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Green Digitalization for Smart Mobility and Low-Carbon Transportation in East Kalimantan

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Abstract: This research examines the application of the smart mobility concept as a transition strategy towards low-carbon transportation in East Kalimantan, focusing on the cities of Samarinda and Balikpapan. This research aims to analyze the role of transportation digitalization in improving public service efficiency, reducing carbon emissions, and identifying barriers to implementation. The method used is an exploratory case study with a content analysis approach to secondary data. The results show that smart mobility in East Kalimantan is beginning to have a positive impact. E-parking services, the development of e-ticketing, and the use of navigation applications have proven effective in reducing congestion and fuel consumption. Furthermore, the adoption of electric vehicles (EVs) has shown a significant increase, marked by a 452% increase in electricity consumption and a 406% increase in SPKLU (Public EV Charging Station) transactions by 2024. The expansion of SPKLU and SPBKLU infrastructure has strengthened the electric vehicle ecosystem in this region. However, obstacles remain, such as a digital literacy gap among the community, particularly among the elderly, low-income groups, and residents in rural areas. This limits the optimal utilization of digital transportation services.

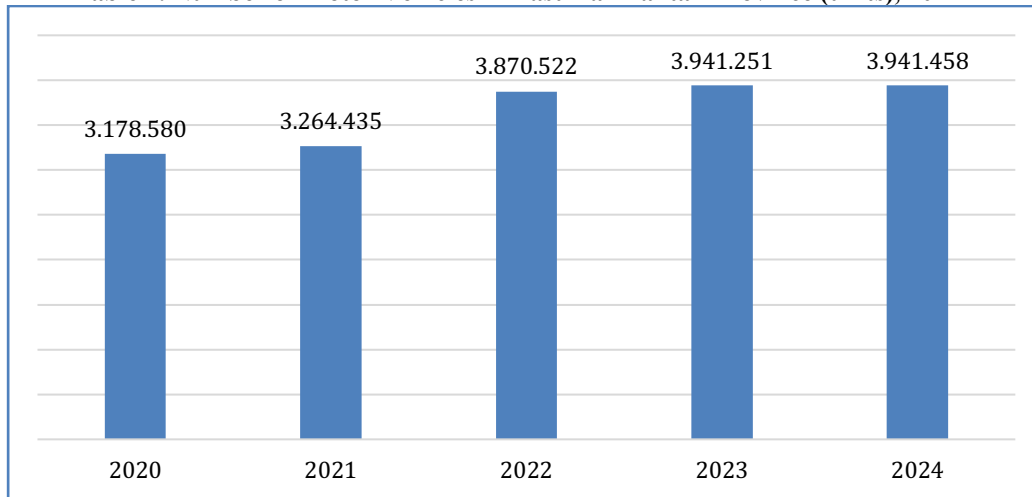
Keyword: Smart Mobility, Low Carbon Transportation, Green Digitalization, East Kalimantan, Sustainable Cities.

INTRODUCTION

The development of digital technology has brought significant changes to transportation systems in various cities around the world (Sakti, 2023). One of the rapidly developing innovations is smart mobility, namely the concept of intelligent mobility that integrates information and communication technology (ICT) to increase the efficiency, safety and sustainability of transportation (Malisan et al., 2021). This concept is in line with efforts to realize low-carbon transportation, which emphasizes reducing greenhouse gas (GHG) emissions through managing environmentally friendly modes of transportation, using clean energy, and optimizing urban transportation networks (Wahyudi, 2024).

Samarinda, the capital of East Kalimantan Province, has a relatively high population and motor vehicle growth rate (Adi, 2018). Based on data from the Central Statistics Agency (BPS) in 2024, the number of motor vehicles in East Kalimantan reached 3,941,458. With average growth.

Table 1. Number of Motor Vehicles in East Kalimantan Province (units), 2024



Source: Archive data from the Central Statistics Agency of East Kalimantan, 2025

Based on data on the number of motorized vehicles in East Kalimantan Province for the 2020–2024 period, an increasing trend was recorded each year, albeit at varying rates. In 2021, the number of vehicles increased by 2.70% compared to the previous year. A significant growth surge occurred in 2022, reaching 18.57%, likely influenced by the recovery of economic activity after the COVID-19 pandemic and the increasing need for public mobility. Entering 2023, growth slowed to 1.83%, and in 2024, growth remained relatively stagnant, with an increase of only 0.005% compared to the previous year. Overall, the average growth rate of motorized vehicles in East Kalimantan Province during the 2020–2024 period was approximately 5.78% per year.

The data above indicates that, despite fluctuations, the number of vehicles continues to increase year after year. This situation has the potential to put pressure on transportation infrastructure capacity and environmental quality, necessitating more sustainable mobility management strategies, including the implementation of smart mobility and low-carbon transportation concepts. These conditions trigger increased fossil fuel consumption and carbon dioxide (CO₂) emissions, which contribute to climate change and deteriorating urban air quality. Furthermore, traffic congestion, limited public transportation, and a lack of integrated transportation systems present challenges in creating sustainable mobility. The increase in the number of motorized vehicles can be used as a benchmark for the condition of the transportation sector (Sugiyono et al., 2011). This indicates the growing need for transportation facilities.

The Indonesian government, through Presidential Regulation Number 98 of 2021 concerning the Implementation of Carbon Economic Value, has set a target of reducing GHG emissions by 29% by 2030, or 41% with international support (Sulistiyowati et al., 2025). The transportation sector is one of the main contributors to greenhouse gas (GHG) emissions in Indonesia, especially carbon dioxide (CO₂), due to its high dependence on fossil fuels (Hidayat & Syafei, 2023). This effort is strengthened by the Long-Term Strategy towards Low Carbon Development and Climate Resilience 2050, which is in line with the NZE target of 2060 or even earlier (Kementerian ESDM, 2021). Cities in East Kalimantan currently face serious challenges in transitioning to a low-emission transportation system. Rapid urban population growth, particularly in large cities like Balikpapan and Samarinda, is driving intensive urbanization. This has a direct impact on the increasing demand for mobility, which is largely

driven by the use of private vehicles powered by fossil fuels. Data from the East Kalimantan Central Statistics Agency (BPS) shows that the number of motorized vehicles continues to increase year after year, with an average annual growth rate of around 5.78% from 2020 to 2024. This surge in motorized vehicles not only exacerbates traffic congestion but also increases carbon emissions, contributing to air pollution and climate change at both the local and global levels.

East Kalimantan region also has an important role in the national energy sector (Hudaifah, 2025). The relocation of the capital city is projected to significantly increase energy demand in the region, and the new capital city is designed as a green city with a sustainable energy system, with 70% of energy needs targeted to come from renewable energy (Bappenas, 2023). Currently, approximately 85% of power generation in East Kalimantan still relies on coal-fired power plants (PLTU) and diesel as the primary energy source. This dependence has implications for high carbon dioxide (CO₂) emissions, with the energy sector in this region contributing approximately 30% of total regional carbon emissions. One approach currently being widely developed is the concept of smart mobility. This smart mobility emphasizes the use of digital technology in transportation systems to increase efficiency, reduce congestion, and reduce carbon emissions (Hariyadi et al., 2025). The implementation of smart mobility can be realized through various strategies, such as the use of digital-based transportation applications, real-time traffic management systems, integration of public transportation modes, and the development of Electric Vehicles (EVs) (Darmawan, 2022). This approach is in line with the principles of green digitalization, namely the use of information technology that is not only oriented towards efficiency, but also towards environmental sustainability (R. P. Sari & Veri, 2025).

East Kalimantan, as the prospective new capital city (IKN Nusantara), faces a greater urgency in accelerating the transition to low-carbon transportation. The IKN's development envisions a modern, inclusive, and sustainable city with a green energy-based public transportation system (Fristikawati et al., 2022). However, the implementation of smart mobility in East Kalimantan still faces several obstacles. Limited digital infrastructure, a limited integrated public transportation fleet, low electric vehicle penetration, and a lack of public awareness of switching to environmentally friendly transportation are the main obstacles (Hafasy, 2022). In addition, coordination between agencies and involvement of the private sector is still not optimal in supporting the development of low-emission transportation systems.

METHOD

This research uses an exploratory case study design focused on the context of East Kalimantan, specifically large cities such as Samarinda and Balikpapan, as regions facing challenges in transitioning to a low-emission transportation system. The case study design was chosen because it provides an in-depth understanding of specific phenomena related to transportation digitalization and carbon emission reduction, taking into account the surrounding social, economic, and environmental dynamics.

To analyze the data, this study employed content analysis techniques. This approach was used to examine secondary data relevant to sustainable transportation issues, including policy documents, local government reports, and academic publications related to the implementation of smart mobility. Through content analysis, the research can identify patterns, trends, and policy implications for sustainable transportation management.

The data used in this study are secondary data. This data was obtained from various official sources, such as the Central Statistics Agency (BPS), reports from relevant ministries/agencies, and annual reports from the East Kalimantan regional government. The selection of secondary data aims to provide a more comprehensive picture of the relationship between transportation digitalization and carbon emission reduction efforts in the study area.

RESULTS AND DISCUSSION

Implementation of Smart Mobility in East Kalimantan

Smart Mobility is a key element in the development of a Smart City, which focuses on the use of information and communication technology in transportation systems to provide services that are more efficient, safe, comfortable, and accessible (Aini et al., 2024). The implementation of smart mobility in East Kalimantan, particularly in Samarinda City, is beginning to show a positive impact on increasing the efficiency of public transportation services. One concrete example is the introduction of electronic parking (e-parking) services at several strategic locations, such as the Segiri Sports Center (GOR) and the Mahakam River. Although still in the trial phase, this system makes it easier for the public to pay for parking digitally, without having to use cash. The introduction of e-parking also marks the first step towards broader integration with the transportation e-ticketing system. This means that in the future, the public will not only be able to use electronic cards or digital applications to pay for parking, but also access public transportation services with a single, integrated payment system. This effort is expected to boost efficiency, reduce queues, and strengthen the implementation of the smart mobility concept in Samarinda.

This aligns with findings from the Ministry of Transportation (2022), which stated that digitalizing transportation payments can improve operational efficiency and transaction transparency, while simultaneously encouraging a cashless culture in society. Furthermore, the use of transportation navigation applications integrated with real-time traffic data has reduced travel times by up to 14% (Ministry of Transportation, 2022). A study by the National Development Planning Agency (Bappenas, 2023) shows that the use of digital technology in urban transportation management can reduce congestion and fuel consumption, thus indirectly contributing to carbon emission reductions. With data-based navigation services, public and private transportation users can choose more efficient alternative routes, thus supporting the principle of sustainable mobility. Overall, the implementation of smart mobility in East Kalimantan not only improves transportation comfort and efficiency but also makes a significant contribution to sustainable development targets, particularly in the context of reducing carbon emissions and improving the quality of public services. However, challenges remain in the aspect of digital infrastructure and connectivity between transportation modes, which are not yet fully optimized.

Emission Reduction

According to the report of PLN UID Kaltimara, electricity use for electric vehicles experienced a significant surge, increasing by 452%. If in 2023 electricity consumption was recorded at 19,873 (kWh), then in 2024 the number increased drastically to reach 109,751 kWh. In addition to the increase in electricity consumption in electric vehicles, there was also a significant surge in the number of transactions at Public Electric Vehicle Charging Stations (SPKLU) in the East and North Kalimantan regions, namely by 406% from 1,086 transactions in 2023 to 5,497 transactions in 2024. This reflects the increasingly massive adoption of electric vehicles in the region. PLN UID Kaltimara's consistent strategy in expanding SPKLU infrastructure is in line with the government's commitment to supporting the national energy transition while realizing Indonesia's Net Zero Emission (NZE) target by 2060. The increase in the use of electric vehicles directly contributes to reducing carbon emissions from the transportation sector (Suryan et al., 2024). Especially in urban areas like Samarinda, which have long faced problems with traffic congestion and high air pollution, the adoption of electric vehicles, supported by digital traffic management, can result in more tangible emission reductions.

With the addition of 56 new SPKLU units, the total number of SPKLU units operating in East Kalimantan and North Kalimantan has now reached 71 units, spread across 57 strategic locations. This SPKLU network covers urban areas, community activity centers, and main

transportation routes, providing convenience and a sense of security for electric vehicle users. Furthermore, PLN UID Kaltimara has also operated a Public Electric Vehicle Battery Swapping Station (SPBKLU). The availability of this increasingly comprehensive infrastructure strengthens optimism for the development of the electric vehicle ecosystem (Setiawan et al., 2025). Through the PLN Mobile app, users can also easily find the nearest SPKLU (Storage Service Station) and make payments online. This convenience is expected to alleviate concerns for prospective electric vehicle users and buyers, while also encouraging the adoption of environmentally friendly vehicles in the community.

Challenges/obstacles

One of the main challenges in implementing transportation digitalization in East Kalimantan, particularly in Samarinda, is the persistent digital literacy gap among public transportation users. Digital literacy indicators reflect various skills and knowledge that demonstrate an individual's ability to adapt and interact optimally within the digital ecosystem (Saragih et al., 2024). In the context of public transportation, digital literacy is very important because the majority of digital-based services, such as e-ticketing, online navigation systems, and travel schedule information, can only be accessed via smartphone devices or special applications (E. N. Sari et al., 2021)

In East Kalimantan, some community groups, especially the elderly, low-income communities, and residents in outlying areas, still face limitations in accessing digital technology (Astri et al., 2025). This is characterized by limited smartphone ownership, unequal internet access, and limited skills in operating digital applications. As a result, even though local governments and transportation operators have promoted digitalization, some users still experience barriers to accessing these services.

CONCLUSION

Research results show that the implementation of smart mobility in East Kalimantan, particularly in Samarinda City, has had a positive impact on increasing the efficiency of public transportation services and significantly contributed to reducing carbon emissions. Innovations such as e-parking and the development of an e-ticketing system have made it easier for the public to access digital-based transportation services, while simultaneously promoting a more transparent and efficient cashless culture. Furthermore, the use of navigation applications based on real-time traffic data has been proven to shorten travel times, reduce congestion, and reduce fuel consumption. This aligns with the principles of sustainable mobility promoted in smart city development.

Meanwhile, the adoption of electric vehicles (EVs) in East Kalimantan has also shown significant growth. According to data from PLN UID Kaltimara, electricity consumption for electric vehicles has increased by 452% in the past year, accompanied by a 406% surge in SPKLU transactions. Infrastructure support in the form of the addition of 56 new SPKLU units and the operation of SPBKLU further strengthens the electric vehicle ecosystem in East and North Kalimantan. This situation not only marks the acceleration of the energy transition in the transportation sector but also represents a concrete contribution to Indonesia's 2060 Net Zero Emission (NZE) target. With increasingly comprehensive infrastructure and easy access through digital applications such as PLN Mobile, The prospects for electric vehicle growth in this region are promising.

However, this study also found that the challenge of the digital literacy gap remains a major obstacle to optimizing the implementation of smart mobility. Certain community groups, such as the elderly, low-income groups, and those living in rural areas, are not yet fully able to access and utilize digital transportation services. This has the potential to hinder the inclusive expansion of smart mobility benefits and reduce the potential for broader emission reductions.

Therefore, it can be concluded that the transformation towards smart mobility and low-carbon transportation in East Kalimantan is on the right track, but still requires further strategies. Future efforts need to focus on strengthening digital infrastructure, accelerating integration between transportation modes, and increasing public digital literacy. If these challenges can be overcome, East Kalimantan especially with its position as the future capital city has the potential to become a pilot model for implementing low-carbon transportation based on green digitalization in Indonesia.

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