



ENHANCING TOURISM ACCESSIBILITY IN BATAM CITY THROUGH SMART SUSPENDED MONORAIL ROUTE MODELLING

Livvy Rinoa¹, Hendro Murtiono², Stivani Ayuning Suwarlan^{3*}, Andri Irfan Rifai⁴

Department of Architecture, Universitas Internasional Batam^{1,2,3,4}

Department of Civil Engineering, Universitas Internasional Batam²

E-mail: ¹livvyrinoa1.2019@gmail.com, ²hendro.murtiono@uib.edu, ³stivani@uib.ac.id, ⁴andrirfan@yahoo.com

Informasi Naskah:

Diterima:

14 September 2025

Direvisi:

16 Oktober 2025

Disetujui terbit:

5 November 2025

Diterbitkan:

Cetak:

29 Desember 2025

Online

29 Desember 2025

Abstract: The transportation fulfils as the support of human activity and is the leading factor for economy as well as tourism development. Batam City, positioned strategically close to Singapore and Malaysia, is confronted with severe problems in urban mobility after experiencing a rapid rise in population and the inflow of international tourists. The low capacity of Trans Batam and infrastructure development stagnation have restricted tourism access, calling for urgent new and sustainable solutions for transportation. In this research, an integrated suspended monorail route in the framework of the Smart City will be designed to enhance tourism connectivity and sustainable urban mobility in this regard. It is a qualitative approach, including interviews with stakeholders, observation on the field and survey of 400 tourists, both domestic and international. Thematic analysis based on GIS spatial mapping was utilized to analyze accessibility gaps and to develop strategic routes. The results indicate that there is a strong support from public and institutional to introduce a technology-based monorail system that will connect Nongsa-Batam Center-Harbour Bay as the main tourism nodes. Its potential integration with Intelligent Transportation Systems (ITS) and Smart Tourism concepts further emphasizes its importance in improving efficiency, equity, and the experience of the visitors. This paper makes conceptual contributions by linking spatial-qualitative methods and smart transport design in the context of mid-sized cities in Southeast Asia, and offers practical policy implications for tourism-based sustainable mobility innovation in Batam.

Keyword: intelligent transportation systems; smart city; smart mobility; suspended monorail; tourism accessibility

Abstrak: Transportasi berfungsi sebagai penopang aktivitas manusia dan merupakan faktor utama bagi perekonomian serta pengembangan pariwisata. Kota Batam, yang secara strategis berdekatan dengan Singapura dan Malaysia, dihadapkan pada masalah serius dalam mobilitas perkotaan setelah mengalami peningkatan pesat populasi dan arus masuk wisatawan internasional. Rendahnya kapasitas Trans Batam dan stagnasi pembangunan infrastruktur telah membatasi akses pariwisata, sehingga membutuhkan solusi baru dan berkelanjutan yang mendesak untuk transportasi. Dalam penelitian ini, rute monorel gantung terintegrasi dalam kerangka Kota Cerdas akan dirancang untuk meningkatkan konektivitas pariwisata dan mobilitas perkotaan berkelanjutan. Pendekatan yang digunakan adalah kualitatif, meliputi wawancara dengan para pemangku kepentingan, observasi lapangan, dan survei terhadap 400 wisatawan, baik domestik maupun internasional. Analisis tematik berdasarkan pemetaan spasial SIG digunakan untuk menganalisis kesenjangan aksesibilitas dan mengembangkan rute strategis. Hasil penelitian menunjukkan adanya dukungan kuat dari publik dan lembaga untuk memperkenalkan sistem monorel berbasis teknologi yang akan menghubungkan Nongsa-Batam Center-Harbour Bay sebagai simpul pariwisata utama. Potensi integrasinya dengan Sistem Transportasi Cerdas (ITS) dan konsep Pariwisata Cerdas semakin menekankan pentingnya dalam meningkatkan efisiensi, kesetaraan, dan pengalaman pengunjung. Makalah ini memberikan kontribusi konseptual dengan menghubungkan metode spasial-kualitatif dan desain transportasi cerdas dalam konteks kota-kota menengah di Asia Tenggara, dan menawarkan implikasi kebijakan praktis bagi inovasi mobilitas berkelanjutan berbasis pariwisata di Batam.

Kata Kunci: aksesibilitas pariwisata; kota cerdas; mobilitas cerdas; monorel gantung; sistem transportasi cerdas.

INTRODUCTION

Transportation is one of the most important parts of human life since it connects people and things and makes all social, economic, and cultural activities

possible. Schorn et al. (2021) stress that transportation includes facilities, flows, and control systems that make it easy for people to move from one place to another at any time. Without enough

transportation infrastructure, people would have a lot of trouble doing their everyday tasks (Zhang & Cheng, 2023). Transportation is seen as a driver of regional growth and economic development (Cascetta & Henke, 2023; Y. Zhang & Cheng, 2023), in addition to the rising need for both domestic and international mobility. This circumstance is especially important for Batam City, which is a strategic city in the Riau Islands that is close to Singapore and Malaysia. As a result, Batam's population has expanded a lot because of how quickly the city has grown. The official population was about 1,196,396 in 2020 (BPS, 2023). This area also helps tourism grow by bringing in a regular stream of visitors from all over the world. Batam has a lot of potential to be one of the top destinations to visit in Southeast Asia since it has superb gastronomy, marine tourism, and shopping malls.

According to One Data Kota Batam, many visitors from various countries have visited Batam in the last two years. There were 565,936 visitors from foreign nations in 2022. The number of visits went up to 1,190,765 in 2023, which is nearly four times as much (Satu Data, 2024). It seems that not a lot of passengers are utilizing Trans Batam's e-ticketing system, which is strange. At that time, just 128,131 people utilized this government-run BRT. So, it's not the most popular option for visitors or residents yet. Batam's city roadways only went 168 km in 2024. As of 2022, there are still 176 main Trans Batam lines and 67 branch lines. This shows that service coverage is still poor, even if the need for mobility is expanding. The number of tourist transportation fleets has likewise been the same at 339 since 2022, which is not enough to meet the needs of tourists who wish to go around (Satudata, 2024). People want to move around more because Batam's public transportation system hasn't kept up with the growing population and the rise in tourist arrivals. This is shown by the fact that Trans Batam isn't being used very much and that both routes and road infrastructure development haven't progressed.

Batam needs new means to get around that are not only easier for tourists to use, but also satisfy the standards for being environmentally friendly and efficient. The Smart City framework is a suitable choice since it employs digital technology and data-driven methodologies to make city transportation systems that are smart, safe, and good for the environment (Zhao et al., 2021). A suspended monorail system is one such proposal. The best thing about them is that they don't block traffic and give tourists a great view of the city from above. Smart City technology lets you see the suspended monorail in real time, make automatic changes, and make timetables work better. All of these characteristics make passengers feel safer and more at ease (Ahmed & Monem, 2020; Rudneva, 2022). The system might help with traffic, make it easier to get to important places, and make travel more modern and memorable.

Smart City, Intelligent Transportation Systems (ITS), monorail, and Smart Tourism are the four key themes

that this research is based on. Smart City is a means to use technology, people, and social capital to make cities better and more competitive (Al-Tit et al., 2022; Soeiro, 2020). Six important aspects make up this idea: smart people, smart government, smart economy, smart transportation, smart environment, and smart way of life. Second, ITS combines information and telecommunications technology to make transportation more efficient by using Advanced Traffic Management Systems, Advanced Traveler Information Systems, and Advanced Vehicle Control Systems (Dia, 2023; Duan, 2023). Third, the monorail, especially the suspended type, is important because it saves space and works well with city planning when there isn't much land available (Adhvaryu & Mudhol, 2022; Zhuang et al., 2022). Fourth, Smart Tourism stresses the use of ICT to make smart destinations, experiences, and business ecosystems that are informational, easy to go to, interactive, and personalized (Goo et al., 2022; Jeong & Shin, 2020; Sustacha et al., 2023). Geographic Information Systems (GIS) also help with spatial-qualitative analysis for planning the best routes for a monorail (Schulze, 2021).

This study's originality is in the amalgamation of a spatial-qualitative methodology with intelligent transportation design, situated within a mid-sized tourism city in Southeast Asia, notably Batam. This research integrates GIS-based spatial analysis, smart city technologies (including Intelligent Transportation Systems, real-time e-ticketing, and data-driven route planning), and tourist perspectives derived from surveys and interviews, distinguishing it from prior studies that concentrated on transportation mode adaptability (Liu et al., 2021), theoretical frameworks of tourist mobility practices (Mertena & Kaaristo, 2024), or the technical dimensions of monorail engineering (H. Zhang et al., 2025). The invention is to propose an intelligent suspended monorail system that can be used for both transportation and to improve the urban tourist ecosystem in Batam in a manner that is open to everyone, flexible, and long-lasting.

This project seeks to make it easier for tourists to go to Batam City's attractions by adding integrated suspended monorail tracks to the Smart City framework. The major goal is to use spatial-qualitative research to determine the best ways to get between three famous tourist spots: Nongsa, Batam Center, and Harbour Bay. This study analyzes stakeholder views, visitor travel behavior, and suburban metropolitan scope. The main aims of the study are to (1) define a theoretical framework combining suspended monorail technology with Smart Tourism and Intelligent Transportation Systems (ITS) concepts, which are related to tourism and transport systems, (2) evaluate the concept by engaging with various stakeholders and analyzing levels of visitor satisfaction, (3) generate a route optimization model that minimizes disruptions to city life and assists tourists' movement and (4) define implementation procedures considering the local government's capacity and willingness of introducing

new technology. The paper addresses a gap in the literature in terms of discussing applications of the suspended monorail for smart tourism in the context of land-scarce island nations in Southeast Asia. It also provides helpful pointers on how to develop transit systems that are green and bring more tourists, which is great for the local economy.

METHODS

Research Design

This research applies qualitative approach to investigate overall accessibility to Batam City for tourists by using the curved suspension monorail line which is part of a smart city based public transit system. This approach considers the social, spatial, and organizational dimensions that are hard to quantitate. As Batam city developing, there are still many things that will affect the performance of smart transportation system. Some of them when look from community perspective, how well the regulation work on them, how prepared the infrastructure are, and what do the visitor needs.

Consequently, narrative data and firsthand field experiences were deemed important and subjected to theme analysis. This research used data triangulation as its principal approach to augment validity and analytical precision. Triangulation allowed the researcher to analyze the phenomena from many viewpoints and data sources, therefore reducing interpretive bias and enhancing the reliability of the results. This research used technologies such as ArcGIS and Google Maps, utilized only as aids for geographical visualization rather than as key instruments for quantitative analysis.

Research Object and Data

The study focused on vital sectors in Batam City that formed integral parts of the city's transportation and tourist infrastructures and might possibly be interconnected by a smart city-oriented monorail system.

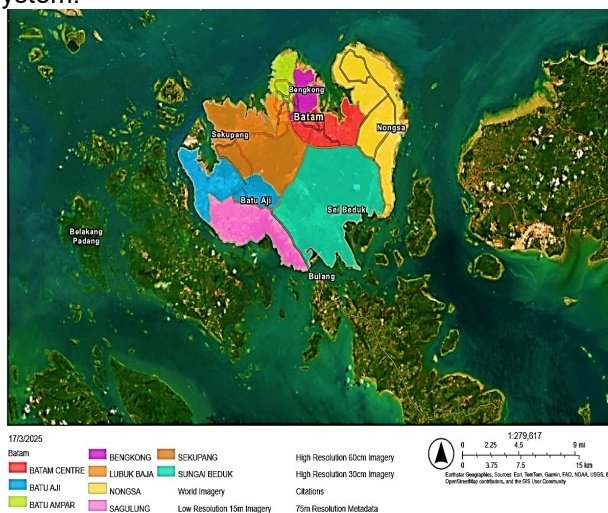


Figure 1. Map of districts classification in Batam City. Nongsa, which located in the northeast of Batam, quickly became a digital and elite tourist destination because of the Nongsa Digital Park and other international resorts. Batam Center was another

well-known site. It was the main economic and government hub of the city and connected other parts of the city. It had a ferry terminal for going to other countries and offices for the government. The final destination was Harbour Bay, an international port that many visitors from other countries used to enter into the country. There were plenty of lodging options and activities nearby. It chose these locations because they are all linked and because accessing them is difficult due to the current state of public transit. Jodoh, Nagoya and Hang Nadim International Airport were among the other key transport nodes examined to identify any further opportunities to integrate different modes of transport.

Research Data Sources

This study employed a full-fledged mixed method design, utilizing primary and secondary data, to analyze at what levels of ease of navigation in Batam and practice of smart city mobility. Primary data were collected through three interrelated components: Key stakeholders at several levels of government, the tourism sector and other were interviewed in depth, revealing insights into transportation policies, the level of access, and institutional willingness to reinvest in a long-suspended monorail system. It went through rigorous fieldwork at such major transit hubs like Batam Center, Harbour Bay, Nongsa as well as other tourist spots around. People weren't happy with the roads, the traffic, or how easy it was to get there.

It surveyed tourists from the country as well as around the world on their current mobility habits and preferences in smart mobility. The sampling was done by stratified random sampling method with proportionate representation. This is in line with the demographic of Batam tourism 2024, that proved out 35% of the tourists are from overseas and 65% from the region. Slovin's formula determined that the minimum required sample would be 400 participants of whom 140 were international and 260 were US. The total attendance was 1,326,839. The reliability of the obtained data was assured and was expected to establish solid analytical foundations.

Research Instruments

This research used three distinct data collection approaches to conduct a comprehensive evaluation of Batam's accessibility and the viability of a suspended monorail system. Triangulation methods were used to make the qualitative approach more valid. Nagoya, Jodoh, Batam Center, Harbour Bay Ferry Terminal, Nongsa resorts, and Hang Nadim International Airport were all areas where detailed field observations were performed. The major purpose of these observations was to look at the current state of roads, walkways, public transit, traffic flow, and other spatial features that might impact the path of the future monorail.

The observational technique looked at factors like how simple or hard it is to use, the likelihood of setting up a suspended monorail, and regional data that backs up the ideals behind smart city design. The questionnaires were sent out on purpose to

persons who resided in the region, people who were coming from other countries, and US tourists. This was done to find out how people utilize public transportation currently and what they expect from smart city systems in the future. For a long time, this organization spoke about critical topics with people in the local government and other people who needed to know about them. These included money, policy direction, institutional and physical preparation, problems with execution, and the predicted social and economic impacts of developing a monorail.

Data Analysis and Validity Techniques

Braun & Clarke's (2006, 2019) analytical framework was used in this study to conduct a theme-based analysis. The framework was well-suited to address the research question about how civil servants in a smart city facilitated transit through transit accessibility, while also examining stakeholder perspectives and the application of smart city technology. The narrative method enables the researchers to identify and analyse centralized meaning patterns within a variety of qualitative data in a systematic manner. This was especially good for qualitative research – interviews, observations, and surveys – in a world where there is no such thing as a right or wrong answer. To make sure that the analysis of the data was conducted in a systematic and organised way, six steps were followed: A number of people read and re-read the transcriptions of the interviews, the field notes and the responses to the questionnaires on several occasions in order to become familiar of with the data. Individuals applied concepts such as "poor access" and "need for frequent service" to identify and categorize relevant data segments for the initial coding process. Transportation inequality in tourist areas was one of the codes where many people voted in the second coding. To ensure the initial themes were fruitful, coherent, and aware, all could be compared to the complete datasets from the previous coding to make the themes from the next round, sure sure of the whole datasets. In the subtype 4 coding, the participants gave each issue a concise and representative label that summarized the whole issue, such as "institutional readiness." Finally, in the fifth coding, the participants crafted narratives based on the themes which align with the objectives and research questions of the study. The narratives constituted the core chapters of results and discussion. It told us how these themes related and what they told us about Batam's development as a smart city. Multiple methods were employed in this study to ensure the accuracy and reliability of the surveys, interviews and field observations. The decisions were taken in order to assist Batam City in its aim of establishing a suspended monorail track which would cater for smart cities. Both content and construct validity were applied for testing the validity of the questionnaire. These methods explored attitudes toward improving transportation, with particular attention to the need for a suspended monorail.

Transportation and smart city planning experts commented that the was a very well worded question as it addressed numerous relevant factors including accessibility, convenience, transit efficiency, and environmental sustainability. It simply verified the truth of the notion by conducting small-group pilot tests. Next, it performed a correlational analysis on the items to assess genuine concerns for ideas surrounding a smart city-related monorail system. The Transportation Office of Batam City, Bappeda, and a tourism company also avidly consumed the interviews. They sent summaries of the interviews to the people who responded to the questions to verify the accuracy of the answers. That was a method to discover if a person was a member.—Experts and professionals in transportation convened to discuss about the research to ensure that the findings would help in the development of the monorail system. Using data triangulation, observational validation looked at what was seen in the field and compared it to what was discovered in secondary data and interviews. It also employed dense description techniques to completely record patterns of movement, traffic jams, and impediments to entrance. This made it feasible to build an extremely precise suspended monorail track.

RESULTS AND DISCUSSION

Summary of Triangulated Data

The goal is to figure out what the needs, possibilities, and direction are for building a suspended monorail system that might be used for smart city transportation and smart tourism. These results are the basis for coming up with the first strategic plan for building a suspended monorail in Batam. Field observations in Batam City were conducted on weekdays and weekends. In addition to the observation, surveys were given out to communities made up of both local and foreign tourists. To identify pertinent factors for this study, semi-structured interviews were performed with relevant officials from BP Batam. Table 1 shows the results of triangulation from the three data sources:

Table 1. Summary of triangulated data

Variable	Key Interview Outcomes	Questionnaire Results	Observational Findings	Preliminary Conclusion
Transportation Condition	Fragmented, lacks tourism connectivity	70.6% consider inadequate	Minimal mass transport, dominance of private vehicles	New mode needed to connect strategic points
Monorail Potential	Efficient and modern solution	>80% support tech-based monorail	Dense areas not directly connected	Suspended monorail is relevant and favored
Smart City & ITS	Requires digital systems and monitoring	82.4% agree on e-ticketing, digital dashboard	No integrated public transport info system	ITS integration is mandatory for monorail planning
Smart Tourism	Monorail supports remote tourism areas	High support for tourism connectivity	Ports and airports not connected to destinations	Monorail will strengthen smart tourism ecosystem
Public Perception	Strong support for modern transpor	98% support construction	Social support seen in congestion and demand	Strong public support drives policy
Strategic Route	Nongsa – Batam Center – Harbour Bay	Main and busy tourist corridor	Dense areas not yet connected	This route is ideal as initial implementation stage

Analysis of Triangulated Results

Transportation conditions and needs for new mode

Transportation in Batam City has major problems with connection and multimodal integration, especially to important tourist sites. Interviews with BP Batam personnel show that the current transportation infrastructure is still broken and doesn't work well for connecting tourists. There are public transportation options like Trans Batam buses, although they don't go to all the important tourist spots, such as Nongsa and Harbour Bay. This is backed up by survey data that shows that 70.6% of respondents think that the current public transportation system is not good enough for either tourists or residents. Field observations also show that private cars are the main way to go around, with few possibilities for public transportation. This reliance could worsen traffic and carbon emissions unless there is reliable public transportation to make up for it. Pitakaso et al. (2024) said that Southeast Asian tourist cities are under the same kind of pressure because they don't have ecologically friendly and integrated transportation systems. Based on all the data sources, Batam needs a new way to get about right away to fix its connectivity problems. The suspended monorail is seen to be a good option since it can go through busy city areas without taking up space on existing roads (Chalermpong et al., 2025). This mode not only serves the needs of people who want to get around, but it also fits with the goals of smart city tourism development that is both inclusive and long-lasting.

Potential for suspended monorail development in Batam

Triangulated findings indicate significant potential for the development of a suspended monorail as an innovative transportation solution in Batam. Interviews with BP Batam and its Transportation Agency reveal that the monorail is a good solution to make connections better without making the already busy roads worse. Batam's land is mostly used for residences, companies, and tourism, therefore its technology doesn't need regular ground-level corridors. The answers to the questionnaire suggest that more than 80% of the people who answered want to create a technology-based monorail. This illustrates that people are willing to try new ways to get around that promise comfort, safety, and time savings. Public acceptance is essential (Mariani et al., 2024) since major infrastructure development projects need to be socially acceptable in order to be carried out successfully.

On the other hand, field studies have shown that several high-activity areas, such as ports, airports, office buildings, and tourist destinations, do not have direct linkages to public transportation. It's tougher to go about the city when there aren't any good connections. This implies that more individuals are driving their own automobiles, which slows down transport. Guo (2024) says that cities that are developing swiftly need to make sure they have a decent means to go about. A technology-based

public transit system is one example of this. It's the main method that cities speak to one other. Considering all of this, the suspended monorail is a great option for Batam's current and future demands. It is possible from a technical point of view, beneficial in real life, and has a lot of popular support. Also, employing it is in line with the long-term objectives for smart city development, which place advances in technology, efficiency, and sustainability at the top of the list.

Integration of Smart City, ITS and Smart Tourism Concepts

Smart City ideas need to be a component of the suspended monorail, especially via smart tourism frameworks and Intelligent Transportation Systems (ITS). Interviews with BP Batam employees show that there are no digital solutions that can keep an eye on information and transport it at the same time. This shows how important it is for ITS to make sure that transportation management is based on data, is open, and performs properly. 82.4% of the participants who took the study also indicated that transportation should adopt e-tickets, digital dashboards, and IoT-based monitoring systems. People expect the new technology to help passengers, clarify fares and simplify doing business. Chavhan & Venkataram (2020) stated that the application of ITS in public transit can enable people to arrive at their destinations faster, leading to more accurate timetables.

Field study results indicate that by and large there was little public transport technology such as digital signage, booking apps and timetables. This is confusing tourists from US and foreigners to go around. These issues are quite significant in smart tourism since travelers enjoy a better experience when they could easily obtain information and move (Chowdhury et al., 2016; Hien & Trang, 2024). The addition of modern transportation options such as an elevated monorail to a Smart City will create a web of connections that will boost the economy and society as a whole. Many people like tourists, investors want to see Batam City. The territory needs to capitalize on these opportunities to develop fresh tourist-friendly ways to get about that will make it more competitive. Improved smart public transport will contribute to a more robust smart tourism ecosystem, make tourists happier, and keep them longer.

Strategic route analysis: Nongsa – Batam Center – Harbour Bay

The goal of the suspended monorail in Batam City is to connect the three major areas of the city: Batam Center, Nongsa, and Harbour Bay. After talking to stakeholders, holding public surveys, and seeing things in the field, people made our choice about the route. All of these sources say that people need a modern, efficient, and connected public transportation system shortly. This method highlights how vital it is to incorporate both types of data when making judgments about policy based on facts.

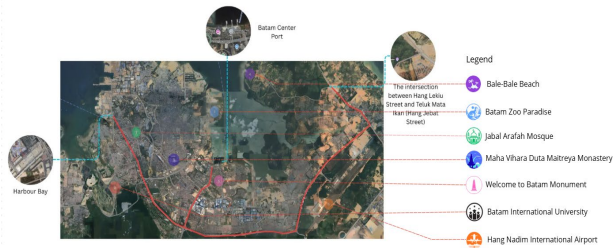


Figure 2 Preliminary route overview of the suspended monorail

Source: Google Earth, 2025 with Author's modification
 The line makes a triangular mobility structure that connects three primary urban functions: technology and innovation (Nongsa), government and commerce (Batam Center), and tourism and ports (Harbour Bay). Each node has its own strategic traits and duties, but they all work together to make cities more connected and digitally advanced. The Nongsa area in the northeast is quickly becoming a center for the digital economy and high-end rural tourism. Nongsa Digital Park has made the area a magnet for foreign investment, tech enterprises, and digital workers. But getting to this location is still hard, since you have to use private cars or ride-hailing services that aren't always reliable or available to everyone. Building a monorail will make it easier for digital professionals, creative industry personnel, and high-end tourists to get about by linking the city core directly and on a schedule to Nongsa. This will also help eastern and central Batam flourish in a fair way, close the gap between regions, and open up new business prospects along the corridor.

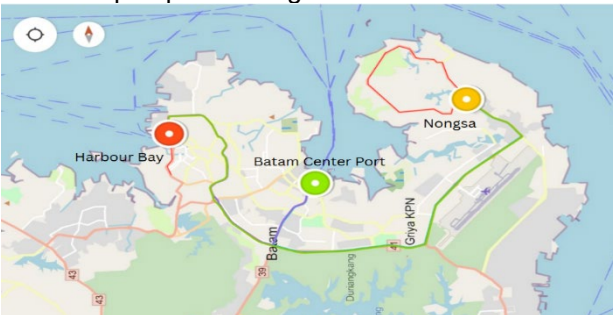


Figure 3. Route overview of the suspended monorail
 Source: Authors, independently mapped using ArcGIS Field Maps, 2025

Batam Center is the key transit and activity distribution hub since it is the administrative, business, and international port hub. There are several ways to go to and from this area, both inside the country and outside of it. For example, there are ferry connections to Singapore and Malaysia. Sadly, the connection between cities is still not great. The monorail route that connects Batam Center and Nongsa will not only make travel more efficient, but it will also increase functional connectivity between important urban nodes. This route will speed up the flow of commuters and tourists while also developing important transit-oriented development (TOD) zones at station sites.

Batam Center is the key transit and activity distribution hub since it is the administrative, business, and international port hub. There are several ways to go to and from this area, both inside

the country and outside of it. For example, there are ferry connections to Singapore and Malaysia. Sadly, the connection between cities is still not great. The monorail route that connects Batam Center and Nongsa will not only make travel more efficient, but it will also increase functional connectivity between important urban nodes. This route will speed up the flow of commuters and tourists while also developing important transit-oriented development (TOD) zones at station sites.

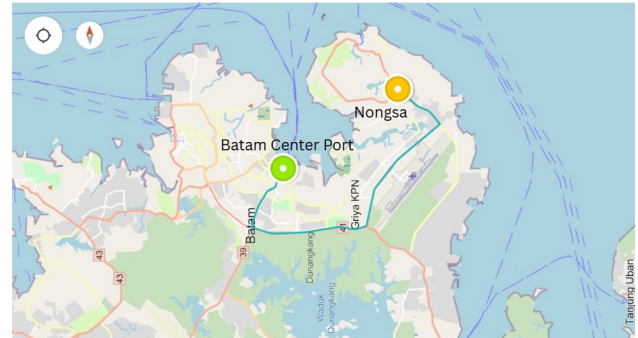


Figure 4. Suspended monorail route from Batam Center to Nongsa

Source: Authors, independently mapped using ArcGIS Field Maps, 2025

Harbour Bay is the principal entry point for international tourists on the city's western side. It is also the center for hospitality, entertainment, and port activity. Right now, there aren't many direct links between Harbour Bay and Nongsa or Batam Center. Because of this, it still takes a long time and costs a lot of money to get from one of these places to another.

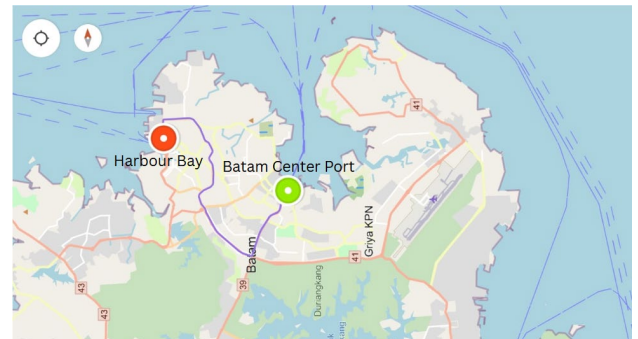


Figure 5. Suspended monorail route from Batam Center to Harbour Bay

Source: Authors, independently mapped using ArcGIS Field Maps, 2025

In this case, the Harbour Bay to Batam Center route provides an important link between two major urban areas: the international port and the city's business and government center. Harbour Bay is the principal entry point for international tourists, especially those coming from Singapore on high-speed ferries. Batam Center, on the other hand, is the center of government, business, and transportation activity. It has connections to both domestic and regional transit systems. But the direct connection between these two locations is still not very good. It presently takes a long time to travel between the nodes, depending on traffic and the availability of land transport options. This makes it harder for both tourists and commuters to get about. A suspended monorail system might greatly increase the flow of

people between Harbour Bay and Batam Center. A regular and reliable transportation system will make it easier for people who live and work in the area, as well as tourists, to get around. Also, strategically placing stations along this route will assist establish integrated TOD zones, which would lead to new urban areas that are both useful and easy to use. The road from Harbour Bay to Nongsa connects the international harbor to the city's digital economy and exclusive resort area in the northeast. At the moment, there isn't a direct and quick connection along this corridor, which means that travel times are long and often go through Batam Center or important roads like Hang Jebat and Hang Lekiu Streets. This makes it challenging to make sure that people from other countries can quickly travel to the best resorts or digital infrastructure facilities in Nongsa Digital Park. Also, the fact that people use private automobiles or ride-hailing services right now makes travel less efficient and worse for the environment. A monorail line that goes directly from Harbour Bay to Nongsa will make it feasible to have a rapid, scheduled, and long-lasting connection. For instance, tourists from Singapore could quickly get to the Nongsa region for work or leisure. This is in line with Batam's vision of becoming a smart city and a center for digital business in the area.

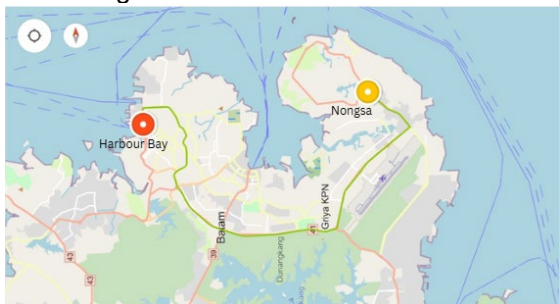


Figure 6 Suspended monorail route from Harbour Bay to Nongsa

Source: Authors, independently mapped using ArcGIS Field Maps, 2025

This route will assist the business along the corridor flourish and promote the ideas of smart mobility as part of the bigger picture of smart cities. The development of this route is about more than just making it easier to move from one point to another. It also fits with the notions of smart mobility in smart city concepts, which use technology to develop transportation systems that are adaptable, survive a long time, and are open to everyone. Also, using new technologies and a transit system that connects people will make going about the city faster and more modern. The suspended monorail system, which is built above ground, offers additional benefits as well, such as needing less area to build on. This makes it great for regions with a lot of people, like Batam. This technology also lets vehicles run more quietly and in a way that is better for the environment than other ways of getting about.

According to a public study, more than 90% of those who answered support this route for both tourists and people who live here and go to school or work there every day. The fact that so many people in Batam

support this shows that they are ready and willing to convert to a new transportation system that is better for the environment and works better. The Nongsa–Batam Center–Harbour Bay corridor is likely to have a substantial impact on the economy. Micro, small, and medium-sized businesses (MSMEs) will do better with the coming of mass transportation. Property prices along the route will go up, and new jobs will be created in tourism, transportation, and services. Batam wants to be a major city in Southeast Asia in the future, with strong infrastructure, a good quality of life, and a commitment to conserving the environment. This fits with that aim.

Integration of suspended monorail route with Trans Batam network: Jodoh-Batam Center-Nongsa Corridor

Based on a complete triangulation of interviews, surveys, and field observations, the alignment of the suspended monorail route in Batam demands rigorous consideration of the existing transportation networks, especially the Trans Batam bus corridors. The Jodoh–Batam Center–Nongsa corridor is a good area for monorail construction since there is a lot of activity there, it is hard to get to, and it may be connected to other forms of transit.

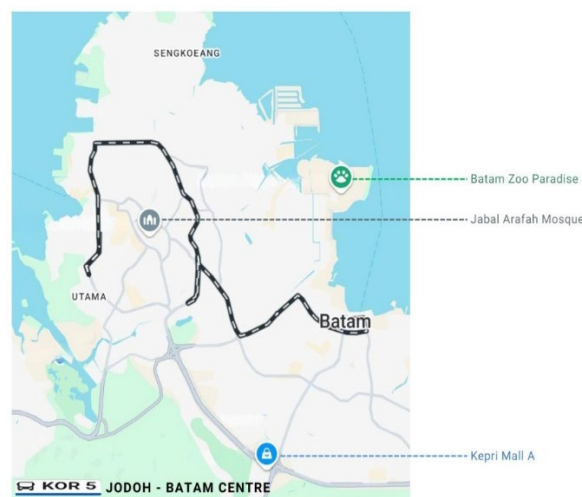


Figure 7. Trans Batam route Corridor 5 (Jodoh–Batam Center)

Source: Moovit, 2025

Corridor 5 (Jodoh–Batam Center) has a lot of challenges for building a monorail. This is mostly because the current Trans Batam route uses side roads that are narrow, curving, and prone to traffic jams and physical barriers. Because of these things, it's challenging to establish normal monorail infrastructure on the ground. The monorail line is supposed to be different from the current bus route by using main highways that have more room for cars to pass and fewer things in the way, as near the Kepri Mall crossroads. This proposed detour will make it simpler and quicker to build the monorail infrastructure while doing as little harm as possible to the road construction that is now going on. This design also links Punggur Port to Jodoh (Corridor 8) via Trans Batam lines, which makes it easy for passengers to move between various modes of transportation. Batam's smart city plan intends to

make public transportation simple to use and healthy for the environment.

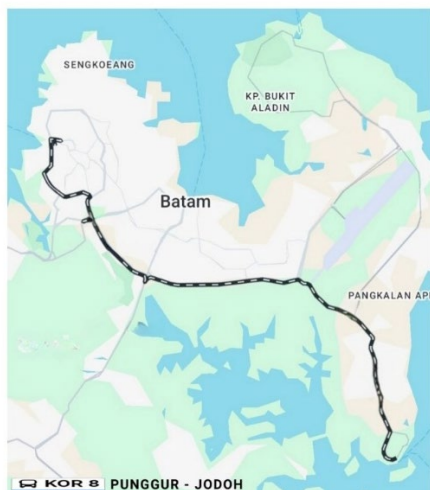


Figure 8. Trans Batam route Corridor 8 (Punggur–Jodoh)
Source: Moovit, 2025

At first, Corridor 7 (Batam Center–Nongsa) was in line with the Trans Batam lines that go across both important roadways and residential areas. The alignment approach was changed to just look at major roads like Ahmad Yani and Hang Tuah Streets because the monorail was put on hold. This is because these roads offer enough room for automobiles to pass and don't irritate the people who live nearby too much. This choice was made to stay away from small residential streets that are hard to construct on, hard to fit into, and not socially acceptable. A monorail can be an elevated system that doesn't go in the way of traffic on the ground and doesn't need to buy difficult property in busy areas. This is possible because the tracks are wide enough to hold a lot of weight. It's easy to get to important tourist spots, industrial areas, Nongsa Digital Park, and other important city functions like Hang Nadim International Airport now that the roads are better aligned. It also fits with Batam's larger vision of smart, sustainable urban mobility, which includes new trans portation technology that works well with city life and makes the most of space.



Figure 9. Trans Batam route Corridor 7 (Batam Center–Nongsa)
Source: Moovit, 2025
Triangulating interview data, community surveys, and field observations indicates substantial

requirements and backing for the suspended monorail development in Batam City. The technology works well with Batam's urban setting and goal of becoming a smart city. It gives people long-lasting means to connect and brings tourists together. The best area to start implementing is the prioritized route that connects Nongsa, Batam Center, and Harbour Bay since it fits all three needs: strategic, economic, and social. The system will work better and users would have a better time if it is combined with ITS and smart tourism frameworks. The initiative is more likely to function since it follows best practices for smart cities all across the globe and could operate with digital infrastructure. For an urban transportation system to succeed and be ready for the future, it requires input from the public, environmental objectives, and collaboration amongst diverse groups.

Limitation and Future Research

This study is quite detailed, however it has a lot of issues. First, although while qualitative data like interviews and open-ended surveys might provide you a lot of information, they can also be biased and subjective when it comes to theme analysis. The research primarily looked at important nodes like Nongsa, Batam Center, and Harbour Bay, therefore it didn't look at the problems that come up when trying to go to rural or expanding tourist areas. The assessment of technological feasibility did not include real-time simulation modeling. This may have demonstrated how well the monorail would perform in operation. The analysis investigated individual attitudes but did not apply quantitative information to measure the economic performance or the environmental alterations. These two features are very inytergral in raising capital and starting up infrastructural work.

For the viability of the suspended monorail system in other locations, further category should investigate more farther points such as Sekupang or Batu Ampar. In future, it may be good to study on route optimization by simulation-based methods including agent-base modeling or traffic flow simulations using GIS. They have also to do a comprehensive social, economic, environmental cost benefit analysis in order to make sensible decisions about investment. It may also facilitate the realization of these ideas more easily in order to learn more about how to get people engaged, prepare institutions, and public-private partnerships work. To observe the efficacy of the system once it is operational, it must consider such things as the availability of multiple routes, user satisfaction, and traffic variability over time.

CONCLUSION

The findings of the study indicate that the government of Batam City needs to seek innovative solutions for cluster connectivity problems that ever come up, simplifying tourists mobility as well as the promotion of sustainable development. The proposed suspended monorail system would be integrated into the smart city concept to address the problem of disjointed transportation. Also, it would

give Batam a better lure for Southeast Asian tourists. The city seeks to build futuristic, livable and green buildings in future. This is possible due to the smart transportation systems and digital integration. This study is significant for integrating smart city and smart tourism frameworks with spatial-qualitative analysis, suggesting a smart transport system that is technically feasible and sufficiently adaptable to the island-based urban context of Batam. There is considerable public enthusiasm and potential for the approach, but its narrow physical scope and reliance on qualitative triangulation create methodological challenges that require further inquiry. To demonstrate that everything can be scaled up then future work should include cost-benefit analysis, assessments of impact on environment, and modeling based on simulations. It also has to grow geographically to encompass places that are far away. The city is going to have to do a more thorough evaluation of how ready the institutions are to establish a public-private partnership for this. This study offers a theoretical and practical lens that acknowledges both the advantages and challenges of urban mobility for researchers, stakeholders, and decision-makers who wish to contribute to inclusive, sustainable, and smart urban transportation in the city of Batam, as well as other cities in Southeast Asia.

ACKNOWLEDGMENT

The authors would like to thank the Research and Community Service Institute of Universitas Internasional Batam (LPPM UIB) for giving them money to help with this project.

REFERENCES

- Adhvaryu, B., & Mudhol, S. S. (2022). Visualising public transport accessibility to inform urban planning policy in Hubli-Dharwad, India. *GeoJournal*, 87(4), 485–509. <https://doi.org/10.1007/s10708-021-10548-6>
- Ahmed, M. M. A. W., & Monem, N. A. El. (2020). Sustainable and green transportation for better quality of life case study greater Cairo – Egypt. *HBRC Journal*, 16(1), 17–37. <https://doi.org/10.1080/16874048.2020.1719340>
- Al-Tit, A. A., Al-Ayed, S., Alhammadi, A., Hunitie, M., Alsarayreh, A., & Albassam, W. (2022). The impact of employee development practices on human capital and social capital: The mediating contribution of knowledge management. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(4), 218. <https://doi.org/10.3390/joitmc8040218>
- BPS. (2023). *Penduduk Kota Batam Hasil Sensus Penduduk Menurut Kecamatan dan Jenis Kelamin (Jiwa)*, 2020. Batamkota.Bps.Go.Id. <https://batamkota.bps.go.id/id/statistics-table/2/NjYjMg==/penduduk-kota-batam-hasil-sensus-penduduk-menurut-kecamatan-dan-jenis-kelamin.html>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp0630a>
- Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, 11(4), 589–597. <https://doi.org/10.1080/2159676X.2019.1628806>
- Cascetta, E., & Henke, I. (2023). The seventh transport revolution and the new challenges for sustainable mobility. *Journal of Urban Mobility*, 4, 100059. <https://doi.org/10.1016/j.urbmob.2023.100059>
- Chalermpong, S., Ratanawaraha, A., & Uchiyama, Y. (2025). *Informal and shared mobility - Status, challenges, and opportunities in Southeast Asia*. Gothenburg: Volvo Research and Educational Foundations.
- Chavhan, S., & Venkataram, P. (2020). Prediction based traffic management in a metropolitan area. *Journal of Traffic and Transportation Engineering (English Edition)*, 7(4), 447–466. <https://doi.org/10.1016/j.jtte.2018.05.003>
- Chowdhury, S., Zhai, K., & Khan, A. (2016). The effects of access and accessibility on public transport users' Attitudes. *Journal of Public Transportation*, 19(1), 97–113. <https://doi.org/10.5038/2375-0901.19.1.7>
- Dia, H. (Ed.). (2023). *Handbook on artificial intelligence and transport*. Edward Elgar Publishing. <https://doi.org/10.4337/9781803929545>
- Duan, R. (2023). A comparative study on ITS (intelligent transport system) standardization policies in the U.S. and Europe. *Heliyon*, 9(11), e21310. <https://doi.org/10.1016/j.heliyon.2023.e21310>
- Goo, J., Huang, C. D., Yoo, C. W., & Koo, C. (2022). Smart tourism technologies' ambidexterity: Balancing tourist's worries and novelty seeking for travel satisfaction. *Information Systems Frontiers*, 24(6), 2139–2158. <https://doi.org/10.1007/s10796-021-10233-6>
- Guo, X. (2024). *Towards a robust integrated urban mobility system: Public transit and ride-sharing systems*. Doctoral Dissertation, Massachusetts Institute of Technology.
- Hien, H. N., & Trang, P. H. (2024). Decoding smart tech's influence on tourist experience quality. *Asian Journal of Business Research*, 14(1), 97–119. <https://doi.org/10.14707/ajbr.240167>
- Jeong, M., & Shin, H. H. (2020). Tourists' experiences with smart tourism Ttchnology at smart destinations and their behavior intentions. *Journal of Travel Research*, 59(8), 1464–1477. <https://doi.org/10.1177/0047287519883034>
- Liu, W., Zhang, C., Wang, F., Zhang, J., & Wang, L. (2021). Study on the selection of middle urban mass rapid transit system and adaptability analysis. *Journal of Internet Technology*, 22(3), 605–613. <https://doi.org/10.3966/160792642021052203010>
- Mariani, I., Mortati, M., Rizzo, F., & Deserti, A. (2024). *Design thinking as a strategic approach to e-participation: From current barriers to opportunities*. Springer Cham. <https://doi.org/10.1007/978-3-031-72160-1>
- Mertena, I., & Kaaristo, M. (2024). Understanding train tourism mobilities: a practice theories perspective. *Mobilities*, 19(4), 704–720. <https://doi.org/10.1080/17450101.2024.2316827>
- Pitakaso, R., Khonjun, S., Gonwirat, S., Luesak, P., Jirasirilerd, G., Boonmee, C., Dinkoksung, S., Nanthasamroeng, N., & Srichok, T. (2024). Optimizing safe and sustainable public transit for wellness tourism: Southeast Asian case studies. *Journal of Cleaner Production*, 475, 143656. <https://doi.org/10.1016/j.jclepro.2024.143656>
- Rudneva, S. E. (2022). Specific features of building transport infrastructure in megacities. *IOP Conference Series: Earth and Environmental*

Science, 988, 052015. <https://doi.org/10.1088/1755-1315/988/5/052015>

- Satu Data. (2024). *Statistik Jumlah Wisatawan Mancanegara, 2022-2023*. Satu Data Kota Batam. <https://satudata.batam.go.id/satu/urusan/pariwisata>
- Satudata. (2024). *Buletin Statistik Sektoral Dinas Komunikasi dan Informatika Kota Batam* (p. 1). <https://kominfo.batam.go.id/buletin-statistik-sektoral-komunikasi-dan-informatika/>
- Schorn, F., Breuer, J. L., Samsun, R. C., Schnorbus, T., Heuser, B., Peters, R., & Stolten, D. (2021). Methanol as a renewable energy carrier: An assessment of production and transportation costs for selected global locations. *Advances in Applied Energy*, 3(1), 1–14. <https://doi.org/10.1016/j.adapen.2021.100050>
- Schulze, U. (2021). “GIS works!”—But why, how, and for whom? Findings from a systematic review. *Transactions in GIS*, 25(2), 768–804. <https://doi.org/10.1111/tgis.12704>
- Soeiro, D. (2020). Smart cities, well-being and good business: The 2030 agenda and the role of knowledge in the era of Industry 4.0. In F. Matos, V. Vairinhos, I. Salavisa, L. Edvinsson, & M. Massaro (Eds.), *Knowledge, people, and digital transformation: Approaches for a sustainable future* (pp. 55–67). Springer Cham. https://doi.org/10.1007/978-3-030-40390-4_5
- Sustacha, I., Baños-Pino, J. F., & Del Valle, E. (2023). The role of technology in enhancing the tourism experience in smart destinations: A meta-analysis. *Journal of Destination Marketing & Management*, 30, 100817. <https://doi.org/10.1016/j.jdmm.2023.100817>
- Zhang, H., Wu, C., Liu, W., Wei, S., & Wang, Y. (2025). Multiple Regression-Based Dynamic Amplification Factor Investigation of Monorail Tourism Transit Systems. *Buildings*, 15(11), 1–17. <https://doi.org/10.3390/buildings15111881>
- Zhang, Y., & Cheng, L. (2023). The role of transport infrastructure in economic growth: Empirical evidence in the UK. *Transport Policy*, 133, 223–233. <https://doi.org/10.1016/j.tranpol.2023.01.017>
- Zhao, F., Fashola, O. I., Olarewaju, T. I., & Onwumere, I. (2021). Smart city research: A holistic and state-of-the-art literature review. *Cities*, 119, 103406. <https://doi.org/10.1016/j.cities.2021.103406>
- Zhuang, X., Zhang, L., & Lu, J. (2022). Past—Present—Future: Urban Spatial Succession and Transition of Rail Transit Station Zones in Japan. *International Journal of Environmental Research and Public Health*, 19(20), 1–35. <https://doi.org/10.3390/ijerph192013633>