

Systematic Review Impact Smart City Technologies on Quality of Life and Environment

Tinjauan Sistematis Dampak Teknologi Kota Pintar terhadap Kualitas Hidup dan Lingkungan

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ABSTRACT — This study conducted a Systematic Literature Review (SLR) to review the impact of smart city technologies on quality of life and environmental sustainability. Using the PRISMA method, this review systematically identified, screened, and selected relevant studies from reputable databases, focusing on recent publications from 2019 to 2024. The research addresses various aspects of smart city initiatives, including benefits, challenges, real-world applications, potential risks, and strategies to overcome implementation barriers. The results show that smart city technologies contribute positively to urban resource management, energy efficiency, and waste reduction, thereby improving quality of life and promoting sustainable urban development. However, data privacy, cybersecurity, and high implementation costs remain significant obstacles. Community engagement and customized approaches are identified as critical factors in the successful adoption of smart city initiatives. This study provides insights into strategies to optimize the benefits of smart city projects, offering a basis for further research and practical guidance for stakeholders in urban planning.

INTISARI — Penelitian ini melakukan Systematic Literature Review (SLR) untuk meninjau dampak teknologi kota pintar terhadap kualitas hidup dan keberlanjutan lingkungan. Dengan menggunakan metode PRISMA, tinjauan ini secara sistematis mengidentifikasi, menyaring, dan memilih studi relevan dari database terkemuka, berfokus pada publikasi terbaru dari tahun 2019 hingga 2024. Penelitian ini membahas berbagai aspek inisiatif kota pintar, termasuk manfaat, tantangan, aplikasi nyata, potensi risiko, dan strategi untuk mengatasi hambatan implementasi. Hasilnya menunjukkan bahwa teknologi kota pintar berkontribusi positif pada pengelolaan sumber daya perkotaan, efisiensi energi, dan pengurangan limbah, sehingga meningkatkan kualitas hidup dan mendorong pembangunan perkotaan yang berkelanjutan. Namun, tantangan seperti privasi data, keamanan siber, dan biaya implementasi yang tinggi tetap menjadi kendala signifikan. Keterlibatan masyarakat dan pendekatan yang disesuaikan diidentifikasi sebagai faktor penting dalam keberhasilan adopsi inisiatif kota pintar. Studi ini memberikan wawasan mengenai strategi untuk mengoptimalkan manfaat proyek kota pintar, menawarkan dasar untuk penelitian lanjutan dan panduan praktis bagi pemangku kepentingan dalam perencanaan kota.

KEYWORDS — Smart city, Quality of life, Environmental sustainability, Systematic Literature Review (SLR), PRISMA, Urban development, Data privacy, Community engagement.

I. INTRODUCTION

The idea of "smart cities" is becoming an essential tenet in the evolution of contemporary "smart cities" in the context of expanding urban growth. The concept was introduced to incorporate information and communication technology into urban environments to boost infrastructure and services' efficiency, improve people's quality of life, and promote environmental sustainability. The worldwide endorsement of the smart city idea highlights the need for new strategies in tackling progressively intricate urban issues [1]. The evolution of the smart city concept has led to a paradigm shift towards a comprehensive integration of modern technology, effective urban governance, and initiatives aimed at enhancing resilience against various pressures. The primary goals of smart city development—improving resource efficiency, raising energy efficiency, and revolutionizing waste management—reflect this in these endeavors. Integrating renewable energy sources and other energy systems is a growing trend in developing a Smart Grid (SG), which utilizes information and communication technology (ICT) to enhance power generation, distribution, and consumption. Furthermore, Big Data (BD) produced by SG offers valuable information for load profiling and demand response applications.

This effort demonstrates significant potential to enhance quality of life while balancing ecological protection and urban growth. However, implementing smart city technologies also poses challenges along with the potential benefits. A better understanding of their impact on people's quality of life and environmental sustainability is needed, and practical strategies are needed to address the associated risks. The impact of innovative city technologies on quality of life and environmental sustainability is an essential aspect of urban development that is receiving increasing attention in research and practice. This effort demonstrates significant potential to enhance quality of life while balancing ecological protection and urban growth. These initiatives go beyond digitization and seek to add value to the urban environment and address urban challenges. The concept of smart cities is evolving towards a more holistic understanding, including technological advancements, governance, and management of urban systems [3].

Resilience in urban systems, which emphasizes a city's ability to endure and recover from various shocks and pressures, is also conceptually gaining relevance [4]. Integrating innovative solutions in urban environments is a potential enhancer of city resilience. However, there needs to be more debate about the impact of increased interdependence resulting from smart technologies. Awareness is increasing regarding the need for a more holistic approach to urban development incorporating environmental sustainability and quality of life as discussions concerning smart cities progress.

Integrating resilience theory with smart city technology presents an opportunity to reevaluate urban planning frameworks, leading to more robust and sustainable outcomes that enhance the environment and overall quality of life in urban areas. By thoroughly examining the effects of smart city technology and looking into strategies that cities have employed to overcome the difficulties associated with putting smart city projects into action, this study seeks to close the gap [5]. Integrating resilience theory with smart city technology presents an opportunity to reevaluate urban planning frameworks, leading to more robust and sustainable outcomes that enhance the environment and overall quality of life in urban areas.

Prior studies have demonstrated that smart city technologies enhance the quality of life and environmental sustainability. Smart cities can tackle urban difficulties, including energy efficiency, waste management, and pollution reduction, by merging information and communication technology (ICT) with the Internet of Things (IoT). Besides improving infrastructure efficiency, these technologies also respond to community needs, including green spaces and public engagement through social media [23].

However, implementation costs, data privacy, and infrastructure remain significant concerns [8]. With more sophisticated data analytics and citizen engagement, there is an opportunity to develop smart cities in a more inclusive and sustainable direction. This research explores the role of innovative city technologies in supporting quality of life and sustainability, offering guidance for more responsive and resilient urban planning. This research will guide governments, stakeholders, and decision-makers in planning and implementing practical and sustainable smart city initiatives. Therefore, this research can improve cities' quality of life and environmental sustainability by reducing risks, optimizing benefits, and directing urban development toward more resilient and sustainable results.

II. METHODOLOGY

To achieve the objectives of this systematic literature review (SLR), researchers designed an SLR approach focusing on smart cities. This systematic literature review employed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to organize and document each phase of data gathering systematically. The systematic method was chosen to ensure that the literature review was thorough. With the PRISMA method, the process of identifying, screening, and selecting articles can be organized more transparently and in a repeatable manner, thus strengthening this study's methodological rigor.

In this study, PRISMA served as a structured guide, from the initial identification of articles to the screening stage based on inclusion criteria, ensuring the systematic and replicable selection process. Conversely, the SLR technique provides a comprehensive framework for synthesizing and evaluating existing literature, enabling the discernment of trends, research deficiencies, and the impact of research on smart city technology concerning quality of life and environmental sustainability. The combination of PRISMA and SLR methods ensures that the results of this study have a strong evidence base, reduce selection bias, and support valid conclusions, thus benefiting future research developments. The methodological process in this research includes the following stages:

- A. FORMULATION OF RESEARCH QUESTIONS
- B. LITERATURE SEARCH PROCESS
- C. APPLICATION OF INCLUSION AND EXCLUSION CRITERIA
- D. DATA COLLECTION

The comprehensive structure of this methodological process ensures a robust approach to literature synthesis, allowing for high-quality conclusions that are insightful, relevant, and supportive of further advancements in the smart city domain. This systematic approach enhances the validity and reliability of the study's contributions to the growing body of knowledge on sustainable urban innovation.

A. FORMULATION OF RESEARCH QUESTIONS

This subsection outlines the research topics addressed in this SLR through the formulated research questions (RQs). The following research questions are designed to explore various aspects of smart city initiatives, including the benefits, challenges, applications, and strategies used in their development:

- RQ1.** What benefits and drawbacks come with smart city initiatives?
- RQ2.** What are a few real-world uses for the technologies that smart cities adopt?
- RQ3.** Considering the extent to which smart city systems are interconnected, what are the possible hazards, and how are they addressed?
- RQ4.** How does community involvement influence how smart city programs are developed and carried out?
- RQ5.** What tactics and approaches have cities used to overcome obstacles and implement smart city projects?

This research aims to provide a comprehensive understanding of the various aspects of smart city implementation by answering these questions.

B. LITERATURE SEARCH PROCESS

In this subsection, the researcher outlines the process of identifying each article in our study. Various electronic databases were consulted and accessed to gather relevant Systematic Literature Review (SLR) studies about smart cities. The researchers created the following search string in order to look across these internet databases:

(Smart cities) AND (quality AND of AND life) OR (environmental) AND (impact) OR (challenge)

TABLE I
KEYWORD SEARCH RESULTS

Database	Keyword(s)	Identified
Scopus	smart cities	55.567
Scopus	smart cities AND quality AND of AND life	3.498
Scopus	smart cities AND environmental	8.381
Scopus	smart cities AND quality AND of AND life OR environmental	5.528
Scopus	smart cities AND quality AND of AND life AND environmental	130
Google Scholar	smart cities AND applications AND impact OR challenge	252

Table I above summarizes the results of searching for articles using various keywords in the Scopus and Google Scholar databases. In Scopus, the keyword “smart cities” alone yielded 55,567 articles, while the combination with “quality of life” reduced the number to 3,498. Adding “environmental” yielded 8,381 articles and a more specific combination with all keywords identified only 130 articles. A search with “smart cities AND applications AND impact OR challenge” found 252 articles on Google Scholar. The search results constituted the foundation for the screening procedure, guaranteeing that the gathered material was pertinent to the influence of smart cities on quality of life and environmental sustainability.

C. APPLICATION OF INCLUSION AND EXCLUSION CRITERIA

Specific criteria guided the selection of studies for this Systematic Literature Review (SLR) to determine their eligibility for inclusion. Any study failing to meet these criteria was excluded from consideration. Every piece needed to be written in understandable and unambiguous English, a crucial requirement for inclusion. Table II displays the list of inclusion and exclusion criteria.

TABLE II
TABLE INCLUSION AND EXCLUSION CRITERIA

Inclusion Criteria	Exclusion Criteria
a. Each article must be written in simple language to be understandable.	a. Articles published outside 2019 to 2024 were excluded.
b. Each article must be published between 2019 to 2024	b. Articles that do not directly address smart cities or relevant aspects of quality of life and environmental sustainability were excluded.
c. Each article must be related to Smart Cities, including technologies, applications, and impacts on urban areas.	c. Articles that need to provide sufficient data or answer the research questions outlined in this study were excluded.
d. Each article should discuss the impacts of smart city technologies on quality of life, environmental sustainability, or both.	d. Sources such as opinion pieces, editorials, book chapters, and non-peer-reviewed content were excluded to maintain academic reliability.
e. Only peer-reviewed journal articles, conference papers, and academic research were included to guarantee trustworthiness and scientific rigor.	e. Duplicates or redundant studies with overlapping data or results already covered in other included articles were excluded.
f. Articles must provide clear information on research methods, data collection, and analysis procedures.	

Table II of inclusion and exclusion criteria was designed to ensure that only studies that were relevant, of high quality, and supported the research objectives were selected in this systematic literature review. The inclusion criteria included language appropriateness, publication period (2019-2024), topic relevance, and methodological appropriateness so that only articles addressing smart city technologies related to quality of life and environmental sustainability were included. Only peer-reviewed sources were included to ensure data accuracy. Conversely, the exclusion criteria excluded articles published outside this period that were irrelevant, lacked sufficient data, were not peer-reviewed, or were duplicates to maintain academic integrity and avoid bias. With these criteria, the rigorous article selection process ensured that the study was based on relevant and reliable data.

D. DATA COLLECTION

The authors prioritized extracting specific types of information from each article, focusing mainly on data related to smart cities and pertinent details regarding ongoing innovative city projects. From every article that was included in the study, different kinds of data were retrieved, including the following:

- Author details
- Publication year
- Their country
- The details of the response to our research questions

The data collection process was conducted over 8 weeks, focusing on articles published between 2019 and 2024. This period was selected to capture recent advancements in smart city technology and their impact on quality of life and environmental sustainability. Data were sourced from reputable databases, including Scopus and Google Scholar, using carefully chosen keywords like "smart cities," "quality of life," and "environmental." This timeframe and targeted collection period demonstrate notable progress in smart city projects, including using Internet of Things (IoT) technologies and sustainability methods in urban design, establishing a robust basis for the research. Figure 1 shows how PRISMA gives detailed information about the total number of articles considered.

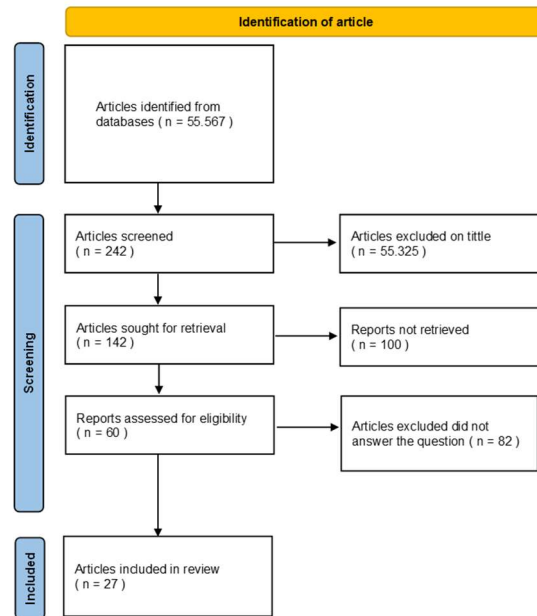


Figure 1. PRISMA Diagram

- This initial stage involves identifying all potential studies that could be included in the review. This process is usually done by searching through electronic databases such as Google Scholar and Scopus. At this stage, the number of articles found reached (n=55.567).
- Screening: Once all potential studies were identified, the articles were screened to determine if they met the inclusion criteria. The screening process often entails reviewing the title and abstract of the article. At this juncture, 242 papers were examined, and those that failed to match the criteria were excluded from the review.
- Eligibility: After the screening process, the remaining articles were further evaluated to ensure their eligibility, which is usually done by reading the full text of the article. At this stage, the number of articles assessed for eligibility was (n=100), and 82 articles were excluded because they did not address the research question.
- Included: The concluding phase of the procedure encompassed papers that satisfied all inclusion criteria for the review. The final evaluation comprised a total of 27 articles.

This process ensured that only the most relevant articles that fit the focus of the study were included in the analysis.

III. RESULTS

In this section, the authors will analyze and discuss the findings following the previously outlined study questions. A total of 55,567 papers related to Smart City Technologies were identified for this study. These papers were selected based on specific criteria to ensure relevance to the study's objectives. However, a thorough evaluation process further reduced the number of pertinent articles to 100, considering the study's focus on environmental sustainability and quality of life. Subsequently, after thoroughly examining abstracts and contents, the final selection comprised 27 articles.

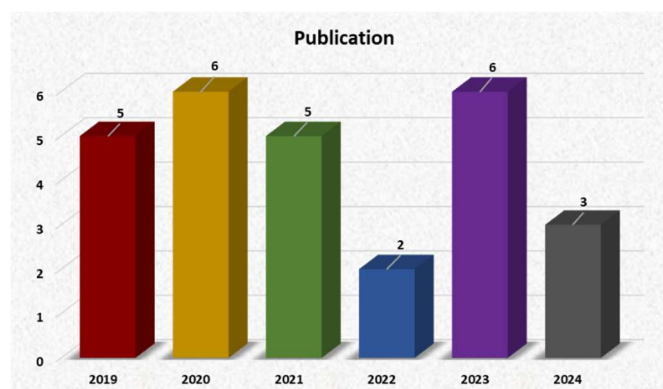


Figure 2. Number of Smart Cities Publication

Figure 2 shows the number of publications cited in this research related to the 'Smart Cities' theme from 2019 to 2024. This figure shows how many references were selected from each year to support the analyses in this study. By selecting publications from each year, the researcher ensured that the references covered the latest smart city developments. This research focuses on data from 2019 to 2024 as it considers the limitations of literature relevance. By using five years back, this research can cover literature that is still current and relevant, given that smart city technology is rapidly evolving. In addition, this five-year span is a common standard in research to ensure that the information referenced remains relevant to the current situation and technological advancements.

This section outlines the key topics addressed in this Systematic Literature Review (SLR) through the formulated research questions. Each question explores different aspects of smart city initiatives, including benefits and challenges, real-world applications, potential risks, community engagement, and tactics and approaches used in smart city implementation. These inquiries aim to elucidate the influence of smart cities on quality of life and environmental sustainability, alongside the techniques employed to surmount obstacles to their development.

RQ1. WHAT BENEFITS AND DRAWBACKS COME WITH SMART CITY INITIATIVES?

According to [6][7], Smart city initiatives bring significant benefits, including increased efficiency in resource management, creating a business-friendly environment, and technological advancements that promote citizen welfare and open new business opportunities, especially in the ICT sector. Moreover, smart cities promote the development and execution of innovative solutions to tackle urban challenges, utilizing advanced technologies to improve infrastructure, transportation, and public services while ensuring sustainable resource management. However, these initiatives also bring challenges, over-reliance on technology, privacy, and data security concerns, social inequalities, as well as implementation and cost constraints. The development of smart cities needs to address these challenges and ensure that the benefits can be equally felt by all segments of society, supporting the transition to more innovative and more sustainable, smarter, and more sustainable cities [8][9]. Reliance on the private sector for expertise that the government may need to improve, the speed of technology development that can make technology obsolete quickly, questions about financial return on investment, especially for private sector participants, and bureaucratic barriers that can inhibit entrepreneurship [10].

RQ2. WHAT ARE A FEW REAL-WORLD USES FOR THE TECHNOLOGIES THAT SMART CITIES ADOPT?

Practical applications of smart city technologies encompass various domains, including urban mobility and environmental sustainability. According to [11][12], Intelligent Transportation Systems (ITS) is deployed for traffic management and public transport, as well as the utilization of sensors, IoT, and cloud-based solutions for waste management and air quality monitoring. These projects seek to improve urban mobility, customize services to customer requirements, maximize resource use, and ultimately foster sustainable growth and enhance the quality of life in urban settings. Moreover, the application of data analytics to enhance services across diverse industries, including healthcare, the Internet of Things, 5G networks, fiber optic networks, and cloud infrastructure, aims to augment IT infrastructure and deliver services to residents. [13][14]. This shows how smart technology can prevent deaths, improve patient care, reduce traffic congestion, and customize policies according to citizens' needs.

RQ3. CONSIDERING THE EXTENT TO WHICH SMART CITY SYSTEMS ARE INTERCONNECTED, WHAT ARE THE POSSIBLE HAZARDS, AND HOW ARE THEY ADDRESSED?

The heavy reliance on interconnected smart city systems presents significant risks, including cybersecurity vulnerabilities, privacy breaches, and potential system failures. These risks stem from the complex and expansive attack surfaces created by IoT devices, drones, and interconnected communication networks, making them vulnerable to malicious exploitation [15][12]. Over-reliance on technology risks system failure and disruption in essential services if not managed effectively. The accumulation and dissemination of extensive data in smart city systems pose issues about data privacy and security [16].

Solid Cyber security measures, data privacy regulations, and backup systems are essential to address the risks. Encryption, continuous monitoring, and public engagement can help mitigate these risks, ensuring security, reliability, and privacy. It can help mitigate these risks, ensure the smart city systems' security, reliability, and privacy, and foster a resilient urban environment [17][18]. In addition, according to [16], built-in redundancy and security mechanisms must be built into the system to ensure the continuity of essential services. Strict data privacy regulations and ethical guidelines are essential to protect citizens' personal information and prevent unauthorized access. Regular risk assessments, collaboration with cyber security experts, ongoing training for personnel, and public awareness campaigns on cyber security practices are essential components of a comprehensive risk mitigation strategy.

RQ4. HOW DOES COMMUNITY INVOLVEMENT INFLUENCE HOW SMART CITY PROGRAMS ARE DEVELOPED AND CARRIED OUT?

Community involvement is essential in shaping smart city initiatives concerning the citizen participation framework put forward by Krijveld, emphasizing citizens' growing influence on these projects. Study Tadili and Fasly highlight the importance of citizen engagement at various stages by highlighting challenges such as limited budgets and long-term vision. However, the work of Mohseni and Behnagh indicates a positive trend toward increased citizen empowerment in smart city development. Citizen empowerment in smart city development. By using various engagement methods such as hackathons and workshops, these initiatives aim to cultivate [2][19].

Conversely, communities can enhance legislative frameworks and technology standards through collaborative planning and cooperative fact-finding, facilitating more informed and inclusive outcomes. Standards, thus paving the way for more informed and inclusive outcomes. Ultimately, community participation fosters the technological progression of smart cities and amplifies their

social and economic advantages, rendering smart cities more attuned to the communities' requirements. More responsive to the needs of the communities they serve [20], [21].

RQ5. WHAT TACTICS AND APPROACHES HAVE CITIES USED TO OVERCOME OBSTACLES AND IMPLEMENT SMART CITY PROJECTS?

According to [2][3], various cities have adopted diverse solutions to address the issue of implementing smart city programs. These strategies include approaches tailored to the economic and industrial status of the pillar, emphasizing technological innovation with consideration of environmental impacts, involving stakeholders in strategy development and implementation, overcoming limitations of new projects, and prioritizing sustainable development goals. Similarly, [22] Urban centers aim to optimize and efficiently by leveraging technology across various sectors, including transportation, energy management, trash disposal, healthcare, and education. Additionally, efficiency. Data analytics, IoT, and artificial intelligence have become essential tools for strengthening city resilience. By integrating economic incentives with environmental education and continuous infrastructure enhancements, cities can effectively manage the complexities of smart city initiatives, promoting a more sustainable and efficient urban environment while reconciling technological advancements with social, environmental, and economic factors.

IV. DISCUSSION

In this study, Sankey Diagrams were used to visualize the association between authors and the journals or conferences where articles were published and the topics covered in each publication. This visualization is instrumental in understanding each author's research focus, their connection to certain topics, and the distribution of topics across different publication platforms. Figure 3 shows the relationship between authors, journals, and keywords in the form of a Sankey Diagram.

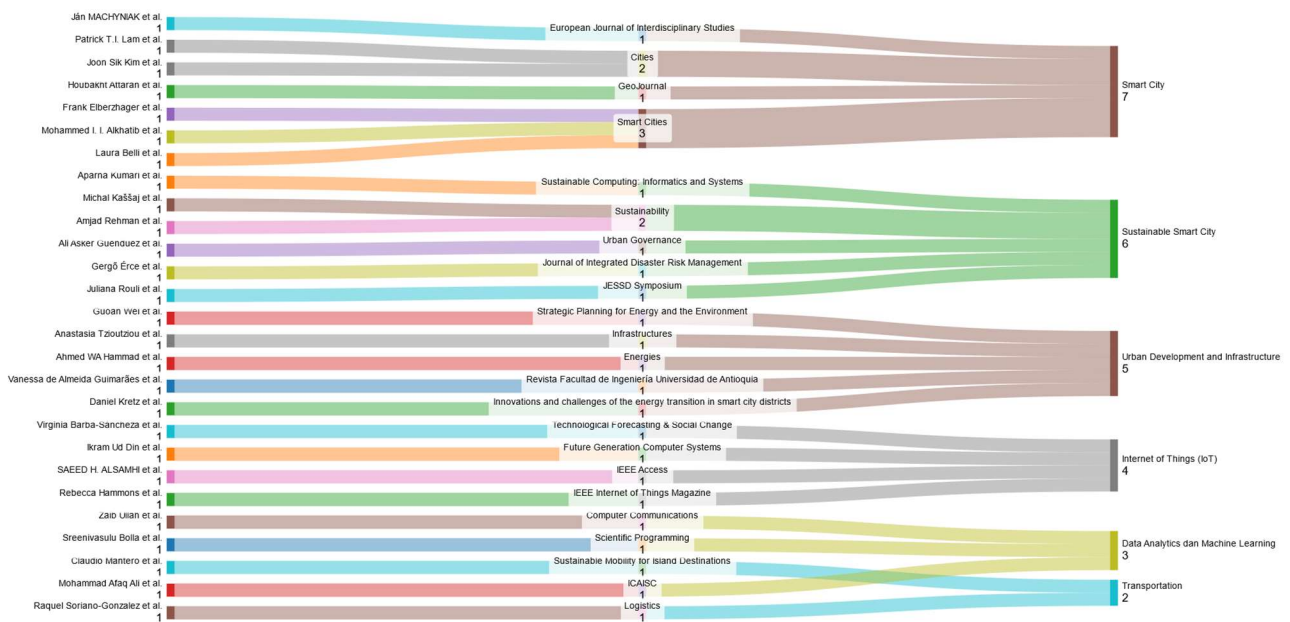


Figure 3. Sankeys Diagram Distribution of Research

Figure 3 presents a Sankey diagram illustrating the connections between various authors (left), journals or conferences (middle), and the primary subject of each publication (right). Thick connecting lines indicate more publications or contributions on a particular topic. The graphic indicates that the subjects "Sustainable Smart City" and "Smart City" garner considerable attention from many authors and are disseminated throughout numerous journals and conferences. In addition, the topics of "Urban Development and Infrastructure" and "Internet of Things (IoT)" also have strong linkages with several existing publications. This diagram effectively shows the distribution of key topics in related academic publications and identifies the journals and conferences that are the main media for these publications.

This section will explore the beneficial effects of smart city technologies on improving quality of life and fostering environmental sustainability. Additionally, the section will examine the various solutions implemented to overcome obstacles to smart city technology adoption, providing insights into strategies that enable successful integration and maximize benefits for urban communities.

A. THE OVERALL IMPACT OF SMART CITY TECHNOLOGIES ON QUALITY OF LIFE

The literature assessment results demonstrate that smart city technologies significantly influence quality of life. Research [23] underscored the need for smart city technologies, especially in addressing environmental issues resulting from urbanization. The ICT-based "smart city" concept aims to sustain the urban environment while enhancing the quality of life. Implementing smart city initiatives like IoT applications, cloud-based waste management, and smart air quality monitoring systems has successfully addressed

environmental issues. These technologies have effectively managed energy use, waste, and air pollution. Establishing green open spaces and thematic parks and using social media channels like Twitter for public comment has enhanced the urban environment. The smart city concept is essential in addressing urban waste issues and reducing carbon emissions. Therefore, overall, smart city technologies have positively impacted the quality of life by addressing environmental challenges and promoting sustainable urban development.

As stated in [8], the amalgamation of information and communication technology (ICT) with the Internet of Things (IoT) is anticipated to enhance infrastructure efficiency, transportation systems, and energy management in smart cities. Furthermore, smart city technology is anticipated to enhance environmental quality, expand public service availability, and lower pollution. In light of this, smart city technologies would enhance daily convenience, sustainability, and efficiency to benefit city dwellers' quality of life.

Applications like IoT, propelled by the amalgamation of the Internet of Things (IoT) and Information Communication Technology (ICT), seek to tackle the issues posed by urbanization and population increase, thereby enhancing individuals' quality of life technologies facilitate the monitoring, controlling, and managing of resources like electricity, water, and public infrastructure, resulting in enhanced efficiency and sustainability in urban operations [24]. In light of these conditions, implementing smart city technology can profoundly enhance inhabitants' quality of life by delivering more efficient services and elevating their overall standard of living [13].

B. CONTRIBUTION OF SMART CITY TECHNOLOGY TO ENVIRONMENTAL SUSTAINABILITY

Smart city technologies have demonstrated significant promise to lessen adverse environmental effects regarding environmental sustainability. Smart city initiatives offer many benefits, including improved quality of life, economic development, environmental sustainability, governance, and technological innovation [9]. In implementing smart cities, leveraging ICT can optimize resource management, transform the economy and society to be more knowledge-based and environmentally friendly, and focus on stronger handling of sustainable smart cities [25]. By implementing such smart city contributions, an environmentally sustainable approach can be taken, such as using reusable resources, eco-friendly materials, and optimized energy consumption. Implementing these measures can mitigate the adverse effects of innovative city initiatives on environmental sustainability and tackle environmental challenges [26]. Potential Risks of Smart Cities for Environmental Sustainability and Quality of Life.

C. SYNERGY BETWEEN QUALITY OF LIFE AND ENVIRONMENTAL SUSTAINABILITY

The interplay between quality of life and environmental sustainability is fundamental to community involvement in the development and execution of innovative city initiatives, enhancing the project's effectiveness, sustainability, and responsiveness to local needs [1]. This is because quality of life and environmental sustainability work well together. The advancement and execution of smart city programs are enhanced by the community's active involvement in the decision-making process, promoting transparency, inclusivity, and accountability. It also enables the determination of key performance indicators (KPIs) relevant to citizen mobility in an innovative and sustainable city [27]. The interplay between Quality of Life and Environmental Sustainability is an essential basis for these initiatives. The development and execution of smart city initiatives focus on the interplay between environmental sustainability and quality of life. At the same time, the active participation of citizens in the creation and decision-making processes ensures that the projects align with their needs and objectives [19].

D. CHALLENGES AND OPPORTUNITIES FOR FURTHER IMPROVEMENT

Challenges faced in optimizing smart city technologies' positive impact on people's quality of life and environmental sustainability include high implementation costs, lack of supporting infrastructure, and concerns about data privacy [8]. However, opportunities for improvement abound. Advanced data analytics and citizen engagement can optimize decision-making and ensure solutions align with community needs. Embracing circular economy principles and sustainable practices minimizes environmental impact and promotes resource efficiency. Robust connectivity infrastructure supports the seamless operation of smart city applications, while comprehensive policy frameworks address legal, ethical, and societal implications, ensuring responsible innovation and safeguarding public interests. Smart cities can enhance living standards and environmental sustainability in metropolitan areas by addressing these challenges and capitalizing on opportunities.

E. TECHNIQUES AND APPROACHES USED BY CITIES TO GET AROUND OBSTACLES IN THE WAY OF PUTTING SMART CITY PROJECTS INTO ACTION

The methods and strategies cities employ to tackle the problems of implementing smart city programs have profoundly influenced residents' quality of life and environmental sustainability. Various approaches have been adopted, which include innovative technologies, stakeholder engagement, and an emphasis on sustainable development goals. One proven effective strategy is to adopt an approach tailored to local economic and industrial conditions. Initiatives for smart cities can be created to address the particular requirements of local communities while taking the environment into account by considering each city's distinctive features. This allows cities to optimize efficiency and sustainability while reducing environmental negative impacts.

Stakeholder participation in formulating and applying strategies is essential to accomplishing smart city projects. Cities may ensure that the suggested solutions address the community's requirements and receive widespread support by incorporating residents, local companies, local governments, and community organizations in decision-making. Technology utilization in transportation, energy management, waste management, healthcare, and education has become a central emphasis for optimization and efficiency. Utilizing data analytics, IoT, and artificial intelligence, municipalities may refine decision-making, augment public services, and optimize resource utilization [22].

Approaches that combine economic incentives with environmental education and sustainable infrastructure improvements have also proven successful in facilitating the implementation of smart city initiatives. By encouraging active community participation, providing incentives for companies and individuals to adopt sustainable solutions, and continuously improving the infrastructure that supports smart city technologies, cities can achieve sustainable development goals while considering social, environmental, and economic considerations. The quality of life and environmental sustainability have significantly improved due to the methods and strategies cities employ to address the challenges of implementing smart city initiatives. By further advancing and refining these methodologies, urban areas can persist toward a more intelligent, sustainable, and inclusive future.

V. CONCLUSION

Smart city initiatives have contributed positively to resource management, citizen well-being and sustainable development, although challenges related to privacy, data security and implementation costs remain. Cities worldwide are increasingly tailoring strategies relevant to local economic and industrial contexts, utilizing Information and Communication Technologies (ICT) and the Internet of Things (IoT) to strengthen urban resilience and encouraging community engagement to create projects responsive to citizens' needs. For the future, research is recommended to focus on developing comprehensive sustainability indicators for long-term impact evaluation and methods of mitigating privacy and data security risks integrated with IoT and AI. Sustainable smart city development also needs to pay attention to applying circular economy principles, renewable energy, and infrastructure upgrades. Community engagement and responsible innovation policies are crucial in ensuring smart city projects are inclusive and environmentally friendly, thus realizing a more innovative, more efficient, sustainable urban future.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

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