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Challenges of Developing Environmentally Friendly Transportation Infrastructure in Urban Areas

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ABSTRACT

This research aims to identify and analyze the main challenges in developing environmentally friendly transportation infrastructure in urban areas, as well as to provide technical solutions based on calculations and scientific approaches in the field of transportation infrastructure engineering.The method used is a descriptive qualitative approach, with data collection through literature studies and field observations. The results of the study indicate that the development of environmentally friendly transportation in urban areas faces various challenges, ranging from budget constraints, weak coordination between sectors, to low public awareness. To strengthen the qualitative data, a system dynamics based on quantitative data is used with simulation 1 showing sustainability up to 30% of 100%, simulation 2 up to 25% of 100%, simulation 3 up to 20% of 100%, simulation 4 up to 15% of 100%, and simulation 5 up to 10% of 100%, thus showing that the factor that must be maximized is infrastructure and technology.

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INTRODUCTION

Sustainable development has become a central issue in the planning and development of cities worldwide. As population growth and urbanization rates continue to increase, urban areas face increasingly complex challenges, one of which stems from the conventional transportation system that dominates people's mobility [1], [2]. High dependence on fossil-fueled private motorized vehicles has given rise to various serious problems, such as air pollution, traffic congestion, excessive energy consumption, and increased greenhouse gas emissions [3], [4],[5],[6]. These problems can have a direct impact on public health and environmental quality, then spread by hampering economic growth and reducing people's quality of life.

As a response to these issues, the concept of environmentally friendly transportation or sustainable transportation is becoming increasingly important and relevant [7]. This concept emphasizes the development of transportation systems and practices that are oriented towards energy efficiency, low emissions, and social and environmental friendliness. The goal is to continue to meet people's mobility needs efficiently without sacrificing environmental sustainability. Sustainable transportation is known for its potential in addressing various urban challenges, ranging from congestion, air pollution, and greenhouse gas emissions to uncontrolled urban expansion [8].

This approach also seeks to improve public mobility by reducing dependence on private vehicles and expanding the choice of cleaner and more inclusive modes of transportation. Previous studies have shown that investment in sustainable transportation infrastructure can provide tangible benefits, such as reduced emissions, improved air quality, and improved accessibility to public transportation [9], [10]. Implementation of sustainable transportation includes the development of an integrated public transportation network, the provision of safe and comfortable facilities for pedestrians and cyclists, the use of low-emission electric or hybrid vehicles, and the application of smart technology for efficient traffic management.

However, although more and more parties recognize the urgency of transitioning to a more environmentally friendly transportation system, the development of sustainable transportation infrastructure in urban areas still faces various obstacles. This transition process is not simply a matter of changing modes of transportation, but involves multidimensional challenges that encompass technical, financial, social, and institutional aspects. Developing environmentally friendly transportation infrastructure requires careful planning and implementation, as well as collaboration across various sectors and stakeholders [11].

Essentially, sustainable transportation infrastructure development is a multifaceted concept, as it focuses not only on mobility efficiency but also considers its impact on the environment, social welfare, and economic sustainability. In practice, this concept involves a series of complementary strategies and approaches, such as expanding and improving the quality of public transportation, building non-motorized transportation routes such as sidewalks and bicycle lanes, and adopting environmentally friendly technologies, such as electric vehicles and digital-based traffic management systems [12], [13].

Therefore, a thorough understanding of these constraints is needed to formulate effective strategies and policies to realize the vision of cleaner, healthier, and more sustainable cities.

Several previous studies have identified various major obstacles in the implementation of green infrastructure and sustainable transportation. The first study identified five key challenges that hinder the effectiveness of sustainable infrastructure: lack of uniform design standards, complex regulatory pathways, inadequate socio-economic considerations, limited funding, and a lack of innovation [14]. Meanwhile, in green city development, [15] shows that the biggest challenges arise from funding, limited technology, and the high risks faced in the implementation process.

Meanwhile, a study focused on Johannesburg, South Africa, highlighted the obstacles to integrating sustainability principles into transportation infrastructure. Key barriers identified included a lack of political commitment to sustainable transportation, a lack of investment in energy-efficient vehicles, and limited available resources. The study also emphasized the importance of expanding and modernizing infrastructure in response to population growth and increasing economic activity [16]. Furthermore, a study discussing the green transformation in Poland emphasized the importance of a strategic approach to supporting the "greening" of the transportation sector. The strategy adopted embraced the concept of "reorganization," which requires a comprehensive restructuring of transportation development policies [17].

These studies demonstrate a significant gap, particularly in the technical and scientific approaches that can be directly implemented to design sustainable transportation solutions in urban areas. Most studies focus on identifying general constraints without outlining technical steps that can be implemented by transportation engineers, urban planners, and policymakers. This research aims to address this gap and offer a novel approach based on calculations and scientific analysis in the field of transportation infrastructure engineering. The primary objective of this research is to identify and analyze the key challenges faced in developing environmentally friendly transportation infrastructure in urban areas and to provide technical solutions based on calculations and scientific approaches in the field of transportation infrastructure engineering.

After understanding the various identified barriers, this research is expected to significantly contribute to formulating more targeted and evidence-based policy recommendations. Furthermore, the results can also serve as a foundation for developing more effective and applicable implementation strategies for local governments, city planners, and other stakeholders. The approach offered is not merely conceptual but also prioritizes technical and scientific aspects relevant to field conditions, thereby strengthening institutional capacity to comprehensively respond to urban transportation challenges. This is expected to result in concrete policies and measures capable of encouraging the creation of an efficient, inclusive, and environmentally and socially sustainable transportation system in the future.

RESEARCH METHOD

This study uses a descriptive qualitative approach to deeply understand the various challenges faced in developing environmentally friendly transportation infrastructure in urban areas. A qualitative approach is a research method that aims to deeply understand social phenomena or problems through the collection of descriptive data, not numbers [18]. This approach was chosen because it is able to explore phenomena holistically and contextually, especially in uncovering the interrelated technical, social, financial, and institutional aspects of the transportation infrastructure development process.

Data collection was conducted through two main methods, literature review and field observation. Literature review was used to examine various previous research findings, government policies, and relevant transportation planning documents, thus forming a strong conceptual and theoretical foundation for this research. Meanwhile, field observation was conducted to directly observe the actual condition of transportation infrastructure in urban areas, including user behavior and the obstacles that arise in the implementation of environmentally friendly transportation policies and development.

The data collected in the study were then analyzed using the Miles and Huberman model of analysis. The analysis process began with the data reduction stage, which involved filtering, sorting, and summarizing important information from various sources to focus on data relevant to the research objectives. This stage helped researchers eliminate irrelevant information and highlight meaningful findings. After the reduction process, the data were presented in narrative form and a structured matrix. This data presentation aimed to facilitate researchers in interpreting patterns, trends, and relationships between variables in the challenges of developing environmentally friendly transportation infrastructure. The final stage of the analysis process was drawing conclusions, in which researchers interpreted the meaning of the presented data and identified key emerging patterns. The conclusions drawn were provisional and subject to review as new data became available. However, through iterative analysis and data triangulation, the conclusions obtained became increasingly robust and scientifically sound.

To strengthen the results of qualitative analysis, quantitative analysis using system dynamics. A system represents a unified interaction between elements of an object within a specific scope that work together to achieve a goal. These interactions bind or connect elements, providing structure to the object, enabling it to differentiate from other objects, and influencing the object's state. The elements of a system are defined by their function; sometimes the term "element" is more commonly referred to as a subsystem.

In system dynamics, there is a boundary or scope that separates the system's state from the external environment. This boundary can be divided into two categories: a closed-loop system, considered impermeable to external environmental influences, and an open-loop system, which continues to analyze external environmental influences.

When discussing systems, one must begin with a systemic approach, or systemic thinking, which has several stages:

- Identifying the processes that generate real events
- Identifying expectations

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- Identifying gaps between reality and expectations
- Identifying dynamics to address these gaps
- Policy analysis

A. Identifying the processes that generate real events

For example, this process can be seen in the event of a decline in sales due to a weak marketing team. All supporting factors are expected to be objective, or their validity is beyond question based on scientific knowledge. Therefore, this process demonstrates an actual transformation toward an actual state.

B. Identifying expectations

This process refers to targets that are feasible and acceptable so they can be anticipated to become reality. These two criteria limit the plan's stability and allow it to remain dynamic in the face of change.

C. Identifying gaps between reality and expectations

Gaps or differences must be resolved both qualitatively and quantitatively. For example, in qualitative terms, a system must be in place to address employee quality issues. Similarly, in quantitative terms, a system must be in place to address financial issues, such as sales and purchasing.

D. Identifying dynamics to address these gaps

This process aims to correct gaps and aims to produce a system model that is future oriented and able to adapt to past actions so that there is a feedback loop.

E. Policy analysis

This is the final stage of the system dynamics process, where the output is alternative interventions that should be selected after testing (in this case, using Powersim Studio 10 software) to ensure the intervention is safe and effective.

To simulate a model, software is needed that can quickly observe the behavior of the model, one of which is Powersim Studio 10. A dynamic model is a collection of variables that influence each other over time. Each variable corresponds to a distinct quantity. All have numerical values and are part of the system itself.

The purpose of this study is to examine the influence of budget and development priorities, intersectoral coordination and policies, public behavior and awareness, infrastructure and technology, sociological and institutional factors on sustainable transportation.

The Causal Loop Diagram, often abbreviated as CLD, refers to the system characteristics mentioned in the previous section. The presence of supporting elements, internal and external feedback, and equilibrium. The causal relationship (CLD) is a precondition before proceeding with the flow diagram process in Powersim Studio 10, a software program used for dynamic systems.

Cause-and-effect relationships in a CLD are dynamic, meaning they change over time. These relationships come in two forms: unidirectional or mutually reinforcing (marked with a + sign), meaning that if one variable increases, the other related variable will also increase. The second type is the opposite relationship (marked with a - sign), meaning that if one variable increases, the other related variable will decrease.

A collection of causal relationships forms a loop to provide feedback. Loops come in

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two forms. Reinforcing (marked with the letter "R") and Balancing (marked with the letter "B"). A reinforcing loop is a mutually reinforcing relationship, meaning that the interconnected variables will continue to increase or decrease in value without any one contributing to the system's equilibrium. Meanwhile, Sympal Balancing means a mutually balancing relationship. This means that interrelated variables will continuously increase in value, while other interrelated variables will decrease in value, thus achieving system equilibrium.

Using the CLD model has several advantages, including:

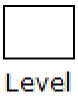
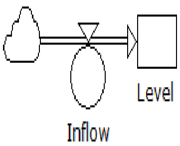
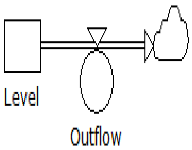
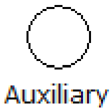
-Helping to find and explore answers to problems by considering the many relationships between variables.

-Understanding the complexity of problems dynamically over time, thus improving decision-making.

-Understanding the possibilities that will occur in a problem, thus enabling mitigation of potential problems.

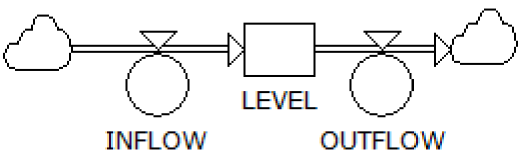
System dynamics are depicted by flow diagrams with various functions that have aims and objectives which can be seen in the following table 1.

Table 1. Symbol System Dynamics

Symbol	Description
	Describes the accumulation of systems
	Describes the process of adding states to a LEVEL
	Describes the process of reducing states at LEVEL
	Explanatory variables of the relationship

Mathematically, the system dynamics can be written as follows in figure 1.

Figure 1. System Dynamics



$$LEVEL = \frac{dINFLOW}{dt} - \frac{dOUTFLOW}{dt}$$

$$LEVEL\ (t) = LEVEL\ (t-1) + \frac{dINFLOW}{dt} - \frac{dOUTFLOW}{dt}$$

The values taken in this study are on a Likert scale ranging from 1 to 5. The overall values from the system dynamics model (flow diagram) are as follows in figure 1.

RESULT AND DISCUSSION

One of the main focuses of the current global development agenda is ensuring energy availability for all. This energy must not only be economically accessible, but also safe, environmentally friendly, and in line with modern technological developments. This commitment is reflected in one of the major goals of sustainable development, which emphasizes the importance of equitable access to energy to support prosperity and sustainable growth for all [19].

Awareness of the importance of preserving the environment is not only coming from industry players, but has also become a serious concern for the government. This is reflected in various policies and regulations aimed at preserving the environment. In Indonesia, increasing public awareness of environmental issues has also encouraged the emergence of various initiatives, both in the form of social movements and changes in lifestyles that are more environmentally friendly and healthy. The community is now increasingly actively involved in environmental conservation actions as part of a shared responsibility [20]. An approach oriented towards environmental sustainability offers various benefits, ranging from more efficient energy use, reduced greenhouse gas emissions, to the creation of a healthier and more comfortable environment to live in. These efforts not only have a positive impact on nature but also improve the welfare of society as a whole [12].

Transportation is a crucial element supporting the dynamics of community life and developments in the social, political, and mobility sectors. Transportation development goes hand in hand with progress in various other sectors. The availability of adequate road infrastructure is a key factor in driving local economic growth, including the emergence of new businesses within the community. With increasing awareness of the importance of environmental conservation, Indonesia is currently undergoing a major transformation towards an electric-powered transportation system. As part of its efforts to reduce carbon emissions, the government has issued Presidential Regulation No. 55 of 2019, which encourages the accelerated use of battery-based electric vehicles in the country. Transportation activities are also a major factor contributing to air pollution, thus playing a significant role in accelerating global warming. The increasing number of motorized vehicles each year worsens environmental conditions and accelerates ecosystem damage. Environmental problems related to the transportation sector are not new; since the invention of fossil-fueled motorized vehicles, this issue has been a concern [21]. Therefore, development efforts in the transportation sector, both at the national and regional levels, need to be designed with a comprehensive and integrated analytical approach. This approach must be able to see the relationship between transportation and other economic sectors and include consideration of environmental impacts as part of the planning [22].

Previous research has shown that the implementation of innovation in infrastructure development has a significant positive impact on the health, education, and well-being of students. To achieve optimal results, madrasas need to continuously encourage improvements in learning programs, the provision of infrastructure, and forge strong collaborations with various stakeholders outside the institution. Furthermore, conducting regular evaluations and adopting proven best practices are crucial steps to ensure the sustainability and quality of future programs [23].

Environmentally conscious architectural design also prioritizes the principle of harmony with nature, where green open space elements and natural landscapes are an important part of building design. This approach not only creates a calming atmosphere and supports the mental health of residents but also plays a role in reducing air pollution levels, which are often a major problem in urban areas [24]. To achieve energy efficiency in urban residential areas, careful design strategies are required. Some approaches that can be taken include adjusting the direction of the building to maximize natural lighting and air circulation, utilizing passive ventilation systems, and choosing building materials that can effectively inhibit heat transfer. This combination of strategies not only reduces energy consumption but also creates more comfortable and environmentally friendly housing [25].

An integrative and collaborative approach between stakeholders is essential to address these challenges and drive the transition towards a sustainable transportation system in urban areas.

1. Budget Limitations and Development Priorities

One of the biggest obstacles to realizing environmentally friendly transportation infrastructure in urban areas is the limited budgets available to local governments. Limited budgets often lead governments to prioritize building infrastructure for motorized vehicles, such as road widening or flyovers, over investing in public transportation or pedestrian and bicycle facilities. This reflects a development approach that is still short-term in nature and fails to consider long-term environmental impacts and sustainability.

Alhosani et al. (2021) [19] highlighted that public funding allocation in many developing countries is still biased towards developing private vehicle-based transportation systems. This reinforces public dependence on motorized vehicles and slows the transition to a more sustainable transportation system. The lack of budgetary support for mass transit and non-motorized routes results in slow public transportation system development, making it difficult to achieve the goals of reducing carbon emissions, congestion, and air pollution. Therefore, a paradigm shift in budget planning is needed to favor inclusive, efficient, and environmentally friendly transportation development [26].

2. Low Inter-Sectoral Coordination and Fragmented Policies

Sustainable transportation development cannot be optimally implemented without cross-sector collaboration. Synergy between the

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transportation, spatial planning, environmental, and financial sectors is key to creating an integrated and efficient transportation system. Each sector plays a crucial, complementary role, from transportation route planning and zoning to funding and environmental impact management. When this collaboration is harmonious, sustainable transportation can be more easily realized within the context of modern, environmentally conscious urban development.

However, as Xia et al. (2022) [22] noted, weak inter-agency coordination often poses a serious obstacle to achieving this integration. The lack of synchronization between transportation planning and spatial development leads to inefficiencies in land use and the development of transportation infrastructure. This results in overlapping policies and low program effectiveness, leading to budget wastage and a transportation system that is not aligned with community needs. Therefore, a stronger and more sustainable coordination mechanism is needed between agencies to support the achievement of a more holistic and efficient transportation system [22].

3. Changes in Public Behavior and Awareness

Public resistance to shifting modes of transportation is a significant challenge in creating a sustainable transportation system. Many urban residents still prioritize private vehicles, perceived as more convenient, flexible, and a reflection of social status. This perception often leads to public transportation, despite its perceived environmental friendliness. This negative perception is difficult to change without improving the quality of public transportation services and approaches that address public awareness and mindsets.

Al-Ghaili et al., (2022) [23] showed that the low use of environmentally friendly transportation is not only due to a lack of awareness of the negative impacts of fossil-fueled vehicles on the environment, but also due to limited access to alternative modes of transportation. The lack of supporting infrastructure such as bicycle lanes, adequate bus stops, and the availability of comfortable and timely public transportation are inhibiting factors. Therefore, a comprehensive approach is needed that includes public education, infrastructure improvements, and incentives for users of environmentally friendly modes so that changes in community behavior can occur gradually but sustainably [23].

4. Infrastructure and Technology Limitations

In many cities, limited basic infrastructure is a major obstacle to realizing environmentally friendly transportation systems. Essential facilities such as safe bicycle lanes, comfortable sidewalks for pedestrians, and efficiently connected public transportation stations are still not widely available. This lack of infrastructure discourages people from switching from private vehicles to more sustainable transportation alternatives, as they are perceived as less practical and safe.

Kashem et al., (2024) [12] emphasize that although environmentally friendly technologies such as electric vehicles and smart transportation systems continue to develop, their effectiveness will be severely limited without adequate supporting infrastructure. For example, the availability of electric charging stations, integrated ticketing systems for various modes of transportation, and access to real-time information are crucial for the use of these technologies to be truly efficient and attractive to users. Without these elements, the transformation towards a sustainable transportation system will be slow and uneven [12].

5. **Socio-Political and Institutional Factors**
Socio-political factors play a crucial role in supporting the successful transition to sustainable transportation in urban areas. While technological innovation and infrastructure development are crucial components, without consistent, targeted, and long-term policies, these transformation efforts will struggle to achieve optimal results. Political decisiveness and commitment are crucial for the direction and speed of green transportation policy implementation. Without strong support from policymakers, designed programs tend to be reactive, patchwork, and unsustainable. Therefore, visionary leadership and government institutions capable of bridging public interests with environmental needs are needed. Therefore, sustainable transportation becomes not only a technical agenda, but also part of a broader socio-political vision to create inclusive, healthy, and livable cities [27].

Thus, transparency in every stage of public transportation planning and implementation is a crucial element in building public trust and encouraging private sector involvement in the funding and development of environmentally friendly transportation infrastructure. Open information and accountability not only enhance policy legitimacy but also strengthen public participation in supporting sustainability programs. Without strong socio-political support, including commitment from policymakers and public participation, various green transportation initiatives risk stalling due to a lack of legitimacy, budget support, and long-term program sustainability.

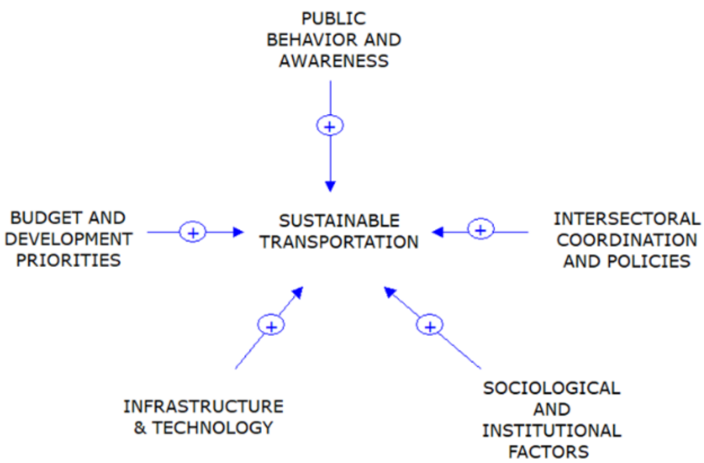


Figure 2. Causal Loop Diagram

The causal loop diagram above can be concluded as follows in figure 2. Based on the causal loop diagram of system dynamics,:

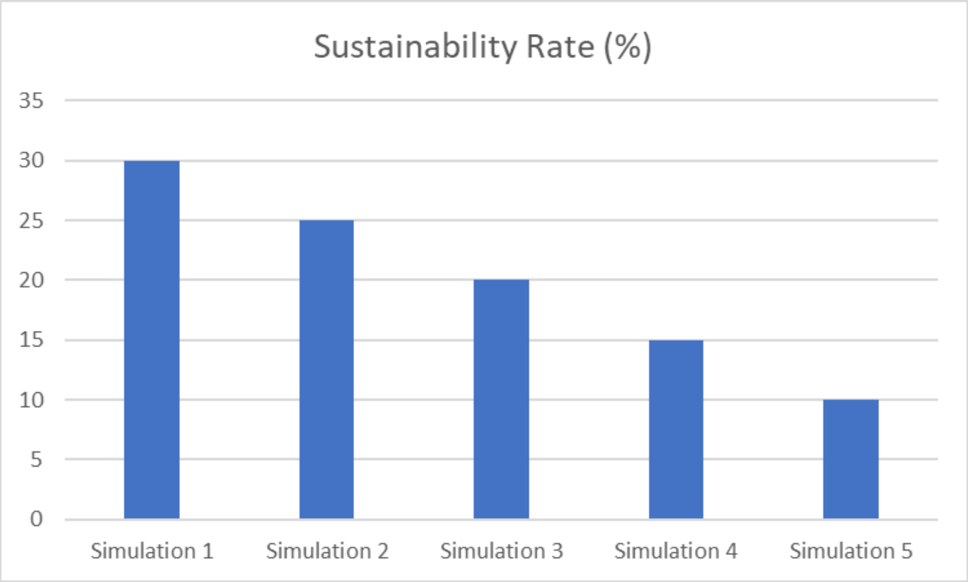
- Budget and development priorities have a direct relationship with sustainable transportation. Therefore, if the government increases budget and development priorities, sustainable transportation will be achieved.
- Infrastructure and technology have a direct relationship with sustainable transportation. Therefore, if the government improves infrastructure and technology, sustainable transportation will be achieved.
- Sociological and institutional factors have a direct relationship with sustainable transportation. Therefore, if the government and society both improve sociological and institutional factors, sustainable transportation will be achieved.
- Intersectoral coordination and policies have a direct relationship with sustainable transportation. Therefore, if the government improves intersectoral coordination and policies, sustainable transportation will be achieved.
- Public behavior and awareness have a direct relationship with sustainable transportation. Therefore, if the community improves public behavior and awareness, sustainable transportation will be achieved. The level of importance of each influencing factor is as follows with a total of 100%:
- Infrastructure and Technology (30%), considered the most important factor because it influences the ease of using sustainable transportation, such as EV charging, bicycle lanes, and integrated transportation modes.
- Intersectoral Coordination and Policies (25%), government policies are considered more influential on transportation sustainability than budgeting, given that all development decisions are made within a non-overlapping policy domain, for example, public transportation subsidy policies.
- Sociopolitical and Institutional Factors (20%), political and institutional stability also significantly influences sustainable transportation issues, as this can influence investors' willingness to invest in the transportation sector. Political turmoil and rampant corruption reduce the sustainability of the transportation sector.
- Budget and Development Priorities (15%), while budgets are necessary for development, if they are not well-targeted for infrastructure and technology, overlapping intersectoral coordination and policies, and sociopolitical instability and institutional factors such as corruption and mismanagement occur, transportation sustainability will be compromised.
- Public Behavior and Awareness (10%), public habits are fundamental factors within individuals who use public transportation, but they are highly dependent on the four factors mentioned above.

Regarding the system dynamics simulation above, three possibilities can be made:

- Simulation 1: Infrastructure and technology are maximized, even though other factors are not supportive
- Simulation 2: Intersectoral coordination and policies are running well, even though other factors are not supportive
- Simulation 3: Sociopolitical and institutional factors are running well, even though other factors are not supportive
- Simulation 4: Budget and development priorities increase but are not channeled and utilized effectively

- Simulation 5: Public behavior and awareness show an increased desire to use public transportation

Figure 3. Sustainability Rate



The results show in figure 3 that simulation 1 shows sustainability up to 30% of 100%, simulation 2 up to 25% of 100%, simulation 3 up to 20% of 100%, simulation 4 up to 15% of 100%, and simulation 5 up to 10% of 100%, thus showing that the factor that must be maximized is infrastructure and technology.

CONCLUSION

Given the various challenges faced, developing environmentally friendly transportation infrastructure in urban areas requires an integrative and collaborative approach across stakeholders. Obstacles such as budget constraints, weak cross-sector coordination, public resistance to mode shifts, limited infrastructure and technology, and complex socio-political factors indicate that solutions cannot be implemented in isolation. With this comprehensive approach, the transition to a sustainable, inclusive, and environmentally friendly transportation system in urban areas can be realized more effectively and sustainably. To strengthen the qualitative data, a system dynamics based on quantitative data is used with simulation 1 showing sustainability up to 30% of 100%, simulation 2 up to 25% of 100%, simulation 3 up to 20% of 100%, simulation 4 up to 15% of 100%, and simulation 5 up to 10% of 100%, thus showing that the factor that must be maximized is infrastructure and technology.

REFERENCES

[1] A. D. Dwipayana and N. L. Darmayanti, "Green Energy Development Strategy Towards Green Logistics: Case Study At PT. Pelabuhan Indonesia III (Persero) Benoa Bali," *Jurnal Manajemen Industri dan Logistik,* vol. 8, no. 1, pp. 81-96, 2024.

[2] A. Kumar, A. Poddar, and A. Nautiyal, "Urban transportation system problems in context of the Indian conditions," in *Belt and Road Webinar Series on Geotechnics, Energy and Environment*: Springer, 2021, pp. 300-314.

[3] I. Jamal, N. P. T. Widanti, I. A. P. S. Widnyani, and S. BIdul, "Kebijakan Transportasi Umum Berbasis Energi Ramah Lingkungan Di Kota Denpasar," *Innovative: Journal Of Social Science Research,* vol. 4, no. 3, pp. 3220-3234, 2024.

[4] M. Borgstede and M. Scholz, "Quantitative and qualitative approaches to generalization and replication–A representationalist view," *Frontiers in psychology,* vol. 12, p. 605191, 2021.

[5] P. Miner, B. M. Smith, A. Jani, G. McNeill, and A. Gathorne-Hardy, "Car harm: A global review of automobility's harm to people and the environment," *Journal of Transport Geography,* vol. 115, p. 103817, 2024.

[6] G. Patil, G. Pode, B. Diouf, and R. Pode, "Sustainable decarbonization of road transport: policies, current status, and challenges of electric vehicles," *Sustainability,* vol. 16, no. 18, p. 8058, 2024.

[7] R. Anastasya and S. B. Putri, "SDGs 7: efektivitas program penggunaan bus listrik guna mendorong transportasi publik ramah lingkungan," *Journal of Environmental Economics and Sustainability,* vol. 1, no. 3, pp. 13-13, 2024.

[8] A. Carteni, V. Marzano, I. Henke, and E. Cascetta, "A cognitive and participative decision-making model for transportation planning under different uncertainty levels," *Transport Policy,* vol. 116, pp. 386-398, 2022.

[9] M. I. Mulia and N. A. Lutpi, "The impact of air pollution from motor vehicles on public health: a comprehensive analysis," *Environmental and Toxicology Management,* vol. 4, no. 2, 2024.

[10] L. Steg, "Limiting climate change requires research on climate action," *Nature Climate Change,* vol. 8, no. 9, pp. 759-761, 2018.

[11] R. M. Sari, E. Nugraha, and A. Nugraha, "Application of Value Chain Strategy to Ensure the Sustainability of Online Transportation Services," 2025.

[12] M. A. Kashem, M. Shamsuddoha, and T. Nasir, "Sustainable transportation solutions for intelligent mobility: a focus on renewable energy and technological advancements for electric vehicles (EVs) and flying cars," *Future Transportation,* vol. 4, no. 3, pp. 874-890, 2024.

[13] S. Ling, S. Jin, H. Wang, Z. Zhang, and Y. Feng, "Transportation infrastructure upgrading and green development efficiency: empirical analysis with double machine learning method," *Journal of Environmental Management,* vol. 358, p. 120922, 2024.

[14] F. Alanazi, "Electric vehicles: benefits, challenges, and potential solutions for widespread adaptation," *Applied sciences,* vol. 13, no. 10, p. 6016, 2023.

[15] D. Burchart, M. Gazda-Grzywacz, P. Grzywacz, P. Burmistrz, and K. Zarębska, "Life cycle assessment of hydrogen production from coal gasification as an alternative transport fuel," *Energies,* vol. 16, no. 1, p. 383, 2022.

[16] N. Ngcobo, O. Akinradewo, and P. Mokoena, "Challenges to sustainable transport infrastructure integration in Johannesburg, South Africa," *Journal of Sustainable Development of Transport and Logistics,* vol. 9, no. 2, pp. 92-108, 2024.

[17] A. M. Selim and D. M. Saeed, "Infrastructure projects for green cities between implementation challenges and efficiency indicators," *transport,* vol. 5, p. 6, 2021.

[18] H. Sabrina, E. D. S. Tarigan, A. M. U. Nasution, and T. Parulian, "Pengaruh Gaya Hidup dan Pengetahuan terhadap Keputusan Pembelian Produk Ramah Lingkungan di Kota Medan," *Juripol (Jurnal Institusi Politeknik Ganesha Medan),* vol. 5, no. 1, pp. 67-77, 2022.

[19] K. M. Alhosani, Y. O. Kaied, and A. S. K. Darwish, "Ajman an environmentally friendly city with its quality of life: review of sustainability challenges and achievements by Ajman Municipality and Planning Department," *Renewable Energy and Environmental Sustainability,* vol. 6, p. 12, 2021.

[20] M. T. Siregar and G. Y. Samodra, "Analysis of Service Delivery Improvement of Manufactured Products with Lean Method Management," *Journal of Management Science & Engineering research,* vol. 3, no. 2, pp. 26-30, 2020.

[21] N. Kalyviotis, C. D. Rogers, M. R. Tight, G. J. Hewings, and H. Doloi, "The environmental value of sustainable transport infrastructure," *RELAND: International Journal of Real Estate & Land Planning,* vol. 1, pp. 42-57, 2018.

[22] A. A. Zuniga-Teran *et al.*, "Challenges of mainstreaming green infrastructure in built environment professions," *Journal of Environmental Planning and Management,* vol. 63, no. 4, pp. 710-732, 2020.

[23] A. M. Al-Ghaili, H. Kasim, H. Aris, and N. M. Al-Hada, "Can electric vehicles be an alternative for traditional fossil-fuel cars with the help of renewable energy sources towards energy sustainability achievement?," *Energy Informatics,* vol. 5, no. Suppl 4, p. 60, 2022.

[24] S. Cho, K. Choi, and Y. Yi, "Proactive and Sustainable Transport Investment Strategies to Balance the Variance of Land Use and House Prices: A Korean Case," *Sustainability,* vol. 14, no. 21, p. 14191, 2022.

[25] Ł. Brzeziński and A. Kolinski, "Challenges of the green transformation of transport in Poland," *Sustainability,* vol. 16, no. 8, p. 3418, 2024.

[26] Y. Bicer and I. Dincer, "Life cycle environmental impact assessments and comparisons of alternative fuels for clean vehicles," *Resources, Conservation and Recycling,* vol. 132, pp. 141-157, 2018.

[27] D. M. Chhetri, K. Wangmo, K. Dechen, S. Choden, and C. Chimi, "Green Urbanism: Adopting Sustainable Transport in Phuntsholing City," *Bhutan Journal of Research and Development,* 2022.

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