from academic, industrial and governmental sources define

and structure the smart city concept. Various components and stakeholders are integrated to enhance urban life offering step-by-step progression from setting high-level objectives to practical implementation outlining a decision methodology that focuses on operational efficiency and transparency (Maccani et al., 2013). A systematic approach to smart city development focusing on technology, social infrastructure, public-private partnerships, governance, management and smart information services that aimed at bridging gaps in smart service delivery through strategic partnerships of governments, businesses and citizens and suggested a balanced scorecard model for assessing and managing the city strategies, emphasizing the need for SMART goals and critical success factors. The framework integrates technology with social dynamics for sustainable development to enhance urban environments and quality of life through smart technology and participatory planning. It analyses how to develop citizen- and resource-centric smarter cities based on the recent smart city development initiatives (Kuru and Ansell, 2020). According to Yigitcanlar et al. (2018) the framework has three main drivers of smart cities namely community, technology and policy that are linked to the five desired outcomes which are sustainability, productivity, accessibility, well-being, livability and governance to create a multi-dimensional approach to understanding smart cities. Emphasis is put on these drivers and outcomes for guidance for the development of sustainable smart cities as a balanced and sustainable approach. It is unique in bringing together drivers and outcomes under one roof to improve the conceptualization and practice of smart cities by focusing beyond technology. A reusable framework in settings where collaboration among stakeholders is necessary for the advancement of smart city initiatives and facilitates the formulation of joint research agenda and development of new smart city initiatives by illustrating how different topics fit into the causal structure of smart cities (Veldhuis et al., 2014). The framework emphasizes the importance of good governance in meeting government objectives and citizen needs (Achmad et al., 2018). The framework was designed to address urbanization challenges aimed at improving livability, fostering innovation and promoting economic development by incorporating smart evolving components and best practices with an emphasis on the importance of engagement of local government, institutions and residents as the key stakeholders in the development process (Kuru and Ansell, 2020).

4.1.4 Group D

Developed to mitigate urbanisation issues such as energy consumption and environmental degradation, the framework integrates sustainable and smart city concepts. It leverages ICT and sustainable design principles to address these challenges for future cities (Bibri, 2018). Emphasis is on continued development towards better performance and sustainability leveraging on both reactive and proactive strategies (Bakry et al., 2019). Yadav et al. (2019) added that the frameworks are designed to support the development of a sustainable smart city (SSC). The developed framework identified and structured key factors that influence SSC success using a hybrid BWM-ISM (Best Worst Method-Interpretive Structural Modelling) approach to prioritize and organize these factors. Enablers are categorized into major groups such as infrastructure, Strategy and policy, social and personal, mobility, energy and environment highlighting their substantial impact on SSC development. Sustainable resource management, smart building development, advanced research and development systems and intelligent transport systems are prioritized as key enablers. The framework integrates technology with social dynamics for sustainable development to enhance urban environments and quality of life through smart technology and participatory planning (Kumar et al., 2020; Kuru and Ansell, 2020). The framework was designed to address urbanization challenges aimed at improving livability, fostering innovation and promoting economic development by incorporating smart evolving components and best practices with an emphasis on the importance of engagement of local government, institutions and residents as the key stakeholders in the development process (Sourav et al., 2020; Kuru and Ansell, 2020). The framework is designed to be adaptable, supporting urban planning and ICT for the development of good government services and policy making particularly in developing countries, the framework included resources, city services, architecture and goals to enhance city responsibilities and meet citizen needs through ICT capabilities (Achmad et al., 2018).

4.2 SWOT analysis

SWOT analysis is a strategic planning tool used to identify and evaluate the internal and external factors that can impact the success of a project. An acronym for strengths, weaknesses, opportunities, and threats that is widely used across various sectors to inform decision-making processes and strategy formulation. It helps organizations understand their current position and develop strategies to achieve their objectives. This analysis helps organizations understand their current position and develop strategies to achieve their objectives (Abdel-Basset et al., 2018). While SWOT analysis is a valuable tool, it has limitations. Its simplicity may lead to oversimplified conclusions. It may not prioritize factors and lead to subjective interpretations. These issues can be addressed through integration with analytical methods such Importance-performance analysis to enhance its effectiveness (Lee et al., 2020; Phadermrod et al., 2014). The components of SWOT analysis are:

- Strengths and weaknesses: These are internal factors an organization can control. Strengths refer to the attributes that give an organization and advantage over others, while weaknesses are areas where the organization may be at a disadvantage (Abdel-Basset et al., 2018; Dalton, 2019).
- Opportunities and threats: These are external factors that an organization cannot control but can respond to. Opportunities are external chances to improve performance, such as adopting new technologies whilst threats are external challenges that could harm the organization such as regulatory changes (Nagy and Zseni, 2016).

4.3 A SWOT analysis of smart city frameworks

A popular tool for business and strategy students, SWOT analysis has been around for decades, widely used in industry, commerce and charitable organizations. Each group of frameworks was analyzed based on its strengths, weaknesses, opportunities and threats. Tables 3–6 show the SWOT analysis. Though subject to bias and

TABLE 3 People-centric (human-centered approach).

Strengths	Weaknesses
• Effective community engagement • Social innovation (cultural diversity to local insights) • Citizen-centric design to meet citizen preferences • Inclusive and equity for accessibility of smart city solutions	• Technological dependence • Digital exclusions • Regulatory challenges • Funding constraints
Opportunities	**Threats**
• Transparency that brings trust and cohesion • Corruption reduction • Sustainable development • Economic development • Quality of life improvement through citizens' needs prioritization	• Data privacy concerns • Social inequalities • Cybersecurity risks • Technological obsolescence

TABLE 4 Technology-centered approach.

Strengths	Weaknesses
• Technological innovation • Boost business efficiency and resilience to market change • Seamless connectivity • Smart infrastructure and services	• Exclusionary access to certain population • Lack of human-centered design that may result in dissatisfaction • Technology dependency leaves them vulnerable to disruptions such as cyber-attacks, system failures and technological obsolescence • Data privacy concerns
Opportunities	**Threats**
• Digital transformation • Economic growth and innovation • Global competitiveness • International connectivity • Environmental sustainability through techno-centric solutions	• Technological obsolescence • Public trust and acceptance, overreliance on technology may erode public trust and may seem intrusive • Social inequality from social disparities among citizens • Cybersecurity risks • Beliefs and superstitions

TABLE 5 Integrated human-centered-techno-centric approach.

Strengths	Weaknesses
• Enhanced quality of life • Boost business efficiency and resilience to market change • Inclusive development • Effective community outreach • Transparency • Data-driven decision-making	• Complexity and coordination challenges • Digital exclusion • Technological dependency
Opportunities	**Threats**
• Creation of an environment that promotes the health, safety and welfare of the elderly • Corruption reduction • Smart infrastructure and services to boost connectivity • Sustainability and resilience • Economic growth and competitiveness • Citizen engagement and empowerment	• Technological obsolescence • Social inequalities • Data privacy concerns • Cybersecurity risks

subjectivity, SWOT analysis helps in the identification of unique assets and advantages such as innovation potential or technological infrastructure whilst highlighting issues such as cybersecurity vulnerability. It offers a structured approach to evaluating different framework approaches focusing on internal and external factors that influence the elements making up each proposed smart city concept. In addition, recognition of external threats and opportunities is laid bare for all to see, this makes it very useful to this research to articulate essential elements for strategic planning of smart city conceptualization. Through an understanding of internal and external factors affecting the smart city concept, key components that matter to the implementation can be highlighted.

The people-centric smart city approach has the strength of social innovation, inclusive accessibility and community engagement. This

TABLE 6 Environmental approach.

Strengths	Weaknesses
• Improved quality of life • Economic benefits • Climate resilience • Innovation and technological advancement	• Implementation challenges due to huge upfront investment • Technological dependency • Regulatory constraints
Opportunities	**Threats**
• Green jobs and industries • Circular economy initiatives • Community engagement • Sustainable transportation	• Climate change impact • Environmental degradation • Social equity • Resource scarcity

platform provides a platform for transparent governance that reduces corruption and enhances sustainable development since everyone will be involved in the concept implementation. However, the weakness of overreliance on technology needs to be addressed to mitigate data privacy concerns, and social inequalities and reduce cyber-security risks. To succeed, technological advancement must be balanced with social inclusivity, addressing regulatory challenges while prioritizing transparency and citizens' needs.

This group of frameworks leverage technology to boost business efficiency and resilience with seamless connectivity, there are opportunities for digital transformation. However, there is a danger of excluding certain populations which may violate certain cultures and threaten public trust erosion. Hence to succeed, this initiative must address the exclusionary access, mitigate technological vulnerabilities and balance technological advancement with social and environmental considerations while fostering public trust and acceptance.

This group of smart city initiatives highlights the strength of inclusive development through effective community engagement to improve transparency and data-driven decision-making that boosts business efficiency to promote sustainable economic growth. This will enhance the citizen's quality of life. However, coordination complexity due to community engagement must be managed and mitigation strategies for technological obsolescence, social inequalities, data privacy concerns and cyber-security issues need to be in place.

This initiative climate resilience through technological advancement for improved quality of life. There are opportunities to promote the circular economy and community engagement. However, technological dependency and regulatory constraints are an issue and social quality challenges and resource scarcity need attention.

5 Discussion and further research direction

Firstly, from the existing frameworks literature, it was noted that technological frameworks focused more on the development and linking of different infrastructures from data protection, to IoT and the provision of smart transport infrastructure, disregarding human need or consensus. While the human-centred framework was concerned with the citizens' welfare and needs, environmental frameworks focused on infrastructure development that prioritises climatic resilience and green space in urban areas. On the other hand, integrated frameworks combine technological infrastructure development with human needs. Secondly, for the integrated human-technology-centered frameworks, complexity challenges and coordination of different social divides may be a hindrance to smart city implementation/development. However, when it realises the desired organisational issues alignment foundation, SWOT is the go methodology/tool; it lists favourable and unfavourable internal and external issues in a way that management/planners understand how to leverage strengths to realise opportunities and how weaknesses slow progress or magnify organisational threats (Helms and Nixon, 2010). This will enable finding possible ways to enhance growth and overcoming weaknesses and threats that may derail the goal.

In this study, SWOT analysis revealed that cyber-security issues threaten all frameworks and have a weakness in technology dependency, which shows that technology is the driver/enabler of achieving smart city status and implementation of policies and strategies to deal with these issues is of paramount importance. Technology dependency mitigation strategies such as data governance and policy to protect citizens' sensitive information, diverse technology solutions to avoid reliance on a single technology, data security measures and employing public-private partnerships to get a wider range of expertise and technologies can be used. On the other hand, social inequality from citizens' social disparities, and overreliance on technology coupled with beliefs and superstitions may erode public trust, these can be major threats to successful smart city initiatives implementation. Considering that citizen inclusion is key to unlocking potential sustainable smart city forms, empowering and engaging the citizens promotes transparency and data-driven decisions. It removes certain beliefs and superstitions and enhances trust and acceptance of the smart city initiatives. In addition, the goal for sustainable smart city implementation is to solve complex urban challenges and improve the quality of life for its citizens that can be achieved through the citizens' needs consideration and addressing of environmental issues such as climate resilience, hence circular economy initiatives must be included. Furthermore, citizens' engagement in smart city initiatives promotes data-driven decision-making to aid management and governance. Without proper governance, smart city initiatives may face premature death due to the complexity of community engagement.

In summary, the proposed essential framework components emphasise transparent governance based on data-driven decision-making, citizen empowerment and engagement, and protection of the environment and social equity rather than only buttressing the technological urban development. Hence, the authors believe

technology, governance, environmental issues and citizen inclusion are essential components of an adaptable conceptual smart city framework. A framework built on these essential components makes the framework unique due to its adaptability to any city, management, infrastructural development and public engagement levels depending on the city set-up. More effort should be placed on complexity and coordination challenges, riding on all opportunities and strengths from the analysed frameworks and identifying possible ways to reduce weaknesses and alleviate threats emanating therefrom. Areas for further study should be on the development of the adaptable sustainable smart city framework focusing on the integration, complexity and coordination of the highlighted essential dimensions.

6 Conclusion

In conclusion, the systematic literature review (SLR) and SWOT analysis helped uncover fundamental components or dimensions to focus on for developing an adaptable sustainable smart city framework. The essential components/dimensions to focus on are; technological infrastructure, environmental sustainability, citizen engagement and governance.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

PM: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. MM: Supervision, Validation, Writing – review & editing. MS: Supervision, Validation, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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