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THE ROLE OF BIG DATA IN MANAGING SMART CITIES: ACOMPARATIVE STUDY OF JAKARTA AND SINGAPORE

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Abstract
The use of big data has become a key driver in smart city development in Southeast Asia, with Jakarta and Singapore serving as compelling examples of how to navigate the dynamics of modern urbanization. Both cities continue to address the complexities of urban governance through the use of data technology, despite facing distinct challenges in infrastructure, regulations, and community preparedness. The development of big data has also sparked debate about the extent to which this technology can ensure long-term sustainability and inclusiveness. This study aims to analyze the challenges and prospects of utilizing big data to support sustainable smart city management in Jakarta and Singapore. The research method used is a qualitative literature study, focusing on an in-depth review of academic publications, official government reports, and various policy documents related to big data and smart cities. A comparative analysis was conducted to understand the differences in context, strategy, and implementation across the two cities. The results show that Jakarta still faces significant challenges in infrastructure and public digital literacy, while Singapore is more systemically prepared but faces long-term sustainability issues. The differences in preparedness between the community and government in the two cities reflect variations in the technology adaptation process, which directly impacts the effectiveness of data management. On the other hand, the potential for utilizing big data is considered capable of creating a more inclusive smart city model if coupled with cross-sector collaboration and strengthened regulations. Cross-city learning also presents a significant potential for the Southeast Asian region to strengthen shared strategies for building more equitable and sustainable data-driven urban governance.

Keywords: Big Data, Smart Cities, Jakarta, Singapore.

A. INTROUDCTION

The development of modern cities presents increasingly complex dynamics, particularly in the context of managing a growing population, increasing mobility, and the increasingly diverse needs of public services. Major cities worldwide are competing to transform into smart cities, a concept that emphasizes the use of technology to maximize efficiency, improve quality of life, and ensure sustainable development (Ceder, 2021). In this context, big data plays a crucial role as a foundation for supporting decision-making processes, resource management, and the provision of more responsive public services. Cities that can effectively manage large-scale data and integrate it with urban systems will have an advantage in addressing the challenges of increasing urbanization (Nisar et al., 2021).

Jakarta, as one of the largest metropolitan cities in Southeast Asia, faces enormous pressure due to rapid urbanization, population growth, and urban issues such as congestion, pollution, flooding, and disparities in access to public services. This complexity demands innovation that can address urban issues more effectively. Efforts toward a smart city have begun through various local government initiatives, including in the transportation, environmental governance, and digital public services sectors (Luo et al., 2022). However, major challenges remain related to uneven digital infrastructure, limited integration between agencies, and a lack of capacity to utilize data optimally in policy planning. This situation

makes Jakarta an interesting example to study, because even though transformation efforts have been made, the results are still not optimal (Naudé& Vinuesa, 2021).

In contrast to Jakarta, Singapore presents a relatively successful city in leveraging digital technology for urban management. As a city-state with limited land area, Singapore has long faced limited land and resources. However, this situation has actually driven its government to innovate in managing the city more efficiently and sustainably. Through the support of robust digital infrastructure, consistent policy implementation, and close collaboration between the government, private sector, and the community, Singapore has been able to develop an integrated, big data-based city management model (Woods et al., 2024). Various intelligent systems have been implemented, ranging from traffic management and air quality monitoring to energy systems and urban spatial development, fully utilizing real-time data analysis. This success has made Singapore a global benchmark in smart city management (Musa et al., 2023).

The comparison between Jakarta and Singapore is important because they reflect two different realities in the context of smart city development in Southeast Asia. Jakarta, with its large population and complex socio-economic challenges, is striving to build a modern urban system amidst limited infrastructure and bureaucracy (Joo, 2023). Meanwhile, Singapore, with its strong governance and long-term vision, demonstrates how big data can be used strategically to create a more adaptive and sustainable urban environment. Comparing the two will provide an opportunity to understand the key factors that differentiate successful implementation, while also providing insight into the challenges that need to be addressed for Jakarta to accelerate its transformation (Wey & Peng, 2021).

Furthermore, global developments also demonstrate how cities that successfully integrate big data into urban systems are able to create more inclusive governance patterns. With the availability of large amounts of data, governments can more quickly detect problems, design evidence-based solutions, and involve the public in the decision-making process (Cappa et al., 2022). This implies increased transparency, accountability, and citizen participation in city governance. However, this is not easy to achieve, as many cities face technical, institutional, and even social obstacles in optimally implementing big data systems. Therefore, comparative studies between cities with varying levels of readiness are important to identify opportunities for knowledge transfer and learning across countries (Rafique et al., 2023).

This background also underscores that the use of big data is not simply a technical issue, but also relates to political, institutional, and bureaucratic cultural aspects. Jakarta, for example, often faces bureaucratic fragmentation and limited inter-agency coordination, which hinders cross-sectoral data integration. This contrasts with Singapore, which has a more centralized government system and can promote policy consistency. These differences make comparing the two cities relevant to identifying how governance and political leadership influence the effectiveness of big data utilization in managing smart cities.

Given these challenges and opportunities, research into the role of big data in smart city management through a comparative study of Jakarta and Singapore is crucial for providing a comprehensive overview of how data can be optimized to address urban dynamics. This study is expected not only to illustrate the differences in context between developing and developed cities but also to provide strategic recommendations for strengthening the role of data in urban governance in Indonesia, particularly in efforts to build Jakarta as a more adaptive, competitive, and sustainable city in the future.

B. LITERATURE REVIEW

1. Big Data

Big data can be defined by three terms: volume (large amounts of data stored), velocity (the need to access large amounts of data), and variety (the current highly varied data formats). Big data is also defined as a size beyond the capabilities of commonly used software tools to capture, maintain, manage, and process data over time. Another definition of big data is the exponential growth, speed, and variety of data, creating new challenges, not only in managing large amounts of heterogeneous data, but also in understanding it all (Ikegwu et al., 2022). The definition of big data above can be concluded as the size of data that has a growth rate beyond the capabilities of devices with large numbers, large access requirements, and diverse formats. The size of big data is still debated to this day, namely between exabytes, zettabytes, or yottabytes (Osinga et al., 2022).

An exabyte is 1024 petabytes, a zettabyte is 1024 exabytes, and a yottabyte is 1024 zettabytes. In practice, big data can be divided into three main types:

a. Structured Data
   First, there's structured data. This type of data has a well-organized format, such as in a relational database, spreadsheet, or table, that can be easily processed and analyzed. Examples of structured data include information like customer data in a CRM database or financial transaction records in a company's accounting system. The main advantage of structured data is the ease of processing, analyzing, and searching for information that can be extracted from it (Walha et al., 2024).
b. Unstructured Data
   As the name suggests, this type of data lacks a structured format, such as free text, images, and video. Analyzing this data can be more complex. Unstructured data, the second type of data, lacks a structured format. This includes data in the form of free text, images, audio, video, and more. Analyzing unstructured data can be more complex because relevant information is often scattered across multiple sources and must be extracted using specialized analysis tools. Examples of unstructured data include social media posts, email messages, or even video recordings (Teyefi et al., 2021).
c. Semi-Structured Data
   Next, there's semi-structured data, which falls somewhere between structured and unstructured data. Examples include data in XML or JSON format. The advantage of semi-structured data is its ability to combine structured and unstructured data elements. Examples of semi-structured data include sensor data from IoT devices, which can contain structured information about temperature and humidity along with free-text describing the situation (Breitinger&Jotterand, 2023).

Big data plays a crucial role in various aspects of modern business and technology. The primary function of big data encompasses three key elements that have a significant impact on decision-making and operational performance. The primary functions of big data are:

a. Analysis
   One of the primary functions of big data is its ability to analyze large and complex data sets. By identifying patterns, trends, and insights hidden within data, organizations can make smarter and more strategic decisions. This data analysis helps uncover valuable information that may not be readily apparent at first glance, such as customer preferences, purchasing patterns, or operational efficiency levels (Ojeda et al., 2025).

b. Prediction
Big data is also used to predict future behavior based on historical data analysis. By understanding past trends, organizations can make more accurate estimates of what might happen in the future. For example, in business, big data can be used to predict market demand, price fluctuations, or inventory needs. This allows companies to take appropriate actions to anticipate changes and optimize their strategies (Chaudhary et al., 2021).

c. Optimization
Big data provides opportunities to improve operational efficiency and save costs. By leveraging data to understand how a company's operations are running, organizations can identify areas for improvement. For example, big data can be used in manufacturing to optimize the supply chain, reduce waste, or improve resource utilization. This not only results in cost savings but also increases the company's competitiveness (Niu et al., 2021).

2. Smart Cities

A smart city is a concept for the development, application, and implementation of technology applied to a region (particularly urban areas) as a complex interaction between the various systems within it. The term "city" is used here to refer to a city as the center of a country or region, where all aspects of life are located (government, commerce, education, health, defense, etc.). Similarly, a city's population is relatively much larger than other areas (e.g., villages/sub-cities) (Kashef et al., 2021).

Pratama defines a smart city as a city that performs well, supported by a smart combination of all activities, studies, discoveries, and awareness of its citizens. Smart cities can have a positive impact on governance, social life, transportation, quality of life, and healthy competition in all sectors by utilizing information and communication technology (Chen & Chan, 2023).

The smart city concept was first implemented in the United States and Europe. Initially, smart cities aimed to create regional independence and improve public services. Smart cities can be said to be a future concept for cities that aim for a better quality of life, based on computer and communication technology (Correia et al., 2022).

According to Deakin, a smart city utilizes ICT to meet market demands (citizens), and community involvement in this process is essential for a smart city. Therefore, a smart city will be a city that not only has ICT technology in certain areas but also has implemented this technology in ways that positively impact specific communities (Przeybilovicz et al., 2022).

There are four basic characteristics of a smart city:

a. Interconnection between urban areas. A smart city combines communication networks, the internet, sensors, and recognition to facilitate communication between people, thus enabling interconnection between urban areas (Bellini et al., 2022).
b. Integration of urban information systems. Matters related to the internet and cloud computing will be used in every business area, integrating application systems, data, and the internet into core elements that support urban operations and management (Alam, 2021).
c. Urban management and service collaboration. The interconnection of urban components and the support of urban management application systems and services, with the coordination of critical urban systems and participants, to ensure optimal urban operation (Das, 2024).

d. Application of the latest ICT (Information and Communication Technology). A smart city is a modern urban management theory that serves as a guide that emphasizes the application of advanced information technology to management (Vodák et al., 2021).

C. METHOD

This research uses a qualitative approach with a focus on comparative studies to understand the role of big data in smart city management in Jakarta and Singapore. Through this approach, the research seeks to explore in depth how the two cities utilize large-scale data to support urban planning and management. Research data will be collected from various relevant secondary sources, such as previous research results, official government reports, policy documents, academic publications, and other data related to big data implementation in both cities. By utilizing these diverse sources, the research can obtain a comprehensive picture of the actual conditions on the ground and the strategies adopted by each city. After data collection, the next step is to conduct a qualitative analysis by comparing the policies, strategies, and results of big data implementation in Jakarta and Singapore. The analysis process is carried out by examining the similarities and differences that arise in the implementation of big data, both in terms of infrastructure, governance, and the impact on improving public services. The results of this comparative analysis are expected to provide a deeper understanding of the factors that support the success or hinder the use of big data in the urban context. Thus, this research not only describes existing practices but also provides a basis for strategic recommendations to strengthen smart city management, particularly in Jakarta, by learning from Singapore's experience (Hasan et al., 2025).

D. RESULT AND DISCUSSION

1. Digital Infrastructure and Technology Capacity

Digital infrastructure is a key foundation for any city to optimize the use of big data. Jakarta and Singapore demonstrate very different conditions in terms of digital infrastructure readiness to support smart city management. Jakarta, as Indonesia's largest metropolitan city, still faces significant challenges in providing a stable, fast, and affordable network for all levels of society. The digital divide between regions in Jakarta remains significant, with the city center enjoying relatively better access compared to the outskirts. This hampers the integration of big data systems, which should operate comprehensively and not be limited to specific points. In contrast, Singapore has long developed a digital infrastructure that is evenly distributed throughout the city, supported by a high-speed internet network integrated with government systems and public services. This makes Singapore better prepared to implement complex and large-scale big data systems without encountering significant infrastructure barriers.

This difference in infrastructure readiness is also reflected in the scale of data storage, processing, and distribution capacity. Jakarta is still at the stage of building basic capacity, with data storage systems scattered across various institutions and often disconnected. Data center infrastructure in Jakarta remains limited both in terms of quantity and in terms of the ability to efficiently handle massive data volumes (Prabowo et al., 2023). Data processing is often hampered by technological limitations and human resources that are not yet fully capable of managing big data with optimal accuracy and speed. On the other hand, Singapore has a robust, high-capacity, and nationally integrated data center ecosystem. The city's data distribution system has been designed to support real-time information flow, enabling the government and various sectors to respond quickly to urban issues. This demonstrates that Singapore's data storage and processing capacity far exceeds that of Jakarta, providing significant advantages in smart city management.

Obstacles arising from technological limitations further widen the gap between Jakarta and Singapore. Jakarta still faces challenges such as an often inconsistent network infrastructure and limitations in implementing the latest technologies supporting big data. These constraints prevent much of the collected data from being optimally utilized for policy planning. Furthermore, technical issues such as slow processing speeds and hardware limitations add to the burden on the city government in integrating data from various sectors. In contrast, Singapore is already in a more established position, with technological advantages that enable it to utilize advanced analytics, artificial intelligence systems, and real-time data processing on a large scale. This difference reveals a significant gap in technological readiness, with Singapore moving more quickly to utilize big data, while Jakarta is still struggling to overcome fundamental infrastructure barriers.

The implications of these differences in digital infrastructure and technological capacity are significant for the effectiveness of big data utilization in urban planning. In Jakarta, limited infrastructure makes data-driven decision-making slower, fragmented, and less accurate. This makes it difficult to formulate policies that truly meet the needs of a highly dynamic urban population (Zhang et al., 2022). City governments still rely on fragmented data, ultimately reducing the effectiveness of public policy. In contrast, Singapore has been able to leverage big data to generate adaptive and predictive urban planning. With integrated and rapidly processed data, Singapore can formulate more targeted policies, reduce the risk of planning errors, and increase efficiency in resource use. In other words, differences in digital infrastructure and technological capacity directly impact the quality of smart city governance. Singapore has been able to leverage big data as a strategic tool, while Jakarta is still in the process of building the necessary foundation.

Looking deeper, these differences also demonstrate how digital infrastructure readiness impacts a city's global competitiveness. Singapore, with its world-class data storage and processing capacity, can easily attract investment, build an innovative technology ecosystem, and strengthen its position as a regional digital hub. Meanwhile, Jakarta, which is still struggling to strengthen its digital infrastructure, often faces limitations in attracting investors in the technology sector, due to the still-high risks associated with data system reliability. This situation demonstrates that digital infrastructure not only impacts urban management but also plays a crucial role in determining the direction of digital economic growth and a city's global competitiveness.

Given these differences, it is clear that digital infrastructure and technological capacity are key factors in shaping the effectiveness of big data utilization in smart city management. Jakarta needs to accelerate digital infrastructure development, expand data center capacity, and improve the quality of processing technology to catch up (Apanavičienė&Shahrabani, 2023). Meanwhile, Singapore, which is already in a more advanced position, still needs to maintain the sustainability of its digital infrastructure to keep up with rapid global developments. This comparison confirms that without adequate digital infrastructure, the use of big data in smart cities will not have a significant impact. On the other hand, when the infrastructure is strong, big data can be a very effective instrument for improving governance efficiency and the quality of life of urban communities.

2. Data Governance and Inter-Agency Integration

Data governance is a crucial aspect determining the effectiveness of big data utilization in smart city management, especially when data must be managed by various institutions with differing interests. Jakarta and Singapore exhibit significantly different coordination mechanisms in this regard. Jakarta still faces serious challenges in establishing inter-institutional coordination, as many institutions operate sectorally and lack robust data

integration systems. For example, transportation data is managed by a specific agency, while health, energy, and environmental data fall under the jurisdiction of other agencies, often lacking interconnected communication platforms. This situation makes efforts to utilize big data fragmented, with results that fail to provide a comprehensive picture for urban policymaking. In contrast, Singapore has successfully developed a coordinated, integrated data governance system. The Singaporean government, through its strong institutional structure, encourages each agency to work within a single national data ecosystem, allowing data from various sectors to complement each other and be used collectively to formulate more effective public policies (Van Donge et al., 2022).

This difference is also evident in the level of integration of cross-sectoral data systems. In Jakarta, data integration efforts remain limited and often only implemented at the scale of specific projects. It's not uncommon for data generated across sectors to have different standards, complicating the process of integrating them into a single integrated system. This makes it difficult to produce accurate analyses for overall city management needs. For example, environmental data that isn't aligned with transportation or spatial planning data makes it difficult for the government to formulate integrated policies to address urban pollution or flooding. Singapore, on the other hand, exhibits a high level of data system integration, where data from the transportation, health, energy, and environmental sectors can be collected and analyzed simultaneously. With the support of an integrated digital system, the Singaporean government is able to identify patterns of urban problems more quickly and develop holistic management strategies. This cross-sectoral integration makes big data not just a technical instrument but a key foundation for developing systemic urban policies (Huseien & Shah, 2022).

Bureaucracy and institutional structures significantly influence the consistency of big data implementation in both cities. Jakarta is often mired in multi-layered bureaucratic complexity, resulting in slow data coordination between agencies. Institutional fragmentation prevents big data management from having a clear command, causing each sector to operate according to its own priorities. This reduces consistency in big data implementation, as there is no unified vision binding all agencies. On the other hand, Singapore exhibits a more streamlined bureaucratic model, with an institutional structure that supports centralized coordination. The national government can provide consistent policy direction while ensuring that each agency has equal obligations in integrating data. Strong leadership within this bureaucratic structure enables the implementation of big data to proceed consistently and continuously, undisturbed by differing interests between agencies.

The implications of these differences in data governance are particularly evident in the city's ability to respond quickly to urban challenges. In Jakarta, the response process is often delayed because the government lacks access to truly integrated and up-to-date data. For example, when severe traffic congestion or flooding occurs, the government's response is hampered by a lack of coordination between agencies that should be sharing data in real time (Kandt & Batty, 2021). This delay not only reduces the effectiveness of problem-solving but also undermines public confidence in the city government's ability to manage urban challenges. Singapore, on the other hand, can demonstrate a much faster and more accurate response thanks to cross-sectoral data integration. When problems arise, real-time, connected data from various sectors is immediately analyzed to generate swift and targeted policy actions. This speed of response demonstrates that data integration is not merely a technical issue but is also closely linked to the effectiveness of overall urban governance.

Thus, a comparison between Jakarta and Singapore in terms of data governance and inter-institutional integration demonstrates the significant influence of institutional structure, coordination mechanisms, and bureaucratic consistency on the successful use of big data in

smart cities. Jakarta still needs to build a more integrated governance framework, unifying data from various sectors, and simplifying bureaucracy to facilitate faster and more effective coordination. Meanwhile, Singapore, which already has a solid data governance model, must maintain policy consistency and strengthen integration with new technologies to keep pace with global developments. This difference illustrates that the success of big data utilization is determined not only by the availability of technology but also by how well governance and institutional integration are built to support comprehensive city management.

3. Long-Term Policy Strategy and Vision

The government's strategic vision for utilizing big data as a city management tool demonstrates a fundamental difference between Singapore and Jakarta. Singapore views big data not simply as an administrative tool, but as the foundation of the entire modern city governance system. This is evident in the development of the Smart Nation Initiative, which, from the outset, has placed data at the center of decision-making across sectors, from transportation and energy to public services. Meanwhile, Jakarta, despite demonstrating serious efforts through programs like Jakarta Smart City, still faces limitations in establishing big data as a long-term strategic vision. The Jakarta government's vision tends to be more responsive to short-term issues, resulting in data management not being fully linked to sustainable city development strategies, but rather focusing on solving day-to-day operational issues.

Policy consistency is also a significant difference between the two cities. Singapore has successfully demonstrated policy continuity from one administration to the next thanks to a nationally agreed-upon strategic framework. Policies related to big data and smart city technology are maintained consistently, enabling all implemented programs to form a mutually supportive ecosystem (Chen, 2024). In contrast, Jakarta faces more complex political dynamics, resulting in policy direction frequently changing depending on the current leadership. This shift in priorities has resulted in many data-driven programs being stalled or discontinued, hampering the effectiveness of big data implementation. This also demonstrates how policy consistency in Singapore can create certainty, while Jakarta still faces recurring inconsistencies.

Political leadership plays a crucial role in determining the direction of big data utilization in both cities. In Singapore, political leadership demonstrates a high level of commitment to the smart city vision, with national leaders promoting data-driven policies as a top development priority. Consistent support from the highest levels enables every public institution to operate within a unified framework. In Jakarta, political leadership plays a significant role in influencing the intensity of big data utilization, but tends to focus on image building and responding to populist issues. This results in data programs being implemented that focus more on demonstrating quick results than on building long-term data infrastructure. As a result, despite advances in technology utilization, policy direction often lacks sufficient consistency to make big data an integral part of city governance (Alojail & Khan, 2023).

Policy sustainability also significantly determines the effectiveness of big data implementation in each city. Singapore demonstrates how a well-maintained policy can create a robust system, where data is not only collected but also consistently utilized to support long-term planning. This sustainability enables Singapore to respond to urban issues more quickly and measurably, as the database used is integrated into the decision-making system. In contrast, in Jakarta, policy sustainability is often problematic because each new leader brings different priorities. Initial programs can be discontinued or replaced, disrupting the sustainability of data systems. This creates uncertainty in big data implementation, ultimately reducing its effectiveness in addressing increasingly complex urban challenges.

Ultimately, a comparison of Singapore and Jakarta in terms of policy strategy and long-term vision demonstrates that the utilization of big data depends not only on technological infrastructure but also on the quality of leadership, policy consistency, and the sustainability of the vision. Singapore demonstrates that data-driven urban governance can succeed when there is alignment between strategic vision, political commitment, and policy consistency across time. Jakarta, on the other hand, still needs to strengthen sustainability and consistency so that big data is not merely a short-term project but a truly important instrument in building a resilient and sustainable city in the future (Syabri et al., 2024).

4. The Impact of Big Data on Public Service Efficiency

The use of big data in public services has brought about significant changes in how governments manage and deliver services to the public. In Singapore, big data is used comprehensively to accelerate and simplify access to public services through a well-integrated system. For example, various data collected from the transportation, health, education, and government administration sectors are processed in real time to ensure that citizens can access services quickly and efficiently. This contrasts with Jakarta, which, despite having initiated similar initiatives, still faces challenges in inter-agency integration and a lack of robust data infrastructure. As a result, bureaucratic processes in Jakarta tend to be lengthy and multi-layered, while in Singapore, big data has drastically reduced service waiting times and created a simpler user experience.

The difference in efficiency is even more pronounced in urban mobility. In Singapore, the use of big data in the public transportation system allows for analysis of people's movement patterns to predict congestion, manage transportation schedules, and distribute fleets more effectively. The smart transportation system they have developed has shortened travel times, controlled congestion, and maintained the city's air quality (Singh et al., 2023). Meanwhile, in Jakarta, although big data has begun to be implemented in transportation systems, such as integrating mobility apps or traffic monitoring, its effectiveness remains limited due to the misalignment between the data generated and transportation management policies on the ground. Environmental management is another important indicator. Singapore can use big data to accurately monitor energy consumption, manage waste, and monitor air and water quality. In Jakarta, limited data access and inconsistent technology implementation continue to present significant challenges for environmental management.

The link between big data utilization and increased public satisfaction is also a key issue that differentiates the two cities. In Singapore, public satisfaction is felt because big data helps the government deliver more personalized, faster, and tailored public services. For example, healthcare services can utilize historical patient data to expedite diagnosis and treatment, while administrative services can be completed online without requiring frequent face-to-face meetings. This builds public trust in the government and strengthens the legitimacy of policies. Conversely, in Jakarta, despite innovations such as integrated service applications, public satisfaction is often hampered by system instability, the digital access gap, and lengthy bureaucracy. In other words, while big data does help improve public satisfaction, the results depend heavily on the extent to which the technology is implemented consistently and inclusively.

However, some factors hinder efficiency in Jakarta and drive success in Singapore. In Jakarta, the main obstacles lie in the lack of coordination between institutions, limited digital infrastructure, and political challenges that often result in inconsistent implementation of big data policies from one administration to the next. Furthermore, the digital divide exacerbates public access to data-based services, especially for marginalized groups lacking technological tools or literacy. In contrast, in Singapore, their success has been driven by a clear political

vision, consistent leadership, and long-term investment in building a digital ecosystem. Full government support for research, infrastructure, and regulation has made big data not just a tool but an integral part of a modern urban governance system. This is what has enabled Singapore to achieve high and stable levels of efficiency, while Jakarta is still undergoing a long and challenging transition.

The impact of big data on the efficiency of public services is largely determined by infrastructure readiness, policy consistency, and public acceptance. Singapore has successfully demonstrated that with strong political support and a sustainable policy strategy, big data can be a key instrument in creating fast, integrated, and satisfying public services (Hossin et al., 2023). Meanwhile, Jakarta still needs to strengthen its digital foundation, improve its bureaucracy, and reduce structural barriers so that big data can function optimally in improving the efficiency of public services. This difference teaches us that the successful use of big data depends not solely on technology, but also on the extent to which political commitment, policy consistency, and socio-cultural readiness support digital transformation in governance.

5. Challenges and Prospects for Utilizing Big Data in the Future

The use of big data in city governance faces significant challenges, both in Jakarta and Singapore, particularly in ensuring the sustainability of its implementation in the future. One key issue is how governments can ensure that data processing systems remain effective in the long term, given that rapid technological developments can render existing data infrastructure obsolete quickly. In Jakarta, these challenges are exacerbated by budget constraints, technical capacity gaps, and bureaucratic issues that often slow the adaptation to new technologies. Meanwhile, Singapore has advantages in terms of infrastructure and regulatory readiness, but it still faces increasingly complex issues related to data privacy and cybersecurity. Both must find ways to ensure that big data management is not merely a short-term project, but a truly sustainable system with regulatory support, budgetary support, and the involvement of all stakeholders.

The difference in public and government readiness to face more advanced technological developments is also a crucial factor determining the effectiveness of big data utilization (Ghaleb et al., 2023). In Jakarta, the level of digital literacy among the public still varies widely, so technology adoption often encounters resistance or limited understanding. Local governments also lack the technical capacity and human resources to manage big data on a large scale. In contrast, Singapore has made digital literacy a national priority, making its public more receptive to data-driven innovation, while its government has a systematic, long-term strategy for integrating big data into governance. This difference creates a significant gap in the speed of digital transformation, but it also opens up opportunities for Jakarta to learn from the Singaporean model, particularly in creating policies that can increase public participation and strengthen the competence of government officials.

The prospects for utilizing big data are very promising, particularly in efforts to create more inclusive and sustainable smart city models. By leveraging big data, governments can conduct more accurate, evidence-based planning, such as in transportation management, pollution control, and the equitable distribution of public services (Wu et al., 2024). In Jakarta, this prospect could provide solutions to fundamental problems such as traffic congestion, flooding, and unequal access to social services by leveraging real-time data for rapid decision-making. Meanwhile, Singapore has the potential to further deepen the integration of big data to support the development of a green and environmentally friendly city oriented towards sustainability. If managed properly, big data will not only strengthen

the efficiency of city governance but can also form the foundation for a more transparent and accountable system, thereby increasing public trust in government.

Furthermore, the potential for cross-city learning between Jakarta and Singapore opens up significant opportunities for strengthening smart city management strategies in the Southeast Asian region. Jakarta can learn from how Singapore has built an integrated regulatory framework, digital infrastructure, and data literacy culture, while Singapore can also look to Jakarta's dynamics as a large city with complex social, economic, and environmental challenges as a source of reflection for developing more adaptive policies. This exchange of experiences can serve as the foundation for a regional collaborative network in big data management, enabling each city to work more independently and support each other in creating smarter, more inclusive, and more sustainable urban development models. In this way, the use of big data will not only provide local benefits but also become a collective strength for the Southeast Asian region in facing global challenges in the digital age.

E. CONCLUSION

The use of large-scale data technology has a significant impact on the effectiveness of urban governance. A comparison between the two cities shows that despite Jakarta's limited infrastructure, institutional capacity, and implementation consistency, digital transformation efforts continue, with various initiatives aimed at improving public services. Meanwhile, Singapore has been able to maximize big data with the support of integrated policies, disciplined governance, and high technological adaptability. This difference demonstrates that the success of big data utilization depends not only on the technology itself but also on the policy framework, inter-agency coordination, and the readiness of resources that support the urban ecosystem. Furthermore, this study emphasizes the important role of big data in promoting smart cities to be more efficient, transparent, and responsive to community needs. Jakarta can learn from Singapore's management model by emphasizing data system integration, strengthening governance, and developing regulations that support consistent technology implementation. At the same time, Singapore can also gain insights from Jakarta's more complex context in addressing social, political, and demographic challenges as a reflection on maintaining the resilience of its urban system. Thus, this comparison demonstrates that big data is not merely a technological instrument but also a strategic instrument that can balance innovation with social realities in smart city management.

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