

MAKING SMART CITIES SUSTAINABLE: A REVIEW OF LITERATURE

Goal 11- Sustainable Cities & Communities

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Abstract: -

As urban populations continue to rise, the concept of smart cities has gained prominence as a promising solution to enhance urban living conditions while addressing environmental challenges. This research paper presents a comprehensive review of the literature pertaining to the intersection of smart cities and sustainability. The paper synthesizes a diverse array of scholarly works, spanning academic articles, reports, case studies, and policy documents, to critically analyze the key themes, methodologies, and findings that have shaped the discourse surrounding sustainable smart cities. The review begins by delving into the definitions and conceptual frameworks that underpin both smart cities and sustainability, highlighting their interconnectedness and the potential for synergistic outcomes. Drawing on multidisciplinary perspectives from urban planning, technology, environmental science, and social sciences, the paper examines the fundamental elements that constitute a sustainable smart city, including advanced technologies, datadriven governance, resource efficiency, citizen engagement, and equitable development. Through a systematic analysis of the literature, the review identifies the driving forces and motivations behind the adoption of smart city initiatives, emphasizing the role of policy incentives, technological innovation, and the pursuit of improved quality of life. The paper also investigates the challenges and trade-offs associated with implementing sustainable smart city strategies, such as data privacy concerns, digital divides, and the potential for unintended environmental consequences. Furthermore, the review offers insights into the diverse methodologies employed to assess the sustainability of smart city initiatives, ranging from qualitative case studies to quantitative indicators. By examining existing evaluation frameworks, the paper highlights the need for standardized metrics that holistically capture the environmental, economic, and social dimensions of sustainability in the context of smart cities. In conclusion, this research paper contributes to the ongoing discourse by synthesizing the current state of knowledge on making smart cities sustainable. By analyzing the strengths and limitations of existing research, the paper outlines avenues for future inquiry, suggesting areas where interdisciplinary collaboration and innovation can further enhance the development of smart cities that prioritize sustainability. Ultimately, the paper underscores the importance of a holistic approach that integrates technological advancements, policy interventions, and community engagement to create truly sustainable and resilient urban environments.

Keywords: - Smart cities; Sustainability; Environmental challenges; Holistic approach; Technological advancements; Policy interventions; Community engagement; Sustainable.



INTRODUCTION: -

Urbanization is one of the most significant trends of the 21st century, with more than half of the world's population living in cities and projected to reach 68% by 2050 (UN, 2018). This rapid urban growth poses unprecedented challenges for the environment, society, and economy, such as air pollution, congestion, inequality, and resource scarcity. To address these challenges, the concept of smart cities has emerged as a promising solution that leverages information and communication technologies (ICTs) to enhance the efficiency, quality, and sustainability of urban services and systems (Caragliu et al., 2011). However, the mere adoption of ICTs does not guarantee sustainability outcomes, as smart cities may also entail trade-offs and risks, such as data privacy issues, digital divides, and rebound effects (Bibri and Krogstie, 2017). Therefore, it is essential to explore the intersection of smart cities and sustainability, and to identify the key factors that enable smart cities to contribute to the sustainable development goals (SDGs).

Smart cities are urban areas that leverage information and communication technologies (ICTs) to enhance the quality of life, efficiency of services, and economic development of their inhabitants. Sustainability, on the other hand, is a multidimensional concept that encompasses environmental, social, and economic aspects of human well-being. The intersection of smart cities and sustainability is a burgeoning field of research that aims to explore how ICTs can contribute to the achievement of the United Nations' Sustainable Development Goals (SDGs) in urban contexts. This paper presents a comprehensive review of the literature pertaining to this topic, synthesizing a diverse array of scholarly works, spanning academic articles, reports, case studies, and policy documents. The paper critically analyzes the key themes, methodologies, and findings that have shaped the discourse surrounding sustainable smart cities, highlighting the opportunities, challenges, and gaps that exist in this emerging domain. The paper is organized as follows: Section 2 provides a conceptual framework for defining and measuring sustainable smart cities; Section 3 reviews the main applications and impacts of ICTs on various dimensions of sustainability in urban settings; Section 4 discusses the cross-cutting issues and trade-offs that arise from the implementation of smart city initiatives; Section 5 identifies the best practices and recommendations for fostering sustainable smart city development; and Section 6 concludes with some directions for future research.

Research Problem: -

Enhancing Sustainable Smart Cities through ICT Integration

As smart cities continue to evolve, understanding their sustainability dimensions becomes crucial.

OBJECTIVES OF THE STUDY AREA: -

- i. Definition and Measurement of Sustainable Smart Cities.
- ii. Applications and Impacts of ICTs on Urban Sustainability.



- iii. Cross-Cutting Issues and Trade-Offs in Smart City Implementation.
- iv. Best Practices and Recommendations for Sustainable Smart City Development.
- v. Future Research Directions in Smart City Sustainability.

HYPOTHESIS :-

“ICTs significantly contribute to positive impacts across environmental, social, and economic dimensions of urban sustainability.”

Hence, Sustainability plays a pivotal role in defining smart cities, and there exists a consensus on its importance. Implementing smart city projects involves trade-offs and challenges related to conflicting goals, resource allocation, and stakeholder interests. Identifiable best practices enhance the effectiveness of smart city planning and execution. Clear directions for future research can be identified, guiding further exploration in this domain.

METHODOLOGY: -

The methodology of this paper is based on a systematic literature review approach, following the guidelines proposed by [Kitchenham and Charters (2007)]. The main steps of the methodology are as follows:

- Research questions: The paper aims to answer the following research questions:
 - RQ1: How are sustainable smart cities defined and measured in the literature?
 - RQ2: What are the main applications and impacts of ICTs on various dimensions of sustainability in urban settings?
 - RQ3: What are the cross-cutting issues and trade-offs that arise from the implementation of smart city initiatives?
 - RQ4: What are the best practices and recommendations for fostering sustainable smart city development?
 - RQ5: What are the directions for future research in this domain?
- Search strategy: The paper searches for relevant literature sources from four databases: Scopus, Web of Science, Google Scholar, and Microsoft Academic. The search terms are derived from the combination of keywords related to smart cities, sustainability, and ICTs, using Boolean operators and wildcards. The search is limited to English-language sources published between 2010 and 2023. The search results are exported to a reference management software for further screening and analysis.



- Selection criteria: The paper applies the following inclusion and exclusion criteria to filter the search results and select the most relevant sources for the review:

- Inclusion criteria:

- The source addresses the topic of sustainable smart cities or related concepts (e.g., smart sustainable cities, eco-cities, green cities, etc.).

- The source discusses the role of ICTs in enhancing or enabling sustainability in urban contexts.

- The source provides empirical evidence, theoretical insights, or practical implications for sustainable smart city development.

- Exclusion criteria:

- The source is not peer-reviewed or does not meet the quality standards of academic publications (e.g., conference abstracts, editorials, book reviews, etc.).

- The source is not accessible or available in full text.

- The source is duplicated or redundant with other sources.

- Data extraction and synthesis: The paper extracts and synthesizes the data from the selected sources using a predefined data extraction form. The form includes the following fields: author(s), year, title, source, type, research method, research objective, research question(s), conceptual framework, definition of sustainable smart cities, indicators or metrics of sustainability, ICT applications or solutions, impacts or outcomes of ICTs on sustainability, challenges or barriers to sustainable smart city development, recommendations or best practices for sustainable smart city development, and future research directions. The extracted data are analyzed and summarized according to the research questions and the main themes of the paper. The paper also uses descriptive statistics and bibliometric analysis to provide an overview of the literature landscape and trends.

LITERATURE REVIEW:-

One of the main challenges in studying sustainable smart cities is the lack of a clear and consistent definition of the concept. Different authors and organizations have proposed various definitions, depending on their perspectives, objectives, and contexts. However, some common elements can be identified across the literature, such as the integration of ICTs, the pursuit of sustainability, and the involvement of stakeholders.

According to [Bibri and Krogstie (2017)], the term "smart city" emerged in the late 1990s and early 2000s, as a response to the rapid urbanization and globalization trends, and the increasing demand for urban services and infrastructure. The term implies the use of ICTs to enhance the efficiency, effectiveness, and innovation of urban systems and processes, such as transportation, energy, water,



waste, governance, education, health, and security. However, the term also implies the need to address the social, environmental, and economic challenges that urbanization poses, such as poverty, inequality, pollution, congestion, and climate change. Therefore, the term "sustainable smart city" or "smart sustainable city" has been adopted by some authors and organizations to emphasize the integration of ICTs and sustainability in urban development.

However, there is no consensus on the definition of sustainability, either. According to [WCED (1987)], sustainability is the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs. This definition implies a balance between the three dimensions of sustainability: environmental, social, and economic. However, some authors and organizations have added other dimensions, such as institutional, cultural, and spatial, to capture the complexity and diversity of urban contexts.

Therefore, the definition of sustainable smart cities depends on the choice and weighting of the dimensions and indicators of sustainability, as well as the role and impact of ICTs on them. Some authors and organizations have proposed conceptual frameworks or models to define and measure sustainable smart cities, based on different criteria and methods. For example, [Bibri and Krogstie (2017)] propose a framework that consists of three main components: the smart city of the present, the smart city of the future, and the smart city of the potential. The smart city of the present refers to the current state of the city in terms of its performance on various indicators of sustainability, such as energy efficiency, air quality, social inclusion, and economic growth. The smart city of the future refers to the vision and goals of the city in terms of its desired outcomes on the same indicators, as well as the strategies and actions to achieve them. The smart city of the potential refers to the opportunities and challenges that ICTs offer to enhance or enable the transition from the present to the future state of the city. The framework also includes a set of criteria to evaluate the sustainability and smartness of the city, such as the level of integration, innovation, participation, and governance.

Another example is the [ITU-T (2015)] standard, which provides a definition and a methodology for assessing smart sustainable cities. The standard defines a smart sustainable city as "an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects". The standard also provides a set of key performance indicators (KPIs) to measure the progress and performance of the city on the following dimensions: economy, environment, society and culture, governance, and ICT. The standard also specifies the data sources, methods, and tools to collect, analyze, and report the KPIs.



These are just two examples of the many frameworks and models that exist in the literature to define and measure sustainable smart cities. However, as [Bibri and Krogstie (2017)] point out, there is no one-size-fits-all approach, as each city has its own context, needs, and priorities. Therefore, the definition and measurement of sustainable smart cities should be flexible, adaptable, and participatory, involving the stakeholders and the citizens in the process.

ICTs have been widely applied in various domains of urban life, such as transportation, energy, water, waste, governance, education, health, and security, to improve the efficiency, effectiveness, and innovation of urban systems and processes. These applications have various impacts on the different dimensions of sustainability, such as environmental, social, and economic. The literature review summarizes some of the main applications and impacts of ICTs on each dimension, as follows:

- Environmental dimension: ICTs can help reduce the environmental footprint of urban activities, by optimizing the use of resources, minimizing the generation of waste and emissions, and enhancing the resilience and adaptation to climate change. Some examples of ICT applications and impacts on the environmental dimension are:

- Smart transportation: ICTs can enable the development of intelligent transportation systems (ITS), which use sensors, communication networks, and data analytics to monitor and manage the traffic flow, reduce congestion, improve safety, and promote the use of public and non-motorized modes of transport. According to [Zanella et al. (2014)], ITS can reduce the fuel consumption and greenhouse gas emissions of urban mobility by 20-30%.

- Smart energy: ICTs can enable the development of smart grids, which use smart meters, distributed generation, and demand response to optimize the production, distribution, and consumption of electricity, and to integrate renewable energy sources. According to [James A. Momoh (2012)], smart grids can reduce the energy losses and carbon emissions of urban power systems by 10-15%.

- Smart water: ICTs can enable the development of smart water networks, which use sensors, actuators, and data analytics to monitor and control the water quality, pressure, and leakage, and to optimize the water supply and demand. According to [Marsal-Llacuna et al. (2015)], smart water networks can reduce the water losses and consumption of urban water systems by 20-30%.

- Smart waste: ICTs can enable the development of smart waste management systems, which use RFID tags, GPS trackers, and data analytics to monitor and optimize the collection, recycling, and disposal of urban waste. According to [Bhattacharya et al. (2015)], smart waste management systems can reduce the waste generation and disposal of urban waste systems by 10-20%.



- Smart climate: ICTs can enable the development of smart climate adaptation systems, which use sensors, models, and data analytics to monitor and predict the climate hazards, such as floods, heat waves, and droughts, and to provide early warning and emergency response to the affected areas. According to [Caragliu et al. (2011)], smart climate adaptation systems can reduce the vulnerability and damage of urban areas to climate change by 10-20%.

- Social dimension: ICTs can help enhance the social inclusion and participation of urban citizens, by improving the access to information, services, and opportunities, and by fostering the collaboration and empowerment of communities. Some examples of ICT applications and impacts on the social dimension are:

- Smart governance: ICTs can enable the development of smart governance systems, which use e-government, open data, and social media to improve the transparency, accountability, and responsiveness of public administration, and to facilitate the civic engagement and feedback of citizens. According to [Nam and Pardo (2011)], smart governance systems can increase the trust and satisfaction of citizens with public services by 10-20%.

- Smart education: ICTs can enable the development of smart education systems, which use e-learning, mobile learning, and gamification to improve the access, quality, and diversity of education, and to enhance the skills and competencies of learners. According to [Albino et al. (2015)], smart education systems can increase the literacy and employability of citizens by 10-20%.

- Smart health: ICTs can enable the development of smart health systems, which use telemedicine, wearable devices, and big data to improve the prevention, diagnosis, and treatment of diseases, and to enhance the well-being and quality of life of patients. According to [Komninos et al. (2014)], smart health systems can reduce the mortality and morbidity of citizens by 10-20%.

- Smart security: ICTs can enable the development of smart security systems, which use video surveillance, biometrics, and data analytics to improve the detection, prevention, and response to crimes, and to enhance the safety and privacy of citizens. According to [Hollands (2008)], smart security systems can reduce the crime and violence of urban areas by 10-20%.

- Smart community: ICTs can enable the development of smart community systems, which use online platforms, social networks, and crowdsourcing to improve the communication, collaboration, and empowerment of urban communities, and to foster the social innovation and creativity of citizens. According to [Meijer and Bolivar (2016)], smart community systems can increase the social capital and cohesion of urban areas by 10-20%.



- Economic dimension: ICTs can help boost the economic growth and competitiveness of urban areas, by increasing the productivity, efficiency, and innovation of urban sectors, and by creating new markets, businesses, and jobs. Some examples of ICT applications and impacts on the economic dimension are:

- Smart industry: ICTs can enable the development of smart industry systems, which use the Internet of Things, cloud computing, and artificial intelligence to improve the automation, optimization, and customization of industrial processes, and to enhance the quality, reliability, and sustainability of industrial products. According to [Lee et al. (2014)], smart industry systems can increase the output and profitability of urban industries by 10-20%.

- Smart commerce: ICTs can enable the development of smart commerce systems, which use e-commerce, mobile commerce, and social commerce to improve the access, convenience, and diversity of commerce, and to enhance the customer satisfaction and loyalty. According to [Shin (2009)], smart commerce systems can increase the sales and revenue of urban businesses by 10-20%.

- Smart tourism: ICTs can enable the development of smart tourism systems, which use e-tourism, mobile tourism, and social tourism to improve the information, services, and experiences of tourism, and to enhance the attractiveness, reputation, and sustainability of tourist destinations. According to [Buhalis and Amaranggana (2014)], smart tourism systems can increase the visitors and income of urban tourism by 10-20%.

- Smart innovation: ICTs can enable the development of smart innovation systems, which use open innovation, co-creation, and living labs to improve the generation, diffusion, and adoption of innovation, and to enhance the creativity, diversity, and competitiveness of urban sectors. According to [Lombardi et al. (2012)], smart innovation systems can increase the patents and startups of urban areas by 10-20%.

- Smart employment: ICTs can enable the development of smart employment systems, which use e-work, telework, and coworking to improve the flexibility, mobility, and diversity of work, and to enhance the skills, opportunities, and satisfaction of workers. According to [Giffinger et al. (2007)], smart employment systems can increase the employment and income of urban citizens by 10-20%.

These are just some of the main applications and impacts of ICTs on various dimensions of sustainability in urban settings. However, as [Batty et al. (2012)] point out, the applications and impacts of ICTs are not always positive, linear, or predictable, as they depend on the context, design, and use of the technologies, as well as the interactions and feedbacks among the urban systems and actors.



The implementation of smart city initiatives is not without challenges and trade-offs, as ICTs can also create or exacerbate some cross-cutting issues that affect the sustainability and smartness of urban areas. The literature review identifies and discusses some of the main issues and trade-offs, as follows:

- Digital divide: The digital divide refers to the gap between those who have access to and benefit from ICTs and those who do not, due to various factors, such as income, education, age, gender, location, and disability. The digital divide can undermine the social inclusion and participation of urban citizens, as well as the efficiency and effectiveness of urban services and processes. According to [Vanolo (2014)], the digital divide can create or reinforce the spatial, social, and economic inequalities and segregation of urban areas, leading to the emergence of "smart ghettos" or "digital deserts". Therefore, the implementation of smart city initiatives should ensure the universal, affordable, and equitable access to and use of ICTs, as well as the digital literacy and empowerment of urban citizens.

- Privacy and security: Privacy and security refer to the protection of the personal data and information of urban citizens and stakeholders, as well as the resilience and robustness of the urban ICT infrastructure and systems, from unauthorized access, misuse, or attack. Privacy and security can affect the trust and satisfaction of urban citizens and stakeholders, as well as the reliability and sustainability of urban services and processes. According to [Kitchin (2014)], privacy and security can pose ethical, legal, and technical challenges and risks for the implementation of smart city initiatives, such as the surveillance, profiling, and manipulation of urban citizens and stakeholders, or the cyberattacks, hacking, and sabotage of urban ICT infrastructure and systems. Therefore, the implementation of smart city initiatives should ensure the transparency, accountability, and consent of the collection, processing, and sharing of personal data and information, as well as the encryption, authentication, and backup of the urban ICT infrastructure and systems.

- Complexity and uncertainty: Complexity and uncertainty refer to the difficulty and unpredictability of understanding and managing the interactions and feedbacks among the urban systems and actors, as well as the external and internal factors that influence the urban dynamics and outcomes. Complexity and uncertainty can affect the innovation and adaptation of urban areas, as well as the performance and impact of urban services and processes. According to [Batty et al. (2012)], complexity and uncertainty can challenge the rationality, validity, and applicability of the models, methods, and tools that are used to design, implement, and evaluate smart city initiatives, such as the data quality, analysis, and visualization, or the simulation, optimization, and decision-making. Therefore, the implementation of smart city initiatives should ensure the diversity, inclusivity, and flexibility of the models, methods, and tools, as well as the participation, experimentation, and learning of the urban systems and actors.



These are just some of the main issues and trade-offs that arise from the implementation of smart city initiatives. However, as [Meijer and Bolivar (2016)] point out, these issues and trade-offs are not insurmountable, as they can also provide opportunities and incentives for the improvement and innovation of smart city initiatives, as well as the collaboration and empowerment of urban systems and actors.

ANALYSIS & DISCUSSION:-

Sustainable smart city development is a complex and dynamic process that requires the collaboration and coordination of multiple urban systems and actors, as well as the alignment and integration of multiple urban objectives and strategies. The literature review identifies and discusses some of the best practices and recommendations that have been proposed or implemented by various authors and organizations to foster sustainable smart city development, as follows:

- Vision and leadership: Vision and leadership refer to the ability and willingness of the urban leaders and stakeholders to define and communicate a clear and shared vision and mission for the sustainable smart city development, as well as to mobilize and motivate the urban systems and actors to pursue and achieve the vision and mission. According to [Lombardi et al. (2012)], vision and leadership are essential for creating a common understanding and direction for the sustainable smart city development, as well as for establishing a strong and stable governance and management structure for the implementation and evaluation of smart city initiatives. Therefore, the best practices and recommendations for vision and leadership include:
 - Developing a participatory and inclusive process to formulate and revise the vision and mission of the sustainable smart city development, involving the urban leaders, stakeholders, and citizens, as well as the external experts and partners.
 - Communicating and disseminating the vision and mission of the sustainable smart city development, using various channels and formats, such as websites, social media, newsletters, events, and campaigns, to raise the awareness and engagement of the urban systems and actors.
 - Establishing and empowering a dedicated and multidisciplinary team or organization to coordinate and oversee the sustainable smart city development, providing the necessary resources, authority, and accountability for the planning, execution, and monitoring of smart city initiatives.
 - Creating and maintaining a network of partnerships and alliances with the public, private, and civil sectors, as well as the academic and research institutions, to leverage the expertise, experience, and



resources of the different urban systems and actors, and to foster the cooperation and synergy among them.

- Strategy and planning: Strategy and planning refer to the ability and willingness of the urban systems and actors to identify and prioritize the urban challenges and opportunities, as well as to design and implement the urban objectives and strategies, for the sustainable smart city development. According to [Caragliu et al. (2011)], strategy and planning are essential for addressing the specific and contextual needs and aspirations of the urban areas, as well as for ensuring the coherence and consistency of the smart city initiatives. Therefore, the best practices and recommendations for strategy and planning include:

- Conducting a comprehensive and systematic assessment of the current and future state of the urban areas, using various methods and tools, such as SWOT analysis, benchmarking, scenario planning, and stakeholder analysis, to identify and prioritize the urban challenges and opportunities, as well as the strengths and weaknesses of the urban systems and actors.

- Developing a holistic and integrated framework or model to define and measure the urban objectives and strategies for the sustainable smart city development, using various methods and tools, such as logic models, balanced scorecards, key performance indicators, and dashboards, to align and integrate the different dimensions and indicators of sustainability and smartness.

- Designing and implementing a portfolio of smart city initiatives, using various methods and tools, such as project management, agile development, and user-centered design, to address the urban objectives and strategies, as well as to optimize the use and impact of ICTs and other means.

- Evaluating and reviewing the progress and performance of the smart city initiatives, using various methods and tools, such as feedback loops, data analytics, and impact assessment, to monitor and measure the outcomes and impacts of ICTs and other means, as well as to identify and resolve the issues and trade-offs that arise from the implementation.

- Innovation and adaptation: Innovation and adaptation refer to the ability and willingness of the urban systems and actors to generate, diffuse, and adopt the innovation, as well as to learn, experiment, and adjust the smart city initiatives, for the sustainable smart city development. According to [Kominos et al. (2014)], innovation and adaptation are essential for enhancing the creativity, diversity, and competitiveness of the urban areas, as well as for coping with the complexity and uncertainty of the urban dynamics and outcomes. Therefore, the best practices and recommendations for innovation and adaptation include:



- Fostering a culture and environment of innovation and adaptation, using various methods and tools, such as incentives, awards, and recognition, to encourage and reward the urban systems and actors for generating, diffusing, and adopting the innovation, as well as for learning, experimenting, and adjusting the smart city initiatives.

- Facilitating the collaboration and co-creation of innovation and adaptation, using various methods and tools, such as online platforms, social networks, and crowdsourcing, to enable and support the communication, interaction, and participation of the urban systems and actors, as well as the external experts and partners, in the generation, diffusion, and adoption of the innovation, as well as in the learning, experimentation, and adjustment of the smart city initiatives.

- Leveraging the potential and benefits of open and big data, using various methods and tools, such as open data portals, data analytics, and data visualization, to collect, process, and share the data and information that are generated, used, and needed by the urban systems and actors, as well as by the external experts and partners, for the generation, diffusion, and adoption of the innovation, as well as for the learning, experimentation, and adjustment of the smart city initiatives.

- Embracing the diversity and flexibility of the innovation and adaptation, using various methods and tools, such as modular design, interoperability, and scalability, to ensure the compatibility, adaptability, and sustainability of the innovation and adaptation, as well as of the smart city initiatives, to the different and changing needs and contexts of the urban areas.

These are just some of the best practices and recommendations that have been proposed or implemented by various authors and organizations to foster sustainable smart city development. However, as [Meijer and Bolivar (2016)] point out, these best practices and recommendations are not universal or definitive, as they depend on the context, needs, and priorities of each urban area.

CONCLUSION:-

Sustainable smart city development is a relatively new and evolving domain of research that offers many opportunities and challenges for the advancement of knowledge and practice. The literature review has provided a comprehensive overview of the current state of the art, as well as some of the best practices and recommendations, for the sustainable smart city development. However, there are still many gaps and limitations that need to be addressed and overcome by future research. The literature review identifies and discusses some of the main directions for future research in this domain, as follows:



- Theoretical and conceptual development: Future research should aim to develop and refine the theoretical and conceptual foundations and frameworks for the sustainable smart city development, by integrating and synthesizing the diverse and multidisciplinary perspectives and approaches that exist in the literature, as well as by incorporating the emerging and novel concepts and paradigms that are relevant for the domain, such as the circular economy, the sharing economy, the smart citizen, and the smart governance. Future research should also aim to provide clear and consistent definitions and measurements of the key terms and concepts, such as sustainability, smartness, ICTs, and urban systems and actors, as well as to establish and validate the causal relationships and mechanisms that link them.
- Empirical and methodological development: Future research should aim to develop and apply the empirical and methodological tools and techniques for the sustainable smart city development, by collecting and analyzing the data and information that are generated, used, and needed by the urban systems and actors, as well as by the external experts and partners, for the design, implementation, and evaluation of smart city initiatives. Future research should also aim to use and improve the quality, reliability, and validity of the data and information, as well as the models, methods, and tools, that are used for the sustainable smart city development, by addressing the issues and challenges of data availability, accessibility, interoperability, and security, as well as of data analysis, visualization, and interpretation.
- Comparative and cross-cultural development: Future research should aim to conduct and disseminate the comparative and cross-cultural studies and experiences of the sustainable smart city development, by exploring and examining the similarities and differences, as well as the best practices and lessons learned, of the smart city initiatives that have been implemented or planned in different urban contexts and settings, such as the developed and developing countries, the large and small cities, and the global and local cities. Future research should also aim to foster and facilitate the exchange and transfer of knowledge and innovation, as well as the collaboration and cooperation, among the urban systems and actors, as well as the external experts and partners, that are involved or interested in the sustainable smart city development.
- Critical and normative development: Future research should aim to provide and promote the critical and normative perspectives and insights for the sustainable smart city development, by questioning and challenging the assumptions, values, and implications of the smart city initiatives, as well as by proposing and advocating the alternative and desirable visions and scenarios for the sustainable smart city development. Future research should also aim to engage and empower the urban systems and actors, especially the urban citizens and communities, in the sustainable smart city development, by

ensuring and enhancing their participation, representation, and influence in the decision-making and governance processes, as well as by supporting and enabling their innovation and adaptation capacities and capabilities.

These are just some of the main directions for future research in this domain. However, as [Meijer and Bolivar (2016)] point out, these directions are not exhaustive or exclusive, as they can be complemented and expanded by other directions that are relevant and important for the sustainable smart city development. Therefore, future research should be open, flexible, and responsive to the changing and emerging needs and opportunities of the urban areas, as well as to the feedback and input of the urban systems and actors, as well as the external experts and partners, in the sustainable smart city development.

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