Original Article

Encontros Bibli

COMPREHENSIVE ANALYSIS OF SMART CITIES IN INDONESIA: IMPLEMENTATION, CHALLENGES AND URGENCY OF MANAGEMENT INFORMATION SYSTEMS

Análise abrangente de cidades inteligentes na Indonésia: implementação, desafios urgência de sistemas de informação gerencial

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RESUMO

Objetivo: Este estudo apresenta uma análise abrangente da implementação de cidades inteligentes na Indonésia, concentrando-se em três aspectos críticos: estratégias de implementação, desafios tecnológicos e dimensões de sustentabilidade.
Método: Empregando uma abordagem metodológica qualitativa, esta pesquisa examina dados primários de relatórios oficiais do governo e dados secundários da literatura acadêmica contemporânea.
Resultado: As conclusões indicam que, embora as iniciativas de cidades inteligentes em vários centros urbanos indonésios tenham demonstrado progressos, enfrentam desafios significativos, incluindo infraestruturas tecnológicas inadequadas, preocupações com a segurança e a privacidade dos dados, complexidades de integração de sistemas e uma escassez de recursos humanos devidamente qualificados.
Conclusões: Este estudo enfatiza a necessidade de implementar Sistemas de Informação Gerencial (MIS) robustos como base operacional para cidades inteligentes. Os resultados da investigação oferecem informações valiosas para os decisores políticos, planejadores urbanos e outras partes interessadas envolvidas na concepção e implementação de estratégias sustentáveis de cidades inteligentes.
PALAVRAS-CHAVE: Cidade Inteligente. Sustentabilidade. Desafios Tecnológicos. Desenvolvimento Urbano. Indonésia. Sistemas de Informação Gerencial.

ABSTRACT

Objective: This study presents a comprehensive analysis of Smart City implementation in Indonesia, focusing on three critical aspects: implementation strategies, technological challenges, and sustainability dimensions.
Methods: Employing a qualitative methodological approach, this research examines primary data from official government reports and secondary data from contemporary academic literature.
Results: Findings indicate that while Smart City initiatives in various Indonesian urban centers have demonstrated progress, they face significant challenges, including inadequate technological infrastructure, data security and privacy concerns, system integration complexities, and a dearth of appropriately skilled human resources.
Conclusions: This study emphasizes the imperative of implementing robust Management Information Systems (MIS) as the operational foundation for Smart Cities. The research findings offer valuable insights for policymakers, urban planners, and other stakeholders engaged in the design and implementation of sustainable Smart City strategies.
KEYWORDS: Smart City. Sustainability. Technological Challenges. Urban Development. Indonesia. Management Information Systems.

1 INTRODUCTION

The Smart City paradigm has emerged as a focal point in contemporary global urban development discourse (Albino; Berardi; Dangelico, 2015; Angelidou, 2015). This concept represents a development model that comprehensively integrates digital technologies to enhance public service efficiency, stimulate economic growth, and elevate the quality of life for urban populations (Halegoua, 2020; Ismagilova *et al*., 2022; Yin *et al*., 2015). The essence of a Smart City lies in the strategic utilization of information and communication technology (ICT) to manage urban assets with optimal efficiency and effectiveness (Ptichnikova; Antyufeev, 2020).

Smart City initiatives have been implemented globally, encompassing a wide spectrum of endeavors. These include the development of Smart City architectures (Bhattacharya *et al*., 2020; Kumar *et al*., 2020; Prasetyo; Habibie, 2022), innovative policy formulation (Szpilko, 2020), evaluation of smart mobility implementation (Butler *et al*., 2020), technology-based public complaint management (Bastos *et al*., 2022), and the application of Smart City concepts to achieve sustainable urban development (Rani *et al*., 2021).

In the context of developing nations such as Indonesia, Smart City implementation has been undertaken by municipal governments in major urban centers, including Jakarta, Bandung, and Surabaya (Nashiruddin; Sihotang; Murti, 2022; Sukarno; Putri, 2022; Syalianda; Kusumastuti, 2021). However, analysis of current literature reveals that several crucial aspects of Smart City implementation and sustainability in Indonesia remain insufficiently explored. This research gap emphasizes the importance of a comprehensive and systematic analysis of the effectiveness and impact of Smart City initiatives on a national scale, as well as a holistic understanding of how the Smart City concept has influenced urban development dynamics.

2 LITERATURE REVIEW

While community participation has been identified as a critical factor in Smart City development (Capra, 2016; Goodman *et al*., 2020; Levenda *et al*., 2020), there remains a paucity of research on effective mechanisms to enhance and sustain community involvement in Smart City initiatives within Indonesia. Further investigation is warranted to

explore innovative strategies for increasing public participation and ensuring that Smart City implementation is genuinely inclusive and citizen-centric.

The sustainability dimension of Smart Cities in Indonesia represents another crucial area of inquiry. Although several studies have addressed sustainability aspects in the context of Smart Cities (Rani *et al*., 2022; Tura; Ojanen, 2022; Yigitcanlar; Kamruzzaman, 2018), specific research on the financial, technological, and social sustainability dimensions in Indonesia remains limited (Muttaqin, 2024). This gap is particularly significant given the necessity for Smart City initiatives to not only be effective in the short term but also to remain viable and thrive in a long-term perspective.

Numerous studies have reported on Smart City components such as smart mobility, smart governance, and smart economy (Buallay; El Khoury; Hamdan, 2021; Eiza; Cao; Xu, 2020; Khan *et al.*, 2020; Oliveira; Fontgalland, 2024). These studies provide insights into potential strategies for effectively integrating these components to achieve optimal synergy. However, further research is needed to analyze interactions between components and identify strategies to enhance integration and cohesion within the Smart City ecosystem.

In this context, the role of Management Information Systems (MIS) becomes paramount. MIS can be defined as an integrated system that provides information to support operations, management, and decision-making functions within an organization (Laudon; Traver, 2020; Xia *et al.*, 2022). In the Smart City context, MIS serves as a backbone that integrates various urban subsystems, facilitates information flow between departments, and supports data-driven decision-making (Anthony Jnr, 2021). However, the effective implementation of MIS within the context of Smart Cities in Indonesia has not yet been comprehensively explored.

The adaptation of the Smart City concept to local contexts is another area requiring further investigation. While several studies have discussed the adaptation of this concept for the Indonesian context (Hardi; Gohwong, 2020; Kusumastuti *et al*., 2022; Rifaid *et al*., 2023; Widhyastana; Rachmawati, 2022), these studies often employ the concept implicitly and partially. Therefore, there remains a need for more in-depth research on how the Smart City concept can be effectively adapted to the specific characteristics and challenges faced by cities in Indonesia. This includes consideration of cultural diversity, existing infrastructure, and varying institutional capacities across regions.

Based on the identified research gaps, this study aims to comprehensively evaluate the implementation of Smart Cities in Indonesia, with a special focus on aspects of

community participation, long-term sustainability, integration between components, and adaptation to local contexts. Furthermore, this research will explore the strategic role of Management Information Systems in supporting and optimizing the implementation of Smart Cities in Indonesia.

3 METHOD

This study adopts a qualitative approach to provide an in-depth and contextual understanding of Smart City implementation in Indonesia, with particular emphasis on the role of Management Information Systems (MIS). This methodological choice is predicated on its capacity to explore the complexity and nuances of the Smart City phenomenon, as well as to elucidate the perspectives and experiences of various stakeholders in the context of MIS integration into the Smart City ecosystem.

3.1 STUDY DESIGN

The study employs a multiple case study design, facilitating an in-depth analysis of Smart City implementation across several Indonesian cities. This approach enables a comprehensive understanding of variations in MIS adoption across diverse urban contexts, as well as the identification of patterns and best practices in the integration of information technology into Smart City infrastructure. This research adopts a multiple case study design with an explanatory approach. Case selection was carried out purposively with the criteria of cities that had implemented a minimum of three Smart City components for a minimum of 2 years, which included the availability of widely accessible implementation data, geographic variations to ensure representation of various regions in Indonesia, and different levels of urbanization to understand implementation in diverse contexts.

3.2 DATA COLLECTION AND DATA SOURCES

Primary data was collected by analyzing official documents, including Smart City master plans for each city, annual implementation reports (2020-2024), strategic planning documents, regional regulations related to Smart City, and Smart City project evaluation reports.

Meanwhile, secondary data was obtained through literature reviews and other academic document sources. Literature review in this study with the criteria of peer-reviewed journal articles (2015-2024), the databases used were Scopus, Web of Science, Google Scholar, and search keywords: “Smart City Indonesia”, “Smart City Sustainability”, “Management Information System”, “Implementation of Smart City Indonesia”. Meanwhile, other academic sources include theses and dissertations from leading universities in Indonesia, international and national conference proceedings, and scholarly books and book chapters.

However, this research data source has shortcomings, including some documents that may be incomplete or outdated, varying reporting formats and structures between cities, limited accessibility for internal documents, and potential bias in official reporting. Meanwhile, the limitations of this study's secondary data are the possibility of publication bias, varying methodological quality between studies, limited geographic coverage, and temporal gaps in publications.

3.3 DATA ANALYSIS

The data analysis in this research adopts a descriptive-interpretive paradigm, wherein findings are classified and mapped based on identified key themes related to patterns in Smart City implementation and MIS integration. The analysis process comprises several stages:

1. Data reduction: Identification of patterns and contextual factors pertinent to Smart City implementation. At this stage, the researcher transcribes and organizes official government documents and academic literature into a uniform format. Then, the researcher conducted a preliminary reading of all the data to obtain a general picture and made initial notes to identify key ideas and concepts. Apart from that, data reduction also includes identifying patterns and relationships between categories, followed by developing main themes related to Smart City implementation and the role of MIS.
2. Codification: Organization of data into categories relevant to the study's focus. Researchers conducted open coding to identify units of meaning from the data, grouped codes with similar themes into broader categories, developed a codebook

containing operational definitions for each code and category, and coded iteratively to ensure coding consistency.

3. Results Presentation Stage: At this stage, the researcher prepares a narrative of the findings with the support of quotations from the data. Then, develop an outline of key findings followed by organizing the analysis results according to the research questions and validating the conclusions.
4. Data source triangulation: Comparison of data from various sources to ensure validity and reliability. At this stage, researchers triangulate sources by comparing data from various documents. Next, researchers look for negative cases or conflicting data to test the findings. Besides, that is, at this stage the researcher documents the audit trail to ensure transparency of the analysis process.
5. System mapping: Development of a conceptual model describing the interactions between various MIS components within the Smart City ecosystem. Researchers integrate multiple data sources and compare findings with existing literature to identify theoretical contributions. In addition, researchers formulate practical implications of research findings.

To ensure the quality of the analysis, this research applies several trustworthiness criteria that carry out source triangulation to ensure the credibility of the research. In addition, transferability is carried out with a thick description of the context and research process. This approach facilitates the organization of information in a structured and systematic manner, enabling the elaboration of a comprehensive understanding of actual realities, challenges faced, and mitigation measures in the context of Smart City and MIS implementation. Therefore, this research not only presents a holistic perspective on the status quo but also offers a critical analysis that has the potential to serve as a reference for policymakers and practitioners in efforts to optimize Smart City development strategies in Indonesia.

4 RESULTS AND DISCUSSION

4.1 IMPLEMENTATION OF SMART CITIES IN URBAN AREAS OF INDONESIA

A comprehensive analysis of Smart City implementation across various urban areas in Indonesia reveals significant progress, albeit accompanied by multifaceted challenges.

The national “Movement Towards 100 Smart Cities” initiative has served as a catalyst in promoting the adoption of this concept (Ahad *et al*., 2020). Based on the analysis of smart cities in Indonesia, each has varying focus areas. Even though they are in different fields, they are centered on management information systems. As the nation's capital, Jakarta leads with a high level of sustainability through a focus on e-government and data integration. According to Kusuma and Supangkat (2022), through the Jakarta Smart City (JSC) platform, this city is trying to integrate data between government agencies. Asteria *et al.* (2020) noted that although it still faces challenges in its integration process, Jakarta firmly commits to environmental sustainability. Then, Surabaya takes a different approach by focusing on public services and transportation. Nashiruddin, Sihotang and Murti, (2022) report that this city is developing e-government and broadband infrastructure but still faces obstacles in the form of a digital divide in society. Sukarno and Putri (2022) added that Surabaya's sustainability level is at a medium level with a special emphasis on energy efficiency.

Furthermore, Bandung stands out with its focus on digital innovation and the creative economy. Syalianda and Kusumastuti (2021) explain that this city is implementing a command center and Internet of Things (IoT), even though it is still grappling with technological infrastructure challenges. Kusumastuti *et al.* (2022) confirm that the level of sustainability is at a medium level with a focus on technological innovation. Makassar chose to focus development on the digital economy and tourism. A study by Gella and Dwiatmadja (2022) shows that the city integrates war rooms and CCTV systems, while Praditya *et al.* (2021) identified the main challenges in developing human resource capacity. The level of sustainability is moderate, with an emphasis on economic development. Medan takes a more fundamental approach, focusing on urban planning and infrastructure. Rifaid *et al.* (2023) noted that the city is trying to build a strong smart city foundation through the development of smart infrastructure. Wulandari *et al.* (2022) revealed that even though the level of sustainability is moderate, with a focus on developing basic infrastructure, Medan still faces challenges in system integration.

All studies expose the integration of information technology in efforts to accelerate public services (Hardi; Gohwong, 2020; Hidayat; Sunarharum, 2024; Qonita; Giyarsih, 2023). These findings emphasize the importance of effective communication strategies, such as those implemented in Bekasi (Michelle; Felasari, 2021), more inclusive and gender-responsive approaches (Asteria; Jap; Utari, 2020), and the critical role of Management

Information Systems (MIS) in Smart City implementation (Dirsehan; Van Zoonen, 2022; Jiang, 2020). This provides a clear delineation of the successes, challenges, and crucial aspects of MIS in the context of Smart Cities in Indonesia.

4.2 TECHNOLOGICAL CHALLENGES IN SMART CITY IMPLEMENTATION

Smart City implementation in Indonesia faces a variety of complex technological challenges. These include limitations in electronic-based government infrastructure and hygiene management technology (Mahayani, 2024; Tumbade, 2022). The infrastructure encompasses several driving domains, ranging from physical to non-physical components (Serrano, 2018; Vershitsky *et al*., 2021). Physical infrastructure refers to the readiness of electric power to drive various implementation technologies, considering principles of decarbonization, digitalization, and decentralization (Di Silvestre *et al*., 2018).

This emphasizes the urgency of investing in adequate technological infrastructure development. Such investment relies not only on government-led electronic initiatives but also on collaborative efforts with private entities providing technological infrastructure facilities. Effective Smart City implementation can be evaluated through the mapping of information technology indicators (Anthopoulos, 2017). These indicators emphasize management through government-private sector collaboration, allocating resources for supporting infrastructure such as security system digitalization, emergency service systems, and accurate public service systems (Serrano, 2018). Data security and privacy emerge as major concerns, given the substantial volume of data collected within the Smart Cities ecosystem. This aligns with Serrano's (2018) perspective highlighting the importance of security aspects in Smart City application development.

The integration of various applications and systems within the Smart City ecosystem presents a distinct challenge. Hartono and Nurbaity (2021) study on resilient city-based Smart Cities emphasizes the importance of multi-application collaboration and comprehensive planning and maintenance of physical infrastructure. This demonstrates that interoperability between platforms and technologies is crucial to ensure seamless and efficient data flow.

Furthermore, the scarcity of human resources with requisite technological expertise presents a significant obstacle, as evidenced in the Tanjungpinang case study (Mandala *et*

al., 2023). This emphasizes the importance of developing bureaucratic human resource capacity in the technology sector. Societal adoption of technology also plays a pivotal role in the successful implementation of Smart Cities. Herawati, Setianingsih and Saputra (2022) study on the digitalization of public services highlights the significance of social factors in technology adoption, indicating that participatory approaches and public education are key to overcoming this challenge.

4.3 ASPECTS OF SUSTAINABILITY AND URGENCY OF MANAGEMENT INFORMATION SYSTEMS

Sustainability emerges as a crucial element in the implementation of Smart Cities in Indonesia. Kusuma and Supangkat (2022) study on the city sustainability index in DKI Jakarta Province highlights the importance of balancing environmental dependence with efforts to fulfill citizens' basic needs. This indicator of environmental orientation is corroborated by research conducted by (Rifaid *et al*., 2023) in the National Capital, which elucidates that the sustainability of Smart City initiatives depends on the application of renewable energy without compromising long-term environmental impacts. In essence, the management of natural resources and the environment constitutes an integral aspect of Smart City sustainability.

Furthermore, analysis of Smart City supporting indicators necessitates a sustainability perspective from the vantage point of small and medium industrial sectors. This reveals the importance of integrating economic, social, and environmental aspects in business sustainability, as evidenced in several studies (Gella; Dwiatmadja, 2022; Praditya *et al*., 2021; Wulandari *et al*., 2022). These indicators emphasize how public organizations integrate entrepreneurship into a sustainable Smart City framework, extending beyond community economic empowerment to encompass the management of local product marketing systems (Richter; Kraus; Syrjä, 2015).

Community empowerment and participation emerge as critical elements in the context of sustainable development. Evaluation of communication and digital literacy among Jakarta residents in the implementation of Society 5.0 Sugiono (2021) emphasized the importance of community participation in ensuring the sustainability of Smart City programs. This provides a comprehensive picture of the various dimensions of sustainability in the

implementation of Smart Cities in Indonesia, including economic, social, and environmental aspects, as well as integration strategies in governance.

Moreover, the supporting indicators for Smart City sustainability lie in the government's readiness for e-Government. In building Society 5.0, Sugiono (2021) emphasized the importance of collaboration in creating innovation and service sustainability. In this context, Management Information Systems (MIS) and digital ecosystems are crucial. Smart City development requires intelligent digital management, integrating mature city planning followed by comprehensive database blueprint mapping. This MIS involves the development of a planning data analysis system with technical support for government decision-making and supervision of government management in urban social services.

This aligns with the modeling proposed by Huang *et al*. (2022), which delineates a path for the realization of Smart City development by implementing relevant new technologies. Key components include Geographic Information Systems, construction, Internet of Things (IoT), satellite remote sensing, and cloud computing integrated into a unified map. This management information system directly facilitates data-driven decision-making while ensuring the sustainability of Smart City policies in the future.

5 CONCLUSION

This comprehensive analysis of Smart City implementation in Indonesia reveals significant advancements alongside complex challenges. The successful implementation of Smart Cities is heavily contingent upon the effective integration of technology, appropriate policy frameworks, and active community participation. However, current Smart City initiatives face substantial challenges, particularly in terms of technological infrastructure, data security, and human resource capacity.

Sustainability aspects emerge as a critical factor in the long-term success of Smart City initiatives. The integration of economic, social, and environmental dimensions at every stage of Smart City development is imperative. This includes efforts to balance economic growth with social welfare and environmental conservation.

Management Information Systems (MIS) have been demonstrated to play a crucial role in supporting the transformation towards Smart Cities. MIS not only facilitates the integration of various urban subsystems but also supports data-driven decision-making and enhances the efficiency of public services.

The transformation towards sustainable Smart Cities necessitates long-term commitment from all stakeholders. By integrating technological innovation, environmentally sound policies, and active community participation, Indonesian cities can create urban ecosystems that are not only smart and efficient but also inclusive and sustainable, thereby significantly improving the quality of life for their citizens.

This study presents a comprehensive analysis of Smart City implementation within the specific context of Indonesia. Future research could expand the investigation to the context of other countries in the Global South, providing concrete recommendations for the future development of Smart City policies and practices. Special emphasis should be placed on the strategic role of Management Information Systems in these contexts.

6 LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

While this study provides valuable insights into Smart City implementation in Indonesia, several limitations should be acknowledged. Firstly, the qualitative nature of the research, while allowing for in-depth analysis, may limit the generalizability of findings. Future studies could employ mixed-method approaches to provide both depth and breadth of understanding. Secondly, the rapid pace of technological advancement means that some of the challenges identified may evolve quickly. Longitudinal studies could provide a more dynamic understanding of how these challenges change over time and how cities adapt to them. Finally, comparative studies between Indonesia and other developing countries could yield valuable insights into best practices and common challenges in Smart City implementation in similar socio-economic contexts.

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