BIS INFORMATION TECHNOLOGY AND COMPUTER SCIENCE

Volume 1 2024 | DOI: 10.31603/bistyc.132
5th Borobudur International Symposium on Science and Technology (BIS-STE) 2023

UNIMMA PRESS
UNIVERSITAS MUHAMMADIYAH MAGELANG

Realizing sustainable digital transformation for smart city evolution: A systematic literature review

Hariyadi[1*], W Mustakim[2], M Giatman[2], H Effendi[2], Aswardi[2], D P Wulandari[3], M Kamil[1], Yulisman[1], A Dwiharzandis[1], B Santosa[1] and D S Kesuma[1]

[1] Department of Electrical Engineering, Muhammadiyah University of West Sumatera, Padang, Indonesia
[2] Faculty of Engineering, Padang State University, Padang, Indonesia
[3] Faculty of Tourism and Hospitality, Padang State University, Indonesia
[*]Corresponding author email: hariefamily@yahoo.co.id

Abstract

This research focuses on the vital role of sustainable digital transformation in shaping smart cities, where information technology drives urban evolution into intelligent and efficient hubs. Stressing the importance of ongoing digital progress, the study examines the diverse dimensions of sustainable digital transformation, encompassing environmental, social, and economic aspects. Integration of technologies like IoT, big data analytics, and AI forms the basis for a sustainable smart city, promoting resource efficiency, reducing carbon emissions, and improving public services. The study acknowledges challenges, including complex system integration, financial constraints, and security issues, requiring attention for successful transformation. This research aims to make significant contributions to the implementation of sustainable digital practices, fostering adaptive, inclusive, and environmentally friendly smart cities. Utilizing the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) method, the research conducts a systematic literature review to uncover benefits, roles, and challenges, contributing insights for discussions on the path of sustainable digital transformation. Guided by the PICO framework, research questions explore the benefits, roles, and challenges, providing a comprehensive understanding of sustainable digital transformation. Results highlight transformative potential, emphasizing the need to address challenges for the evolution of intelligent and sustainable smart cities. This research aims to make significant contributions to the implementation of sustainable digital practices, fostering adaptive, inclusive, and environmentally friendly smart cities.

Keywords

Sustainable digital transformation, Smart city evolution, Systematic literature review

Published:
October 20, 2024

Selection and Peer-review under the responsibility of the 5th BIS-STE 2023 Committee

Introduction

In this era, the development of information technology has become a key driver in changing the face of modern cities into smart urban centers [1]. Continuous digital transformation is key in guiding the evolution of smart cities towards a sustainable and efficient future [2]. The concept of smart cities has become a major highlight in the urban field, integrating information technology to improve the quality of life of its citizens. In its development, a sustainable digital transformation is needed so that smart cities can continue to adapt to environmental changes and people's needs [3]. The application of sustainable technologies in the digital transformation of smart cities has a positive impact on the efficiency of resource use, reduction of carbon emissions, and improvement of public services [4]. Innovations such as the Internet of Things (IoT), big data analytics, and artificial intelligence (AI) are key components in forming the foundation of a sustainable smart city [5]. Sustainability in the context of digital transformation is not only limited to energy efficiency or waste management but also involves social and economic aspects [6], [7]. Inclusivity and community participation in decision-making are the cornerstones to ensure the long-term sustainability of smart cities [8].

One of the main challenges in realizing sustainable digital transformation is the integration of complex systems [9]. Smart city systems need to be carefully designed and managed to ensure interoperability between platforms and support sustainable growth [10], [11], [12]. Collaboration between the public and private sectors is a key element in creating a sustainable digital transformation ecosystem. The involvement of the private sector not only helps in financing projects but also brings innovation and expertise needed to advance smart cities [13], [14]. The importance of security in the digital environment is increasingly becoming a major concern in smart city transformation [15]. Data protection, network security, and cybersecurity are critical aspects that must be addressed to maintain system integrity and protect citizens' privacy rights [16], [17]. In the context of sustainability, renewable energy and energy efficiency are the main focus in the digital transformation of smart cities. Utilizing technology for smart monitoring and management of energy resources can make a major contribution in reducing the city's carbon footprint [18].

Public education and awareness are important elements in dealing with changes towards a sustainable smart city. Public understanding of the benefits of digital transformation in daily life can encourage technology adoption and support the sustainability of the city [19]. The realization of sustainable digital transformation for smart city evolution is not an end goal, but a continuous journey to build adaptive, inclusive, and environmentally friendly cities. This vision demands continuous collaboration, constant innovation, and a commitment to creating smart cities that are not only smart but also sustainable for future generations [20].

The main objective of this research is to conduct an in-depth investigation and compile a comprehensive understanding of the concept of sustainable digital transformation in

the context of smart city evolution, by adopting the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) literature review method. This research aims to encourage a more in-depth discussion of the challenges, opportunities, and future research directions in the field of digital transformation for sustainable smart cities. The resulting conclusions are expected to provide valuable insights and support the development of smart cities that are not only smart but also sustainable. This research is expected to make a significant contribution to understanding how digital transformation can be implemented sustainably in the evolution of smart cities.

Methods

Conducting a systematic literature review (SLR) represents a crucial preliminary step in the research process, providing the groundwork for knowledge synthesis and aiding in the identification of research gaps within existing studies [21]. This method involves formulating explicit research questions, scrutinizing relevant studies for their applicability [22], and evaluating their quality based on predefined criteria. In this review article, the systematic review is conducted using the review protocol [23]. The protocol consists of seven distinct phases, which include defining the framework, defining research questions, outlining inclusion and exclusion criteria, establishing search strategies and data sources, conducting quality assessment checks, performing data coding and analysis, and presenting findings and discussions, as illustrated in Figure 1.

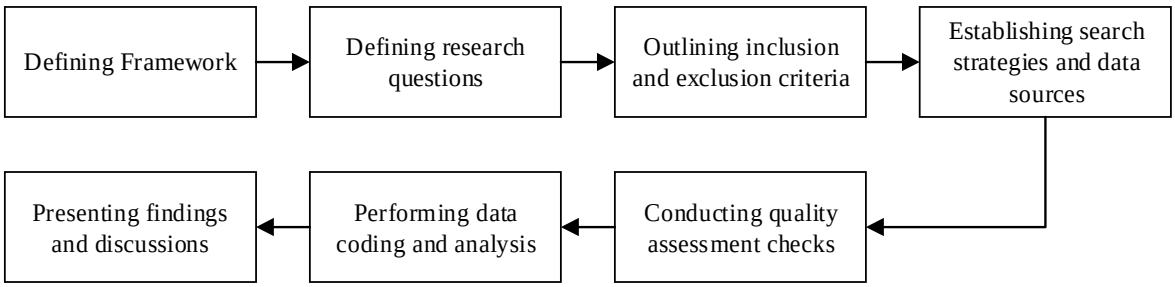

Figure 1. Review protocol adopted in this study

PICO framework

The PICO framework serves as a structured guide for researchers, helping them frame focused questions that facilitate systematic literature review and evidence-based decision-making [24]. Table 1 illustrates the PICO Framework of this research.

Table 1. PICO framework

Aspect		Description
Population (P)	:	Modern cities undergoing digital transformation into smart urban centers, focusing on sustainable and efficient development.
Intervention (I)	:	Application of sustainable technologies in the digital transformation of smart cities, including IoT, big data analytics, and AI.
Comparison (C)	:	Comparison of the impact of sustainable digital transformation on resource efficiency, carbon emissions reduction, and public services improvement.
Outcome (O)	:	Positive outcomes of sustainable digital transformation, such as enhanced resource efficiency, reduced carbon emissions, and improved public services.

Research questions

Research questions play a crucial role in helping researchers define the scope of their work and address the issues to be investigated in the study. Consequently, in this review study, three research questions were developed to provide guidance for the research. The formulated research questions are as follows:

RQ1 : What are the benefits of implementing sustainable digital transformation to achieve the evolution of a smart city?

RQ2 : What is the role of sustainable digital transformation in achieving the evolution of a smart city?

RQ3 : What are the challenges of sustainable digital transformation in achieving the evolution of a smart city?

Inclusion and exclusion criteria

Literature criteria consist of inclusion and exclusion criteria and the criteria in this study were adjusted to the PICO framework that had previously been made with the following additions shown in Table 2.

Table 2. Inclusion and exclusion criteria.

Criteria	Inclusion	Exclusion
Subject	Research on technologies around digital transformation and smart cities.	Outside of research on digital transformation, and smart cities
Language	English	Not in English
Source	Fully accessible and finalized research articles retrieved from Scopus	Research articles that are not fully accessible and finalized and retrieved from Scopus
Article type	Last 4 years (2020-2023)	Before 2020
Timeframe	Application of sustainable digital transformation and smart cities evolution.	Articles that after in-depth analysis do not match the research problem
Journal Theme	Engineering, Computer Science, and Social Science	Other than Engineering, Computer Science and Social Science
Area	Research on technologies around digital transformation, urban living, and smart cities	Outside research from digital transformation, urban living, and smart cities

Search strategies and data sources

The data used in this research is secondary data. The data is in the form of research results published in journals online. A data search was conducted through Scopus. The article search was conducted by combining several keywords that have been obtained with the help of boolean operators (AND, OR), namely ((“digital transformation*” OR "digitalization*” OR “Internet of Things”*) AND ("sustainability*" OR "urbanization" OR "smart cities*" OR "urban development")).

The search and refinement phases of this review study followed the guidelines of the PRISMA, a methodology previously utilized in another digital transformation review study [25]. The PRISMA flowchart is illustrated in Figure 2.

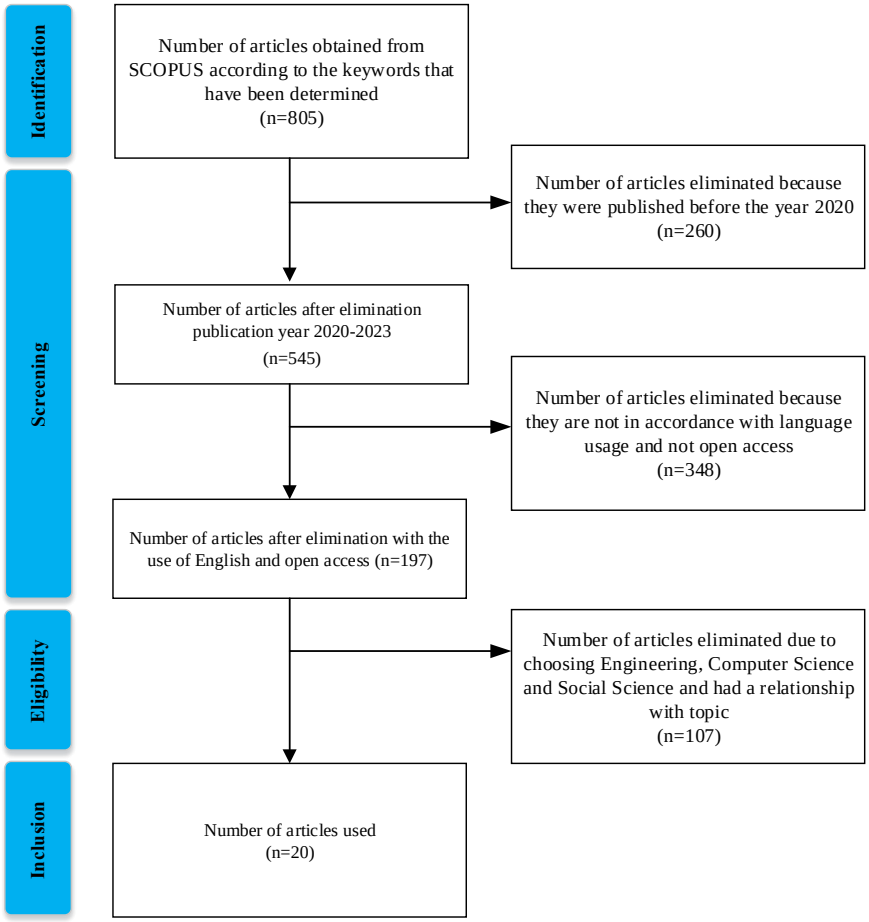

Figure 2. Selection with PRISMA

Search strategies and data sources

The examination of the retrieved papers' quality is a vital step, and the Quality Assessment Check (QAC) plays a key role in this evaluation. The QAC criteria involve assessing whether the chosen sources are included in the Scopus index. Results obtained from the chosen sources indicate that all selected papers, totaling 100%, are indexed in Scopus. The descriptive analysis of the last 20 studies involved coding, extracting, and synthesizing key themes related to sustainable digital transformation in evolving cities. This stage of the study contributes to a more comprehensive understanding of the role of sustainable digital transformation in smart cities. The subsequent section utilizes the insights derived from the examined papers to address the research questions.

Results and Discussion

Regarding the chosen studies on the sustainable digital transformation in the evolution of smart cities spanning from 2020 to 2023, the outcomes of this review are presented in alignment with the previously mentioned research questions.

Benefits of sustainable digital transformation for smart cities' evolution

The evolution of smart cities is significantly enhanced through a sustainable digital transformation, presenting many advantages across diverse dimensions. The

amalgamation of sustainable practices with digital innovations empowers smart cities to attain comprehensive urban development, yielding positive outcomes. Noteworthy benefits of sustainable digital transformation in the progression of smart cities include a commitment to environmental responsibility. Benefits of sustainable digital transformation for smart cities evolution can be seen in the following Figure 3.

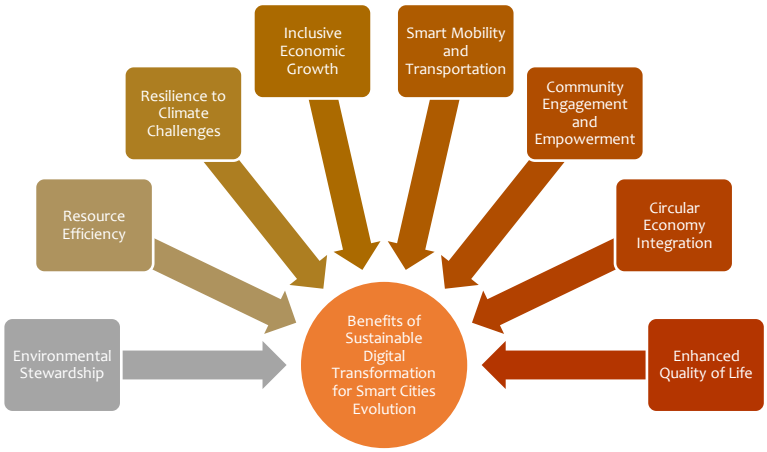

Figure 3. Benefits of sustainable digital transformation for smart cities evolution

This involves prioritizing eco-friendly solutions, thereby reducing carbon emissions and minimizing ecological footprints. By incorporating energy-efficient technologies, optimizing waste management, and encouraging eco-friendly urban planning, smart cities contribute to long-term environmental sustainability [1], [18]. Furthermore, the optimization of resource utilization is a key advantage achieved through digital technologies. Real-time monitoring, data analytics, and smart grids enable precise resource management, leading to a reduction in waste and the promotion of responsible consumption patterns in areas such as energy, water, and materials [26], [27]. Sustainable digital transformation also equips smart cities with the resilience to withstand the challenges posed by climate change and environmental issues. Through data-driven insights, cities can develop adaptive strategies and infrastructure that endure the impacts of climate change, ensuring long-term sustainability [28].

The incorporation of sustainability into digital transformation efforts ensures inclusive economic development, benefitting all segments of society. This approach promotes the creation of green jobs, supports local economies, and encourages socially responsible business practices, contributing to a more equitable distribution of economic opportunities [6], [29]. Smart and sustainable mobility is another pivotal aspect facilitated by sustainable digital transformation. This includes the integration of electric vehicles, intelligent traffic management, and optimized public transportation, resulting in reduced congestion, lower emissions, and improved mobility for residents [30].

Moreover, sustainable digital practices empower communities by providing citizens with information and tools for active participation in decision-making processes. This fosters community engagement, and transparency in governance, and ensures that

residents play a vital role in the sustainable development of their city [31]. Smart cities can further embrace a circular economy model through sustainable digital practices, minimizing waste, promoting recycling, and designing products and services with an emphasis on longevity and reusability. This contributes to a more sustainable and circular urban ecosystem [32]. The integration of sustainability and digital transformation culminates in an overall enhancement of the quality of life for residents. From cleaner air and efficient waste management to improved public spaces and smart infrastructure, sustainable digital transformation creates an environment that promotes well-being [3]. Lastly, the reliance on data analytics for sustainable decision-making in urban planning, resource allocation, and policy development ensures that sustainability goals are measurable, achievable, and continuously optimized based on real-time information [1].

Roles of sustainable digital transformation for smart cities evolution

Sustainable digital transformation serves as a cornerstone in the progression of smart cities, playing a pivotal role in enhancing their efficiency, resilience, and overall development. There are four role areas where sustainable digital transformation makes a significant impact in achieving the evolution of a smart city which is shown in Table 3.

Table 3. Role of sustainable digital transformation for smart cities evolution

No	Role	Description
1	Efficient Resource Management	Energy Efficiency Water Management
2	Integrated Urban Mobility	Smart Transportation Data-Driven
3	Resilient Infrastructure	IoT and Sensor Networks Disaster Management
4	Citizen Engagement and Quality of Life	Digital Services Community Involvement

In the realm of energy efficiency, smart cities leverage sustainable digital technologies such as smart grids, intelligent lighting systems, and energy-efficient buildings. These innovations allow for the optimization of energy consumption, consequently reducing overall energy demand and carbon emissions. Additionally, in water management, the deployment of smart sensors and data analytics facilitates the efficient monitoring and conservation of water resources [1], [33]. Digital transformation brings about intelligent transportation systems within smart cities. This includes real-time traffic monitoring, the implementation of smart parking solutions, and the development of efficient public transportation systems [12]. Through data-driven decision-making powered by analytics and artificial intelligence, smart cities can make informed choices regarding transportation infrastructure [34].

Sustainable digital transformation enables the deployment of Internet of Things (IoT) devices and sensor networks for monitoring critical infrastructure components like bridges, roads, and utilities [10]. Real-time data generated by these technologies facilitates predictive maintenance, ensuring the resilience and durability of essential

structures. Moreover, smart cities employ digital technologies for effective disaster management, utilizing sensors, satellite data, and communication networks to enhance preparedness and response to natural disasters and emergencies [5].

Through the delivery of digital services on online platforms, sustainable digital transformation enhances accessibility and efficiency of public services. This spans across healthcare, education, and government functions, contributing to an overall improvement in the quality of life for citizens [3], [8]. Moreover, smart city initiatives actively involve citizen engagement through digital platforms, allowing residents to participate in decision-making processes, provide feedback, and contribute to the ongoing development and sustainability of the city.

Challenges of sustainable digital transformation for smart cities evolution

While sustainable digital transformation brings about numerous benefits for the evolution of smart cities, it also presents several challenges that need to be addressed. Here are some key challenges associated with sustainable digital transformation for smart cities shown in Figure 4.

Figure 4. Challenges of sustainable digital transformation for smart cities evolution

The realization of sustainable digital transformation in smart cities faces a notable hurdle concerning financial limitations associated with the adoption of advanced technologies and infrastructure [32]. The impact of insufficient financial resources is considerable, obstructing the implementation of sustainable solutions and restricting the capacity of smart cities to invest in state-of-the-art technologies [35]. This limitation may lead to delays in projects or a reduction in scale, ultimately restricting the overall scope and effectiveness of digital transformation initiatives. Consequently, it is crucial for smart cities to innovate funding models and cultivate partnerships between the public and private sectors to navigate these financial challenges.

Securing meaningful engagement and inclusivity in smart city initiatives presents a nuanced challenge, necessitating active participation from residents in decision-making processes and the consideration of diverse community needs [36]. The impact of a lack of community involvement is significant, potentially resulting in resistance, skepticism, or the rejection of digital transformation projects. Additionally, it may lead to solutions that inadequately address the unique requirements of various population segments [8]. To address this challenge, smart cities must implement robust communication

strategies, promote transparency, and embrace inclusive approaches that accommodate the social, cultural, and economic diversity within their populations [19].

The swift evolution of digital technologies introduces a challenge in crafting comprehensive regulatory and policy frameworks to effectively govern smart city initiatives. The impact of the absence of clear and adaptive regulatory frameworks is noteworthy, potentially giving rise to concerns related to ethics, privacy, and the potential misuse of data [37], [38]. This deficiency in regulatory guidance can hinder the responsible deployment of digital technologies in smart cities. Consequently, collaboration between smart cities and policymakers becomes essential to establish agile and up-to-date regulations that ensure the ethical use of technology, safeguard citizen privacy, and guide the overall development of the smart city ecosystem [37].

Conclusion

In conclusion, this research, conducted through a systematic literature review using the PRISMA method, aimed to comprehensively understand the concept of sustainable digital transformation in the context of smart city evolution. The research questions focused on the benefits, roles, and challenges of sustainable digital transformation in achieving the evolution of smart cities. The benefits of sustainable digital transformation in smart cities are manifold. It enhances comprehensive urban development, prioritizes environmental responsibility by reducing carbon emissions, optimizes resource utilization through real-time monitoring and data analytics, fosters resilience to climate change, and promotes inclusive economic development. Sustainable digital practices also empower communities, support smart and sustainable mobility, and contribute to the overall enhancement of residents' quality of life. Sustainable digital transformation plays crucial roles in efficient resource management, integrated urban mobility, resilient infrastructure, and citizen engagement, all of which are vital for the evolution of smart cities. From energy efficiency and water management to smart transportation and disaster management, sustainable digital transformation contributes to the development of resilient and efficient urban systems. However, challenges accompany the realization of sustainable digital transformation in smart cities. Financial limitations pose a significant hurdle, hindering the adoption of advanced technologies. Ensuring meaningful community engagement and inclusivity is another challenge, requiring active participation from residents in decision-making processes. Crafting comprehensive regulatory frameworks to govern smart city initiatives is also a challenge, given the swift evolution of digital technologies. In addressing these challenges, smart cities must innovate funding models, foster partnerships between the public and private sectors, implement robust communication strategies, and embrace inclusive approaches. Collaboration between smart cities and policymakers is essential to establish agile and up-to-date regulations that ensure the ethical use of technology and safeguard citizen privacy. This research contributes valuable insights to the understanding of sustainable digital transformation in smart cities and encourages

further discussions on the challenges, opportunities, and future research directions in this evolving field. The findings of this study support the development of smart cities that are not only technologically advanced but also sustainable for future generations.

References

[1] S. E. Bibri and J. Krogstie, "The emerging data–driven Smart City and its innovative applied solutions for sustainability: The cases of London and Barcelona," Energy Informatics, vol. 3, pp. 1–42, 2020.

[2] H. Kumar, M. K. Singh, M. P. Gupta, and J. Madaan, "Moving towards smart cities: Solutions that lead to the Smart City Transformation Framework," Technol Forecast Soc Change, vol. 153, p. 119281, 2020.

[3] Z. Chen and I. C. C. Chan, "Smart cities and quality of life: a quantitative analysis of citizens' support for smart city development," Information Technology & People, vol. 36, no. 1, pp. 263–285, 2023.

[4] B. Zhang, W. Dong, and J. Yao, "How Does Digital Transformation of City Governance Affect Environmental Pollution: A Natural Experiment from the Pilot Policy of 'National Information City for Public Service' in China," Sustainability, vol. 14, no. 21, p. 14158, 2022.

[5] M. E. E. Alahi et al., "Integration of IoT-Enabled Technologies and Artificial Intelligence (AI) for Smart City Scenario: Recent Advancements and Future Trends," Sensors, vol. 23, no. 11, p. 5206, 2023.

[6] A. Maiurova et al., "Promoting digital transformation in waste collection service and waste recycling in Moscow (Russia): Applying a circular economy paradigm to mitigate climate change impacts on the environment," J Clean Prod, vol. 354, p. 131604, 2022.

[7] S. Pauliuk, M. Koslowski, K. Madhu, S. Schulte, and S. Kilchert, "Co-design of digital transformation and sustainable development strategies-What socio-metabolic and industrial ecology research can contribute," J Clean Prod, vol. 343, p. 130997, 2022.

[8] F. Caputo, P. Magliocca, R. Canestrino, and E. Rescigno, "Rethinking the Role of Technology for Citizens' Engagement and Sustainable Development in Smart Cities," Sustainability, vol. 15, no. 13, p. 10400, 2023.

[9] X. Teng, Z. Wu, and F. Yang, "Research on the relationship between digital transformation and performance of SMEs," Sustainability, vol. 14, no. 10, p. 6012, 2022.

[10] P. Bellini, P. Nesi, and G. Pantaleo, "IoT-enabled smart cities: A review of concepts, frameworks and key technologies," Applied Sciences, vol. 12, no. 3, p. 1607, 2022.

[11] R. Al Sharif and S. Pokharel, "Smart city dimensions and associated risks: Review of literature," Sustain Cities Soc, vol. 77, p. 103542, 2022.

[12] J. S. Gracias, G. S. Parnell, E. Specking, E. A. Pohl, and R. Buchanan, "Smart Cities—A Structured Literature Review," Smart Cities, vol. 6, no. 4, pp. 1719–1743, 2023.

[13] C. Sassanelli and S. Terzi, "The D-BEST reference model: a flexible and sustainable support for the digital transformation of small and medium enterprises," Global Journal of Flexible Systems Management, vol. 23, no. 3, pp. 345–370, 2022.

[14] [E. Leite, "Innovation networks for social impact: An empirical study on multi-actor collaboration in projects for smart cities," J Bus Res, vol. 139, pp. 325–337, 2022.

[15] I. Yaqoob, K. Salah, R. Jayaraman, and M. Omar, "Metaverse applications in smart cities: Enabling technologies, opportunities, challenges, and future directions," Internet of Things, p. 100884, 2023.

[16] F. Khan and A. Mer, "Embracing Artificial Intelligence Technology: Legal Implications with Special Reference to European Union Initiatives of Data Protection," in Digital Transformation, Strategic Resilience, Cyber Security and Risk Management, Emerald Publishing Limited, 2023, pp. 119–141.

[17] L. Xia, D. T. Semirumi, and R. Rezaei, "A thorough examination of smart city applications: Exploring challenges and solutions throughout the life cycle with emphasis on safeguarding citizen privacy," Sustain Cities Soc, vol. 98, p. 104771, 2023.

[18] M. G. M. Almihat, M. T. E. Kahn, K. Aboalez, and A. M. Almaktoof, "Energy and Sustainable Development in Smart Cities: An Overview," Smart Cities, vol. 5, no. 4, pp. 1389–1408, 2022.

[19] [S.-C. Kim, P. Hong, T. Lee, A. Lee, and S.-H. Park, "Determining strategic priorities for smart city development: Case studies of south Korean and international smart cities," Sustainability, vol. 14, no. 16, p. 10001, 2022.

[20] A. R. Javed et al., "Future smart cities: Requirements, emerging technologies, applications, challenges, and future aspects," Cities, vol. 129, p. 103794, 2022.

[21] R. R. Xiong, C. Z. Liu, and K.-K. R. Choo, "Synthesizing Knowledge through A Data Analytics-Based

Systematic Literature Review Protocol," Information Systems Frontiers, pp. 1–24, 2023.
[22] S. K. Sahoo and S. S. Goswami, "A comprehensive review of multiple criteria decision-making (MCDM) Methods: advancements, applications, and future directions," Decision Making Advances, vol. 1, no. 1, pp. 25–48, 2023.
[23] B. Kitchenham, L. Madeyski, and D. Budgen, "SEGRESS: Software engineering guidelines for reporting secondary studies," IEEE Transactions on Software Engineering, vol. 49, no. 3, pp. 1273–1298, 2022.
[24] B. Berger-Höger et al., "Determinants of practice for providing decision coaching to facilitate informed values-based decision-making: protocol for a mixed-methods systematic review," BMJ Open, vol. 13, no. 11, p. e071478, 2023.
[25] [M. J. Page, D. Moher, and J. E. McKenzie, "Introduction to PRISMA 2020 and implications for research synthesis methodologists," Res Synth Methods, vol. 13, no. 2, pp. 156–163, 2022.
[26] [C. X. Hui, G. Dan, S. Alamri, and D. Toghraie, "Greening smart cities: An investigation of the integration of urban natural resources and smart city technologies for promoting environmental sustainability," Sustain Cities Soc, vol. 99, p. 104985, 2023.
[27] S. Sankarananth, M. Karthiga, E. Suganya, S. Sountharrajan, and D. P. Bavirisetti, "AI-enabled metaheuristic optimization for predictive management of renewable energy production in smart grids," Energy Reports, vol. 10, pp. 1299–1312, 2023.
[28] H. Jain, R. Dhupper, A. Shrivastava, D. Kumar, and M. Kumari, "AI-enabled strategies for climate change adaptation: protecting communities, infrastructure, and businesses from the impacts of climate change," Computational Urban Science, vol. 3, no. 1, p. 25, 2023.
[29] L. O. Cezarino, L. B. Liboni, T. Hunter, L. M. Pacheco, and F. P. Martins, "Corporate social responsibility in emerging markets: Opportunities and challenges for sustainability integration," J Clean Prod, vol. 362, p. 132224, 2022.
[30] R. Martínez-Peláez et al., "Role of digital transformation for achieving sustainability: mediated role of stakeholders, key capabilities, and technology," Sustainability, vol. 15, no. 14, p. 11221, 2023.
[31] O. P. Agboola and M. Tunay, "Urban resilience in the digital age: The influence of Information-Communication Technology for sustainability," J Clean Prod, vol. 428, p. 139304, 2023.
[32] A. Dindarian, "Overview: The smart sustainable city initiatives and the circular economy," Circular Economy and Sustainability, pp. 369–384, 2022.
[33] T. Ahmad, R. Madonski, D. Zhang, C. Huang, and A. Mujeeb, "Data-driven probabilistic machine learning in sustainable smart energy/smart energy systems: Key developments, challenges, and future research opportunities in the context of smart grid paradigm," Renewable and Sustainable Energy Reviews, vol. 160, p. 112128, 2022.
[34] S. K. Singh, Y. Pan, and J. H. Park, "Blockchain-enabled secure framework for energy-efficient smart parking in sustainable city environment," Sustain Cities Soc, vol. 76, p. 103364, 2022.
[35] Y. Zhang and A. Dilanchiev, "Economic recovery, industrial structure and natural resource utilization efficiency in China: effect on green economic recovery," Resources Policy, vol. 79, p. 102958, 2022.
[36] M. A. A. Akers, "Digital Placemaking: An Analysis of Citizen Participation in Smart Cities," in Smart Cities and Smart Communities: Empowering Citizens through Intelligent Technologies, Springer, 2022, pp. 171–185.
[37] S. Blasi, A. Ganzaroli, and I. De Noni, "Smartening sustainable development in cities: Strengthening the theoretical linkage between smart cities and SDGs," Sustain Cities Soc, vol. 80, p. 103793, 2022.
[38] Y. Chang and J. Xu, "Application of spatial data and 3S robotic technology in digital city planning," International Journal of Intelligent Networks, vol. 4, pp. 211–217, 2023.