Governance In Smart Cities: Identifying And Analyzing Key Indicators Of Governance Structures

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Abstract

Background: Smart cities are characterized by integrating Information and Communication Technology (ICT) to address urban challenges, involving human and social capital as well as smart governance. Although there is no consensus on their definition, smart cities are generally seen as innovative projects to foster urban development through technology. However, effective governance in these cities poses significant challenges, requiring a multifaceted approach that involves collaboration between public and private sectors and civil society. This study seeks to identify key indicators for constructing effective governance frameworks in smart cities.

Materials and Methods: Through a qualitative analysis of 70 articles from the ScienceDirect portal (2020-2024), this study explores the criteria and indicators of governance in smart cities. The articles were reviewed and filtered using a protocol with nine guiding questions, resulting in the extraction of 311 terms, which were then grouped into 33 indicators across five themes. These themes - Governance and Participation, Policies and Regulations, Strategies and Urban Planning, Technology and Innovation, and Indicators and Assessments - form the foundation for effective governance structures in smart cities.

Results: The results highlight that governance in smart cities must be dynamic and adaptable, incorporating citizen participation, transparent public policies, open data practices, and efficient use of ICT. The findings contribute to a more comprehensive understanding of how governance structures can foster sustainability, inclusivity, and efficiency in smart urban environments. By synthesizing key governance indicators, this research provides a framework to guide the development of governance models that can support the evolving needs of smart cities.

Conclusion: Effective governance in smart cities requires dynamic, adaptable structures that foster collaboration between public and private sectors and civil society. This study provides a framework to promote sustainability, inclusivity, and efficiency in smart urban environments.

Keywords: Smart Cities; Governance Structures; Governance Indicators; Policy and Regulation.

I.   Introduction

Smart cities are often defined by the application of Information and Communication Technology (ICT) (Tura & Ojanen, 2022) to address urban challenges (Antwi-Afari et al., 2021). Some researchers extend this definition to include human and social capital (Ozkaya & Erdin, 2020) and smart governance (Abu-Rayash & Dincer, 2021; Kopackova, Komarkova & Horak, 2022). Despite the lack of a universally agreed definition, the term "smart city" typically refers to innovative projects that leverage ICT to facilitate urban development. In essence, a smart city is a metropolitan area transformed through technology, thus earning the designation of "smart" (Mao et al., 2023).

The implementation of smart city concepts has gained increasing relevance, as numerous studies demonstrate their significance. Big data technology, for instance, is used for effective governance, employing camera analysis for management and monitoring (Al-Badi & Khan, 2022), traffic light control to reduce vehicle congestion (Korecki et al., 2024), smart energy systems (Abu-Rayash & Dincer, 2023), smart transportation and digital factories (Wu, Xie & Lyu, 2023), and Internet of Things (IoT) systems to address complex urban issues (Biloria, 2021). These technologies are propelling the movement of smart cities forward.

The benefits associated with smart city initiatives have led many cities to upgrade their infrastructure in pursuit of achieving smart city status (Antwi-Afari et al., 2021). However, the rapid expansion of these applications raises questions regarding the appropriate governance structures needed to manage such cities

effectively. These governance frameworks must be multifaceted, integrating multiple layers of administration, and promoting collaboration between the public and private sectors, as well as civil society.

The critical discourse surrounding smart cities emphasizes the concept of "smart urbanism" (Hatuka & Zur, 2020), calling for a shift from simplistic policy analysis to a more intricate understanding of how technology, capitalism, and urbanization converge in shaping smart city initiatives and their impacts on urban life (Hatuka & Zur, 2020, p. 55). Nevertheless, Antwi-Afari et al. (2021) raise concerns about how cities can assess their current level of smart development and enhance their governance structures. This research aims to contribute to that discussion.

The primary objective of this study is to identify key indicators for the construction of governance frameworks in smart cities, providing a deeper understanding of the methods and practices relevant to this context. The study's methodology involves a literature review of 70 articles, extracting criteria and indicators related to governance in smart cities.

To be effective, governance structures in smart cities must be dynamic and adaptable, capable of evolving with technological advancements and social shifts. This ensures that smart cities remain sustainable, inclusive, and efficient (Ozkaya & Erdin, 2020). Ultimately, smart cities offer a new approach to urban development, utilizing technology to create more sustainable, efficient, and participatory environments. This innovative approach holds great promise for addressing the challenges of 21st-century cities and improving the quality of life for their inhabitants.

II.   Smart Cities

In recent decades, the concept of smart cities has gained increasing prominence as a solution to the complex challenges faced by urban areas. However, despite its growing importance and potential contributions to urban development, there is still no consensus on the precise definition of a "smart city." The extensive international literature on the subject has explored various models, boundaries, and implications of smart cities. According to Zhu et al. (2024), smart city initiatives are closely linked to specific contexts—whether economic (Zhao et al., 2021), institutional (Ninčević Pašalić, Ćukušić & Jadrić, 2021), cultural (Biloria, 2021), or geographic (Blasi, Ganzaroli & De Noni, 2022)—each of which shapes the distinct characteristics and patterns observed in smart city developments.

Hartog, Akker, and Houdt (2024) propose that smart cities are built upon six core elements: smart economy, smart mobility, smart citizens, smart governance, smart living, and smart environment. However, despite the theoretical depth, there remains limited research into the actual social impacts and governance structures of smart cities.

Although the term "smart city" is relatively new, the preparation and development of these cities can vary significantly depending on the approach taken. Numerous initiatives have attempted to define what constitutes a smart city, each offering different interpretations. Walravens (2015) identified several key areas that cities must focus on to become "smarter," such as "competitiveness, social and human capital, participation, transportation, Information and Communication Technologies (ICT), natural resources, and quality of life" (Walravens, 2015, p. 219).

Smart cities aim to harness technology and innovation to enhance residents' quality of life, optimize resource management, and promote environmental sustainability. While the term is often conceptualized differently across media, politics, and academic literature, Deng, Zhang, and Shen (2021) describe smart cities as "complex systems" that involve a symbiotic connection between people, institutions, technologies, organizations, the built environment, and physical infrastructure.

Building a smart city involves the integration of cutting-edge technologies, efficient use of data, and the creation of comprehensive platforms that streamline various services. A city is deemed "smart" when it uses ICT to enhance administrative efficiency, disseminate information to the public, and improve public services and citizens' well-being (Chen et al., 2024; Hashim, 2024).

The concept of smart cities, however, is understood in two distinct ways. On one hand, some researchers view smart cities as interconnected, technology-driven urban areas that prioritize data management to achieve greater operational efficiency. On the other hand, others advocate for a broader perspective, where smart cities also address issues of accessibility, governance, sustainability, and human and social development. These differing perspectives have fueled ongoing academic debates, reflecting the diverse viewpoints of researchers, international organizations, and industry professionals (Ivars-Baidal et al., 2023; Zhu et al., 2024).

Some scholars have raised concerns about the true contributions of smart cities in addressing urban problems, critiquing the neoliberal framework that often underpins these initiatives. They argue that this paradigm may overlook fundamental human and environmental needs, ultimately benefiting large corporations at the expense of the public (Guenduez et al., 2024).

In conclusion, a smart city is characterized by the convergence of technology, infrastructure, and social elements in urban environments, resulting in an improved experience for its residents. The smart cities paradigm

is guided by policies and objectives that define the governance structures and services necessary to achieve these goals (Bagloee et al., 2021).

III. Governance

Governance refers to the processes, norms, and institutions through which decisions are made and implemented within a society. In the context of smart cities, governance encompasses the active participation of citizens, transparency in public policies, open access to data, and the efficient use of Information and Communication Technologies (ICT) to enhance public service delivery and decision-making (Gonzalez, Ferro, & Liberona, 2020).

Following this principle, the Brazilian Government, through Decree No. 9,203 of 2017, defines public governance as a "set of leadership, strategy, and control mechanisms put into practice to evaluate, direct, and monitor management, to guide public policies and the provision of services of interest to society" (Brasil, 2017).

Governance in smart cities, therefore, presupposes a system that meets the needs of the diverse social fabric by adopting transparent, equitable measures that engage all stakeholders in the development process (Gonzalez, 2020). Although the concept is relatively new in academic discourse, collaboration among all actors involved has already emerged as a key characteristic of governance in smart cities (Nesrine, 2017).

This coordination of various actors toward common goals, such as sustainability, quality of life improvement, and innovation, forms the core of governance in smart cities. However, governance is not a fixed concept. Its interpretation may vary depending on the structure of the smart city being developed (Fahim, 2021).

Several studies offer varying perspectives on smart city governance, some even subdividing it into categories based on specific focuses. Mendes (2022) examines "Climate Governance" in smart cities, emphasizing solutions to climate-related problems, thereby improving the quality of life through mitigation and adaptation strategies. Similarly, "Urban Governance" is aimed at solving the inherent challenges of urban areas, as described by Deng, Zhang, and Shen (2021).

In terms of technology-driven governance, "Smart Governance" refers to the application of technology for urban innovation, aligning politics and critical perspectives to create and implement solutions in smart cities (Prasad & Alizadeh, 2020). A related concept is "Digital Governance," which Zhang et al. (2024) explored through an analysis of data from over 200 Chinese cities. Their study sought to identify the most effective ways to manage resources sustainably and foster innovation, especially in underprivileged cities, thus achieving governance objectives aligned with scientific and economic progress.

Furthermore, "Participatory Governance" emphasizes the active role of citizens in decision-making and their engagement in the co-creation of solutions for smart cities (Julsrud & Krogstad, 2020). This model highlights not just involvement, but a deeper integration of citizen input in shaping urban governance.

However, there are instances where citizens are treated as mere subjects in technological experiments driven by economic motives, which can undermine the social fabric of smart cities (Cugurullo, 2016). To prevent such misrepresentation, it is crucial to critically evaluate and properly define governance concepts, ensuring that flawed projects that lack relevance to citizens' needs are halted.

In conclusion, smart city governance entails the use of digital technologies to improve government operations by fostering multi-actor cooperation (Prasad & Dowling, 2021). This dynamic model ensures that technology serves not only economic purposes but also the broader goal of creating inclusive, sustainable, and participatory urban environments.

IV. Methodology

This study employs a qualitative research approach, relying on a comprehensive literature review of 70 articles from which criteria and indicators related to governance in smart cities were extracted.

The methodological process began with a search on the ScienceDirect portal, focusing on articles published between 2020 and 2024 that contained the terms "governance" and "smart cities" in their title, abstract, or keywords. This initial search yielded 116 articles. After excluding 12 articles due to restricted access, 104 articles were considered for analysis.

A protocol consisting of nine key questions was then developed to guide the review of these articles. One critical filter question was: "What criteria, indices, or indicators does the article use to classify or categorize governance in a smart city?" Based on the responses to these questions, 70 articles were selected for the final literature review.

From these 70 articles, a total of 311 terms related to governance criteria were extracted. These terms underwent a filtering process to identify synonyms and closely related terms. Subsequently, they were grouped based on thematic relevance, resulting in 33 indicators, which were organized into five overarching themes.

V. Discussion

The analysis of the identified literature revealed governance indicators across five major areas and their corresponding themes. Utilizing these indicators enables a comprehensive examination of how governance structures in smart cities are constructed, as illustrated in Table 01.

Table 01: Themes and corresponding Indicators

Themes	Indicators
Governance and Participation	• Collaboration and interaction between actors • Data transparency and openness • Smart and efficient governance • Democratic and citizen participation • Neoliberal and technocratic governance • Smart areas
Policies and Regulations	• Public sector setup and governance • Assessment approaches and methods • Network configurations and sustainability • Privacy and data management • Transformation and innovation • Public processes and services • Community participation and interaction • Socio-spatial disparities • Technological and economic approaches
Strategies and Urban Planning	• Municipal Strategy • Public-private partnerships (PPP) • Technology for urban management • Infrastructure • Urban planning and integration • Foreign direct investment
Technology and Innovation	• Technology • Data and Information Collection • Environment and Sustainability • Urban Management • Social integration
Indicators and Assessments	• Performance • Participation and innovation • Analysis and weighting • Recognition and Benchmarking • Governance and Efficiency

Based on the mixed landscape of analyzed concepts and indicators, this study identifies the primary indicators that permeate research on smart cities, clustering them into five major groups: Governance and Participation, Policies and Regulations, Strategies and Urban Planning, Technology and Innovation, and Indicators and Assessments. These clusters form a framework essential for understanding good governance in smart cities.

The term "governance" encompasses a broad and nuanced concept, especially in the context of smart cities. This subcategory focuses on overseeing and managing processes related to urban resources and services to meet citizen needs and foster sustainable development (Zhang et al., 2022). Participation plays a critical role in measuring citizen engagement—not merely as passive observers or subjects of study, but as active contributors in the ideation and implementation of smart city projects (Kutty et al., 2020).

Collaborative governance encourages the establishment and maintenance of organizational structures that foster an inclusive and cooperative environment. This approach facilitates active participation among stakeholders and government entities during the decision-making process in smart cities (Ben et al., 2017). Promoting a culture of collaboration, cooperation, and shared responsibility among all actors—including government, the private sector, civil society, and citizens—is vital for managing smart cities effectively, driving both innovation and sustainability (Waghmare, 2024; Bem et al., 2017).

According to Gonzalez, Ferro, and Liberona (2020), good governance is closely linked to a "smart government" that leverages technological advancements to make equitable, transparent, and participatory decisions with citizens. The authors emphasize that citizen participation should be central to governance, as smart cities aim to enhance services for residents, who are most aware of their needs and potential solutions. This

indicator focuses on initiatives that analyze management and participation, ensuring optimal processes that respect and serve all stakeholders while genuinely engaging citizens.

Effectively organizing and managing a complex system with multiple stakeholders necessitates a robust structure and clear guidelines. One of the indicators identified in this study pertains to policies and regulations (Ullah et al., 2021). This indicator contributes to organizing governance in smart cities by establishing the conditions necessary for urban innovation and digital ecosystems (Mora et al., 2023).

Smart cities are fundamentally driven by data, necessitating the use of big data typically analyzed through public-private partnerships. This reliance on data underscores the importance of ethical guidelines to protect citizens' interests, particularly against potential manipulation by private entities whose primary focus may be economic rather than addressing citizens' needs (Hartog, Akker, & Houdt, 2024).

Recognizing the significance of this indicator, the study emphasizes that understanding, developing, and implementing technical regulations and standards—such as data protection laws and cybersecurity guidelines—are crucial for shaping the development of digital infrastructures and services in smart cities (Mora et al., 2023).

The goal of smart cities is to foster urbanization through sustainability by leveraging information and communication technologies (ICT) to enhance infrastructure for residents. This approach calls for the adoption of new technologies and eco-efficient building materials, while also balancing the preservation of local culture and traditions (Pareti et al., 2022).

Urban strategies and planning involve the interactions among local authorities, public and private sectors, and civil society in developing and managing urban policies and programs. Such cities are viewed as vehicles for transforming urban industrial structures, minimizing resource consumption, and reducing pollutant emissions. Therefore, constructing smart cities is not merely an option but a necessary step toward achieving new urbanization, emphasizing technological innovation to build a more prosperous and sustainable society (Deng, Zhang, and Shen, 2021).

Creating a conducive environment for effective governance in smart cities requires structured strategies and plans. Within this framework, the study identified approximately 58 indicators. Given the multifaceted nature of this theme, Strategies and Urban Planning can encompass a wide array of technical and innovative solutions across various sectors, including healthcare, education, communication, transport, and energy use (Al-Badi & Khan, 2022). These indicators were grouped to facilitate a clearer organization of the diverse fronts contributing to smart city development.

While neoliberalism often utilizes technology and innovation to create products and services that claim to address urban challenges—advocating that such advancements enhance sustainability, drive economic growth, and improve citizens' quality of life through participatory governance (Spicer, Goodman & Wolf, 2023)—this approach frequently prioritizes economic interests over genuine solutions to complex issues (Biloria, 2021). Thus, the Technology and Innovation cluster serves as a vital indicator, enabling the scaling of diverse strategies for cities and enhancing the effectiveness of solutions and management in smart cities.

Lastly, establishing methods for measuring results is crucial not only for validating strategies but also for realigning efforts when decision-making proves ineffective regarding indicators and evaluations (Guimarães et al., 2019). This aspect of Indicators and Assessments provides robustness to the governance structure, facilitating continuous improvement in processes and validating strategies for the benefit of all citizens.

VI.   Conclusions

The integration of Information and Communication Technology (ICT) in addressing urban challenges, alongside the presence of human and social capital and intelligent governance, defines the concept of smart cities. Although a universal definition remains elusive, the core premise centers on leveraging technology to transform urban environments, thereby justifying the "smart" designation. Current research underscores the significance of this implementation, demonstrating the efficacy of utilizing big data, intelligent traffic management systems, smart energy solutions, and the Internet of Things (IoT) in tackling complex urban issues.

The advantages derived from these technological applications have motivated numerous cities to enhance their urban infrastructures in pursuit of smart city status. However, questions persist regarding the appropriate governance structures required for effectively managing these urban ecosystems. Such governance must encompass various administrative layers and foster collaboration among public and private sectors, as well as civil society. A critical discourse on smart cities highlights the necessity of examining the interplay between technology, capitalism, and urbanization, as these elements significantly impact urban life.

This research aimed to identify the key indicators that contribute to the establishment of governance structures within smart cities, thereby enriching our understanding of the methodologies and practices employed. Through the categorization of these indicators, we discerned characteristics essential for effective governance in smart cities. Governance frameworks must remain dynamic and adaptable, capable of evolving in response to technological advancements and societal shifts while ensuring sustainability, inclusivity, and efficiency.

Consequently, smart cities embody a novel approach to urban development, harnessing technology to foster environments that are more sustainable, efficient, and participatory. This paradigm represents a promising avenue for addressing the multifaceted challenges faced by 21st-century urban centers, ultimately enhancing the quality of life for their inhabitants.

Importantly, this paper serves as a valuable resource for stakeholders, including urban planners, policymakers, and private sector actors. By highlighting critical indicators of governance, it provides a framework that can inform decision-making processes and strategic planning in the development of smart cities. Engaging with this research can empower stakeholders to align their initiatives with best governance practices, ensuring that technological advancements translate into tangible benefits for communities. As cities navigate the complexities of urbanization, the insights gained from this study can facilitate collaborative efforts toward creating inclusive and sustainable urban environments.

However, it is essential to acknowledge certain limitations of this research. The study is primarily based on a literature review, which, while comprehensive, may not capture the full spectrum of experiences and contextual variations in smart city governance globally. Additionally, the focus on articles published between 2020 and 2024 may limit the scope of historical perspectives that could enrich the discussion. Future research could benefit from empirical studies that investigate the practical applications of the identified indicators in diverse urban settings, providing a more nuanced understanding of their effectiveness and adaptability in real-world scenarios.

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