EXPLORING THE ECONOMIC IMPACT OF SMART CITY INVESTMENT: A LITERATURE REVIEW

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Abstract— *The current implementation of smart cities aims to enhance the quality of life for their communities. Smart city investments can be achieved through collaborative efforts between information and communication technology and human resources, transforming areas into sustainable cities. Many countries are becoming increasingly interested in smart city investments. However, it remains unclear how these investments can achieve their intended goals. The primary issue lies in the lack of effective methodologies to measure the economic impact of such investments. Many cities lack comprehensive assessment tools to gauge the economic impact of smart city implementations, making it difficult to determine whether these investments deliver the desired benefits. This article aims to provide references regarding the economic impacts of smart city investments and the frameworks that can be used to measure them. The methodology employed in this research is a literature review based on references published over the past five years. According to findings, smart city investments have been found to impact aspects such as e-commerce and e-business, the creation of environmentally friendly environments, cost savings and economic benefits, GDP growth, and increased income for regions/cities through effective smart city utilization. Several frameworks have been gathered to measure economic impact, such as Computable General Equilibrium (CGE), Energy Efficient Integrated Planning Framework (EEIPF), and Open Data Impact for Smart Cities Framework (ODISC). Each framework serves to illustrate how examples of smart city investments can influence the economy of a region or city.*

Keywords: *economic impact, framework, investment, smart city.*

Abstrak— *Implementasi smart city saat ini bertujuan untuk meningkatkan kualitas hidup masyarakatnya. Investasi smart city dapat dicapai melalui investasi teknologi informasi dan komunikasi yang berkolaborasi dengan sumber daya manusia untuk menjadikan suatu kawasan menjadi kota berkelanjutan. Saat ini banyak negara yang mulai tertarik dengan investasi smart city. Namun, masih belum jelas bagaimana investasi ini dapat mencapai tujuan yang diharapkan. Masalah utama adalah kurangnya metodologi yang efektif untuk mengukur dampak ekonomi dari investasi tersebut. Banyak kota tidak memiliki alat penilaian yang lengkap untuk mengukur dampak ekonomi dari penerapan kota pintar, sehingga sulit untuk menentukan apakah investasi tersebut memberikan manfaat yang diinginkan. Artikel ini bertujuan untuk memberikan beberapa referensi terkait apa saja dampak ekonomi yang diberikan dari investasi smart city dan framework apa saja yang dapat digunakan untuk mengukurnya. Metodologi yang digunakan dalam penelitian ini adalah dengan literature review berdasarkan referensi yang telah terbit selama 5 tahun terakhir. Berdasarkan temuan, investasi smart city ditemukan berdampak pada aspek e-commerce dan e-business, terciptanya lingkungan yang lebih ramah lingkungan, penghematan biaya dan ekonomi, peningkatan PDB, serta peningkatan pendapatan suatu daerah/kota dengan memanfaatkan smart city yang baik. Terdapat kerangka kerja yang dikumpulkan untuk mengukur dampak ekonomi, seperti Computable General Equilibrium (CGE), Energy Efficient Integrated Planning Framework (EEIPF), dan Open Data Impact for Smart Cities Framework (ODISC). Seluruh kerangka kerja berfungsi untuk menunjukkan bagaimana contoh investasi kota pintar dapat mempengaruhi perekonomian suatu wilayah atau kota.*

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***Kata Kunci**: dampak ekonomi, framework, investasi, smart city.*

INTRODUCTION

Over the last decade, several cities around the world have begun to employ the trend of transforming public cities into smart cities or Smart Cities, that is, by adding aspects of information and communication technology into the process of urban development. The term "smart city" was coined in the late 1990s and was initially used by numerous technology companies in 2005 to connect complex information systems and municipal infrastructure operations. The term relates to many sorts of technological urban development and planning (Hatem, 2023). The concept of smart cities is to make urban planning more efficient in terms of resource optimization, urbanization, population growth, energy supply, waste management and related mobility and telecommunications (Biancardi et al., 2021). The city authorities are investing in smart cities aimed at improving infrastructure to offer better services to citizens. In order to develop a smart city, it is essential to gather input and feedback from citizens to address local problems and meet their needs (Karmaker et al., 2023). In order to improve citizens quality of life, smart cities must adapt to the demands and ideas of diverse stakeholders, so that the results can serve and benefit the stakeholders (M. Wang et al., 2023). Cities are considered to have strong geographical roots as a single location so often considered as a major catalyst for organizational innovation, spatial and socio-economic contexts can also be crucial for urban development (Duygan et al., 2022).

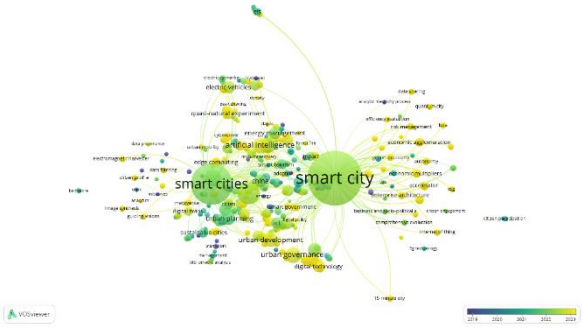
According to Akande, the sharing economy plays an important role in achieving sustainable communities and cities, as its main idea is perfectly in line with the three dimensions of sustainable cities: the economy, the environment, and society. The sharing economy has the potential to create new forms of business and income and from a social perspective, the share economy facilitates the creation of new social ties and helps build communities (Akande et al., 2020). Smart city implementation can be achieved by investing in information and communications technology in collaboration with human resources to make an area a sustainable city. Through education or training, investments in human resources can improve people's capacity to learn and innovate, particularly their ability to develop, comprehend, apply, and manage ICTs. Furthermore, human resource development helps to technical innovation and economic development, which attracts educated and skilled people to the city. Based on the "China's New-type Urbanization Plan (2014-2020)", Smart city development is part of government unification planning and emphasizes the total use of material, information, and intellectual resources through technology integration, data integration, and business integration to socio-economic growth. Only investments that are included in the government's smart city development plan are part of the smart city investment (M. Wang et al., 2023).

During the construction and operational phases, smart city investments have an impact on the economy. Smart city investments in technology and infrastructure stimulate local economic growth throughout the system development phase, mostly through higher capital and labor spending. Successfully applied technology and infrastructure can increase sectoral productivity and modify behavior on a large scale, both of which have an economic impact. Smart city investments are intended to boost regional economic growth, improve quality of life, and enhance a city's sustainability (Chen & Cheng, 2022).

Despite increasing interest in smart city investments, it is still unclear how these investments can achieve their intended goals. The main problem is the lack of an effective methodology for measuring the economic impact of such investments. Many cities lack comprehensive assessment tools to evaluate the economic impact of smart city implementation, making it difficult to determine whether the investment is delivering the desired benefits. This literature review paper discusses what research explains the economic impact of smart city investments and how to assess it. References were obtained from various related articles regarding smart city investment, the economic impact of smart cities, as well as explanations of assessment tools to determine the economic impact of smart city investments.

MATERIALS AND METHODS

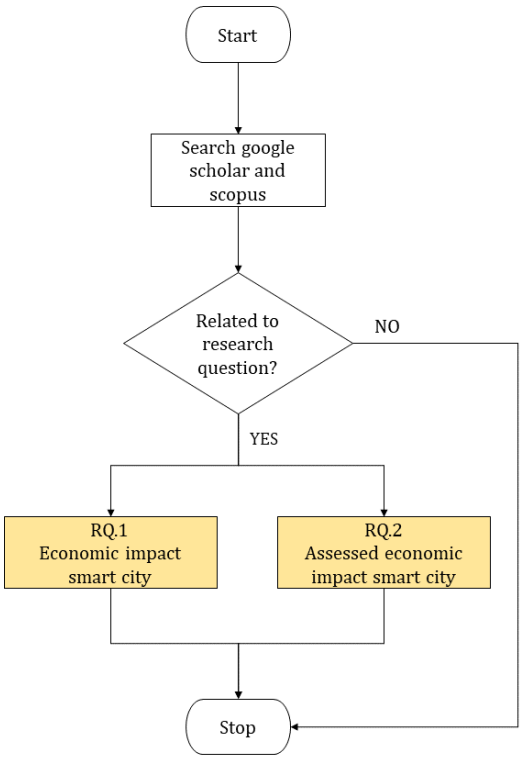
The first stage of our literature review was developing research questions, which assisted us in defining the scope of the study and guiding the review process. The research question will be the focus and explanation of how the review process is carried out. In determining the research question, mapping is needed to find out what has been discussed within the scope of smart cities. By using Vosviewer software, mapping related to smart city discussions can be shown clearly. Mapping result shown in Figure 1.



Source: (Research Results, 2024)

Figure 1. Mapping Smart City Investment

Based on the mapping result in Figure 1, there are still a few sections that discuss how smart city investment has an impact on the economic side. Smart city investment is a very crucial thing if it is not planned. The impact will be felt on society, including on the economic side. Financial stability is needed to produce a real impact on society (Puron-Cid & Gil-Garcia, 2022). The purpose of this literature study is to determine how smart city investment affects the economy and how to assess it. There has been a lot of discussion about smart city investment, but not much has been done regarding the resulting impact. In line with (Chen & Cheng, 2022) research, which states that the economic impact of smart cities is still something that has yet to be seen. The process of finding relevant literature is shown in Figure 2.



Source: (Research Results, 2024)

Figure 2. Literature Review Search Process

The scope that will be described is about the impact and factors that influence it, how to measure the impact as well as the challenges facing it. This Literature review will probably explain the benefits of smart city investments in terms of economics and what can be developed for further research. The research questions are “what is the economic impact of smart city investment and how to assessed the economic impact of smart city investment?”. After determining the research question, start looking for articles that support or are in accordance with the literature review being made.

First, a search query was run on the electronic databases Scopus and Google Schoolar to get a wide range of papers on the economic impact of smart cities. As a result, the databases were searched using the keywords "smart city investment", "impact smart city", "economic impact smart city", and "smart city" in the title, keywords, and abstract sections of peer-reviewed articles. This literature review is based on studies related to smart city implementation and its economic impact published in the last 5 years. Furthermore, the content was matched with the research question that had been made. Only research that discusses the economic impact of smart cities and how to assess it is used as the main source. Therefore, 20 articles were included in this literature review.

RESULTS AND DISCUSSION

Economic Impact of Smart City Investment

The concept of smart cities involves leveraging digital technology to create more efficient and effective environmental services, ultimately improving the quality of life sustainably. Investment in smart cities requires substantial financing and involves multiple stakeholders. Proper allocation of resources is essential for the success and sustainability of these initiatives (Gracias et al., 2023). To optimize smart city investments, it is crucial to assess the city's current capabilities and socio-economic condition (Duygan et al., 2022). Identifying existing infrastructure and determining necessary innovations helps in tailoring the smart city strategy to the specific needs of the population (Lafioune et al., 2024).

For instance, autonomous vehicles (AVs) represent a significant smart city investment. These vehicles are designed to adapt to various urban landscapes, offering cost savings and energy efficiency. The implementation of AVs requires strategic planning to maximize their benefits. Later, this vehicle will make an economic forecast so that users can find out how effectively the AV has been used (Richter et al., 2022). Similarly, transforming traditional offices into smart offices

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by integrating advanced technology can reduce labor costs and increase efficiency. Even though it still requires maintenance costs, tools are still considered more "passive-active" than employing employees (Duygan et al., 2022). Such innovations drive economic growth through enhanced e-commerce and e-business models. In line with what Dirks said, a smarter city system creates cost savings and in addition, increases efficiency. Komninos also added that in addition to better procedures and problem-solving abilities, lower operating costs are also criteria for intelligence (Csukás & Szabó, 2021).

Moreover, smart city investments impact urban planning by attracting tourism and boosting local economies. With so many tourists coming to visit, it will certainly fuel the city's economy through attraction tickets, merchandise sales, lodging accommodation, and so on. All of this can be done using marketing techniques that are adapted to the smart city technology that the city government has (Akande et al., 2020). One of the conditions that cities must pay attention to when investing in smart cities is to look at city finances. Because smart city investment costs a lot of money, cities must have a stable financial condition. It is hoped that a city will not have debt to achieve economic stability. These are the main financial parameters that determine the basic conditions for the creation and development of smart cities (Jonek-Kowalska & Wolniak, 2021). Smart city development has a big influence on the population in it and can be measured based on demographics, economics, and education. What is the financial condition and welfare of the population and how education will be the initial capital for developing a smart city (Siodla, 2020). This is in line with Albino's statement which states that citizen involvement in socio-economic, cultural, and sustainability activities influences the quality of existing or future smart cities (Zhu et al., 2022).

Open data is one of the implementations of smart cities. Quoting European Commission President Ursula von der Leyen who stated that "Data and AI are the ingredients for innovation that can help us to find solutions to societal challenges, from health to farming, from security to manufacturing. To release that potential, we must find our European way, balancing the flow and wide use of data while preserving high privacy, security, safety, and ethical standards" (Zerbes, 2020). Open data initiatives further enhance decision-making processes, enabling better service delivery across sectors. The impact of using open data can be felt directly or indirectly. Many new products or services have been created from the use of open data. Open data not only helps businesses and governments generate more revenue due to new services, or reduce costs by working more efficiently, but it can also help save lives, save time, preserve the environment, or improve the transfer of knowledge through language services (Huyer & van Knippenberg, 2020).

So, it can be concluded that the economic impact of smart city investment is the progress of urban innovation such as the formation of e-commerce and e-business, creating a more environmentally friendly environment, cost and economic savings, increasing GDP, and increasing the income of a region/city by utilizing good smart city. Smart city investments not only foster urban innovation and economic growth but also contribute to environmental sustainability. By analyzing and applying the essence of smart city literature, cities can develop tailored strategies that address specific challenges and opportunities. The following is a brief explanation regarding the economic impact of smart city investment which has been explained as shown in Table 1.

Table 1. Economic Impact of Smart City Investment

No	Smart City Investment	Economic Impact	Source
1	Autonomous Vehicle	Save power and cost	(Richter et al., 2022)
2	Smart Office	Reduce pay, increase income	(Duygan et al., 2022)
3	E-commerce	Increase GDP	(Shamsuzzoha et al., 2021)
4	E-business	More work field, more income	(Shamsuzzoha et al., 2021)
5	Open Data	Reduce cost, efficient	(Zerbes, 2020)
6	City Planning	Increase local income, green environment	(Akande et al., 2020)

Source: (Research Results, 2024)

Assess the Economic Impact of Smart City

Through the use of advanced technology, smart city development aims to increase the efficiency and effectiveness of various aspects of city life. However, to ensure that this initiative actually produces a significant economic impact, a framework or model is needed that can accurately assess the economic impact of smart city implementation (Widiyastuti et al., 2021). Additionally, a comprehensive framework or model can help governments and other stakeholders determine which parts of the strategy need to be improved or adjusted. It is difficult to determine how much smart city technology has helped city economies without a structured model. A more systematic and objective evaluation can be carried out with this model, so that decisions made can be more targeted and based on accurate data (Irfan & Aindita, 2022).

Frameworks for assessing economic impacts also allow for learning and policy adjustments. With the data and analysis produced from this model, other cities can learn from the experiences and results achieved by cities that implemented smart cities first (Hasibuan & Sulaiman, 2020). The research by (Chen & Cheng, 2022) introduces a Computable General Equilibrium (CGE) framework that aims to evaluate how investments in smart city technology and infrastructure affect various aspects of the economy, including job creation, productivity gains, and overall economic growth. The framework enables more targeted and data-driven decision-making, facilitates collaboration between cities and other stakeholders, and contributes to improved efficiency and sustainability of the urban environment.

In other research by (C. Wang et al., 2021), it focused on developing smart technology solutions to improve energy efficiency in smart cities called the Energy Efficient Integrated Planning Framework (EEIPF). The framework includes a range of regulatory and technological implementation measures designed to reduce energy consumption and environmental impacts, while improving economic aspects. Using this approach, smart cities can adopt energy-efficient technologies, reduce carbon emissions, and improve citizens' quality of life. The framework also emphasizes the importance of collaboration between the government, private sector, and communities in creating more sustainable and economically and environmentally efficient cities.

And last, a framework developed by (Neves et al., 2020) covers the use of publicly accessible data to make better decisions in city management, increase transparency, and encourage citizen participation. This framework is named Open Data Impact for Smart Cities Framework (ODISC). By integrating data from various sources, smart cities can monitor infrastructure in real-time, optimize transportation, and improve public services. In addition, the framework also emphasizes the importance of collaboration between the government, private sector, economy and society in utilizing open data to create a more sustainable urban environment that is responsive to the needs of citizens. The following Table 2. is a brief explanation of the framework that can be used to measure the economic impact of smart city investments.

Table 2. Assess Economic Impact of Smart City

Framework	Asses s Of	Definitions	Description
Computable General Equilibrium (CGE	GDP from smart city investment	The CGE model calculates the distributional impact of smart city investment on GDP, considering regional and residential growth, and emphasizes stakeholder collaboration and sustainable investment approaches (Chen & Cheng, 2022).	The model suggests that for optimal smart city outcomes, early-stage collaboration and sustained investment are crucial. This implies a need for policy frameworks that facilitate such cooperation and long-term planning.
Energy Efficient Integrated Planning Framework (EEIPF)	Energy efficiency	The EEIPF method monitors energy efficiency through various metrics, including energy efficiency ratio, energy consumption ratio, and cost-performance ratios (C. Wang et al., 2021).	This framework highlights the need for integrating digital transitions in energy management, suggesting that cities should adopt comprehensive digital solutions to optimize energy use and reduce emissions effectively.
Open Data Impact for Smart Cities Framework (ODISC)	Evaluation and Monitoring Open Data	The ODISC Framework evaluates the impact of open data on smart city development, aiming to enhance governance, citizen empowerment, and economic opportunities (Neves et al., 2020).	Open data initiatives can drive significant societal benefits, indicating that smart cities should prioritize transparency and open data policies to foster innovation, improve public services, and increase citizen engagement.

Source: (Research Results, 2024)

CONCLUSION

We have explored the economic impact of smart city investment and how to assess it using different frameworks. By studying the research topic, we determined that smart city investment has significant economic impacts, such as enhancing e-commerce and e-business, creating environmentally friendly environments, reducing costs, and increasing GDP and regional income. In our assessment of the economic impacts, we employed various frameworks. The Computable General Equilibrium (CGE) model scrutinizes the distributional effects of smart city investments on GDP, stressing the significance of stakeholder collaboration and sustainable practices. Additionally, the Energy Efficient Integrated Planning Framework (EEIPF) directs attention

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towards enhancing energy efficiency using metrics like energy consumption and cost-performance ratios. Furthermore, the Open Data Impact for Smart Cities Framework (ODISC) evaluates the influence of open data in smart city evolution, underscoring transparency and data accessibility as catalysts for innovation and economic.

However, our research has limitations, including the scope of the research questions, the selection of keywords, and the expertise of authors. Future studies could expand beyond economic impacts to explore the social, technological, and environmental aspects of smart city investments, thereby providing a more holistic understanding of their benefits and challenges.

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