

Urban Mobility, Tourism, and Liveability in Penang: Anticipated Benefits of the Proposed Light Rail Transit (LRT) System

Goh Wei Siang¹, Amri Sulong^{1*}, Raja Nor Azuwah Raja Yusof²

¹ Politeknik Seberang Perai, Department of Commerce,
Jln Permatang Pauh, Penang, 13500, MALAYSIA

² SMK Permai Indah, Jln Bukit Minyak,
Taman Bukit Minyak, Penang, 14000, MALAYSIA

*Corresponding Author: amri.sulong@psp.edu.my
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Abstract

Penang Island, Malaysia, continues to face persistent urban challenges, including severe traffic congestion, limited public transportation accessibility, and growing environmental concerns. In response, the Penang state government has proposed a Light Rail Transit (LRT) system as part of the Penang Transport Master Plan (PTMP) to address these critical issues. This conceptual paper examines the potential urban benefits of the proposed LRT project, with a particular emphasis on its capacity to reduce traffic congestion, strengthen the tourism sector, and enhance urban liveability. Through the analysis of secondary data, regional infrastructure trends, and comparative insights from established LRT systems in Southeast Asian cities, the study highlights the anticipated socio-economic, environmental, and mobility-related impacts of the project. The findings suggest that, if effectively planned and implemented, the Penang LRT system could play a transformative role in fostering a more sustainable, connected, and inclusive urban environment, contributing positively to the island's long-term economic growth and quality of life.

1. Introduction

Public transportation functions as a vital mode of mobility, significantly facilitating human movement while shaping the physical, social, and economic dynamics of urban areas. In Malaysia, the transport sector has experienced over 5% growth since 2004, contributing 3.5% to the national GDP (National Transport Policy, 2019). This underscores its essential role as an economic driver, promoting development and influencing land use patterns, urban growth trends, and accessibility nationwide. However, alongside its economic benefits, transportation also presents challenges, including high pollution levels, frequent road accidents, and extended commuting times, which highlight the urgent need for efficient and sustainable alternatives (Alefari et al., 2024). Addressing these issues necessitates the implementation of sustainable transport solutions aimed at improving air quality, conserving energy, and minimising environmental impacts. Among the most widely adopted strategies is the development of advanced transit systems, such as Mass Rapid Transit (MRT), Light Rapid Transit (LRT), Monorail, and Bus Rapid Transit (BRT). Penang, officially known as Pulau Pinang, is Malaysia's second largest and most developed state after the capital, Kuala Lumpur. As of 2024, it has an estimated population of 1.8 million, making it the most densely populated state in the country. The state currently faces a range of urban transport challenges, including severe traffic congestion, low public transport utilisation, and inadequate infrastructure for

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non-motorised transport modes (Bagde et al., 2020). These problems are further intensified by the heavy reliance on private vehicles, rising rates of car ownership, and a growing influx of tourists. This dependency not only heightens environmental concerns but also adversely affects the quality of life, particularly in high-density areas such as Georgetown and Bayan Lepas.

In an effort to reduce reliance on private vehicles and lower traffic-related emissions, construction has officially commenced on the Mutiara LRT Line. This 29-kilometre rail corridor will feature 27 stations and marks a significant milestone in the development of Northern Malaysia's infrastructure. Led by the Penang State Government with support from the federal government, the project involves a substantial investment of RM13 billion aimed at establishing a vital transportation link between Komtar in Georgetown and Bayan Lepas, located near Penang International Airport. The Mutiara LRT Line is an integral part of the Penang Transport Master Plan (PTMP), which has been carefully designed to promote a more efficient and integrated public transport network, supporting sustainable urban growth and stimulating regional economic development. Light rail transit systems are widely acknowledged as dependable urban transport solutions, offering fast, safe and comfortable services while accommodating medium to high passenger capacities, in line with the modern image and evolving needs of contemporary cities (Ibrahim et al., 2024). Furthermore, Rahman et al. (2022) observed that the development of areas surrounding LRT stations can positively influence the lives of low and moderate-income communities by improving access to regional facilities and employment opportunities, creating new job prospects within station precincts, and encouraging economic activities in adjacent rural areas.

The preceding analysis clearly demonstrates that the Light Rail Transit (LRT) project is strategically positioned to deliver a comprehensive and multifaceted range of benefits, primarily focused on enhancing urban mobility, stimulating regional economic development, promoting environmental sustainability, and improving overall urban liveability (Waerden et al., 2024). Liveability, which encompasses the quality of life, access to essential services, environmental health, and opportunities for social and economic participation, has become a key consideration in the planning of modern cities. In this context, the introduction of the LRT project represents a pivotal step toward creating more accessible, efficient, and inclusive urban environments for Malaysia's rapidly growing metropolitan regions. This assertion is strongly supported by empirical findings from the implementation of the LRT3 project in Klang, which has provided tangible evidence of the transformative potential of well-integrated transit systems in enhancing both the functional and social dimensions of urban areas. Analysts anticipate that the populations of Klang, Shah Alam, and Petaling Jaya will experience significant improvements not only in public transportation services but also in economic activity, particularly for communities situated close to transit stations (Ibrahim et al., 2024). Improved transit access is expected to increase convenience, reduce travel costs, and enable greater participation in employment, education, and social opportunities, all of which contribute directly to enhanced urban liveability.

Beyond addressing the persistent issues of traffic congestion and inefficient mobility systems, the LRT project is projected to catalyze broader social and economic development. By improving connectivity between densely populated urban centres, the system is expected to directly benefit approximately 74,000 daily passengers while improving the quality of life for more than 500,000 residents living along its alignment. Furthermore, the project is anticipated to strengthen community ties and support the formation of more vibrant, walkable, and transit-oriented neighbourhoods in key locations such as Shah Alam, Petaling Jaya, and Klang. The integration of such infrastructure is not only intended to meet immediate transportation needs but also to advance long-term urban development objectives, including the creation of higher-density, mixed-use precincts that reduce dependence on private vehicles. This contributes to a reduction in traffic-related emissions and promotes more sustainable urban growth patterns. Additionally, improved access to public transportation has been shown to increase property values, stimulate new business activities, and expand employment opportunities, particularly for low and moderate-income groups, thereby fostering more equitable urban development (Ibrahim et al., 2024; Rahman et al., 2022). In this regard, the LRT project marks a significant milestone in Malaysia's ongoing efforts to modernise its urban transport infrastructure, while enhancing the overall liveability, sustainability, and inclusivity of its major urban centres.

2. Literature Review

Globally, urban rail systems, such as Light Rail Transit (LRT), Mass Rapid Transit (MRT), and metro networks, have been widely adopted as strategic interventions to combat traffic congestion, reduce environmental degradation, and enhance the overall quality of life in rapidly urbanising cities (Maulana et al., 2025). As urban populations grow and private vehicle ownership increases, cities face growing challenges in maintaining efficient, safe, and sustainable mobility systems. In response, many urban centres have invested heavily in rail-based public transport infrastructure, which offers the advantage of high passenger capacity, reliable scheduling, and lower per-capita emissions compared to road-based transport systems. The experience of Southeast Asian cities provides particularly relevant insights for Malaysia and Penang, given their comparable urban contexts characterized by rapid urban growth, mixed land use patterns, and socio-economic diversity. Singapore, Kuala

Lumpur, and Bangkok have demonstrated varying degrees of success in planning, implementing, and operating urban rail transit systems, offering valuable lessons for other cities in the region.

In Singapore, the Mass Rapid Transit (MRT) system, inaugurated in 1987, has evolved into a comprehensive urban rail network that forms the backbone of the city-state's integrated public transport system. The MRT has been a central element of Singapore's urban and transport planning strategies, contributing significantly to decreased car dependency, improved air quality, and enhanced urban liveability (Ebrahim, 2025). The system's success can be attributed to consistent government investment, robust land use integration through transit-oriented development (TOD), and effective multimodal connectivity. Singapore's experience illustrates how a well-planned urban rail system, supported by complementary policies such as vehicle quota systems and congestion pricing, can reshape urban mobility patterns and promote sustainable urban development (Xu et al., 2025).

Kuala Lumpur, Malaysia's capital city, presents another instructive case. Since the late 1990s, Kuala Lumpur has progressively developed an LRT and MRT network to address chronic traffic congestion and accommodate a growing urban population. The Kelana Jaya and Ampang LRT lines, along with the more recent MRT Sungai Buloh to Kajang line, have expanded public transport accessibility across the metropolitan region. Studies have shown that Kuala Lumpur's urban rail systems have stimulated property development along transit corridors, increased ridership, and reduced peak-hour traffic volumes on major roadways (Majid & Zaki, 2025). However, challenges remain in achieving seamless multimodal integration, affordable fare structures, and consistent service reliability.

Bangkok's BTS Skytrain and MRT Subway systems offer further evidence of the transformative potential of urban rail transit (Choorat et al., 2024). Since their inception in 1999 and 2004 respectively, these systems have played a critical role in mitigating the city's infamous traffic congestion, improving urban air quality, and enhancing the efficiency of urban travel. The expansion of the BTS and MRT networks has also catalyzed significant commercial property development around station areas, contributing to economic revitalization in central and peripheral urban zones. Bangkok's experience underscores the importance of long-term infrastructure investment, phased system expansion, and public-private partnership models in sustaining rail-based urban mobility improvements (Klinmalai, 2025).

In Malaysia, outside of the Klang Valley, Penang represents a unique case. The state's public transport system currently relies predominantly on road-based services, including buses operated by Rapid Penang, taxis, e-hailing services, and private vehicles. The public transport modal share remains comparatively low, with most residents and tourists relying on private cars and motorcycles for daily travel (Xie et al., 2025). Chronic traffic congestion, particularly within George Town, along the Tun Dr Lim Chong Eu Expressway, and in the Bayan Lepas industrial area, has imposed significant economic, environmental, and social costs. Unlike Kuala Lumpur, Penang has not yet developed any form of urban rail transit infrastructure, placing it at a competitive disadvantage in terms of mobility options, environmental sustainability, and urban liveability.

In response to these challenges, the Penang State Government, through the Penang Transport Master Plan (PTMP), has proposed the construction of a Light Rail Transit (LRT) system. The initial proposed alignment for the Bayan Lepas LRT line envisions a 29.9 km route connecting George Town to the Penang International Airport, passing through key commercial, industrial, and residential zones. The LRT aims to address the limitations of Penang's existing transport system by introducing a reliable, efficient, and sustainable mode of high-capacity public transport (Kamarudin, Kamal, & Esa, 2022). If effectively planned and integrated with other modes of transport, the LRT has the potential to reduce dependence on private vehicles, alleviate road congestion, and contribute to a more sustainable and connected urban environment.

Existing literature suggests that the success of such an urban rail system in Penang would depend on several critical factors, including system design and alignment, fare affordability, service frequency, station accessibility, and multimodal integration (Masirin, Salin, Zainorabidin, Martin, & Samsuddin, 2017). Furthermore, lessons from Singapore, Kuala Lumpur, and Bangkok emphasise the importance of complementary land use policies, including the promotion of transit-oriented development (TOD) and effective last-mile connectivity options, to maximise the socio-economic and environmental benefits of rail-based public transport (Majid & Zaki, 2025; Wirawan et al., 2024). In summary, the cumulative evidence from regional and global case studies suggests that well-planned and integrated rail systems can significantly transform urban mobility patterns, stimulate economic development, and improve urban quality of life. The proposed Penang LRT system, although still in its conceptual stage, has the potential to deliver comparable benefits, provided that its planning, implementation, and governance frameworks align with best practices in sustainable urban transport development.

3. Method

This study employs a conceptual, qualitative research approach to explore the anticipated benefits of the proposed Light Rail Transit (LRT) system in Penang, utilising secondary data analysis and comparative case studies. Given that the LRT project remains at the proposal and planning stage, with no empirical data currently available from its operation, a qualitative, desk-based research design was deemed appropriate for examining prospective

outcomes based on regional and international experiences with urban rail systems. The study primarily relies on the systematic review and synthesis of secondary data sources. These include peer-reviewed academic journal articles, conference papers, and technical reports that focus on the implementation and impacts of LRT, MRT, and related urban rail systems in Southeast Asian cities, such as Singapore, Kuala Lumpur, and Bangkok. In addition, government publications, including the Penang Transport Master Plan (PTMP), Penang Structure Plan 2030, Malaysian Institute of Road Safety Research (MIROS) reports, and urban development policy documents were reviewed to establish the policy context and objectives of the proposed Penang LRT. A purposive sampling strategy was employed to select literature and policy documents, ensuring the inclusion of relevant and contemporary sources that address urban transport infrastructure, sustainable mobility, and urban development in comparable urban contexts. The literature review focused on identifying empirical evidence of the socio-economic, environmental, and urban planning impacts of rail-based transit systems, as well as lessons learned and best practices in system planning, multimodal integration, and policy implementation. To extrapolate potential outcomes for Penang, a comparative analysis framework was utilised, drawing upon the documented experiences of cities that have successfully implemented LRT or MRT systems within similar Southeast Asian urban environments. The comparative analysis involved examining key variables, including traffic congestion trends, public transport modal share, urban livability indicators, tourism performance, and property development patterns, before and after the introduction of rail transit systems. By analyzing these variables across multiple city case studies, the study aimed to identify transferable insights and anticipated outcomes relevant to the Penang context.

The findings from the secondary data analysis and comparative review were then organized and synthesized into a thematic discussion, structured around three primary benefit categories identified from the literature: (1) traffic congestion mitigation, (2) tourism sector enhancement, and (3) improvements to urban livability and environmental sustainability. These thematic categories were selected based on their prominence in urban transport planning literature and their alignment with the strategic objectives outlined in the Penang Transport Master Plan. Although this qualitative, conceptual study does not involve primary data collection, its methodology is grounded in a rigorous and systematic review of contemporary academic and policy literature. The approach allows for the formulation of informed, evidence-based projections regarding the anticipated impacts of the proposed Penang LRT, while acknowledging the limitations inherent in relying solely on secondary data and comparative extrapolation. Future empirical studies, including ridership surveys, transport modeling, environmental impact assessments, and public perception analyses, will be necessary to validate these projections and refine transport policy strategies as the LRT project progresses from planning to implementation stages.

4. Result and Discussion

4.1 Mitigating Traffic Congestion

Penang has long struggled with escalating traffic congestion, particularly in key urban and peri-urban areas such as George Town, Bayan Lepas, and the Tun Dr Lim Chong Eu Expressway corridor. The socio-economic costs of this persistent congestion are substantial, manifesting in extended commute times, increased vehicular operating expenses, higher accident risks, environmental degradation, and reduced economic productivity due to travel delays (Rosli & Samat, 2025). In urban economies where time-sensitive logistics and efficient mobility are integral to the performance of both the industrial and service sectors, congestion imposes measurable constraints on competitiveness and quality of life. The proposed LRT system is anticipated to alleviate these challenges by providing a high-capacity, reliable, and frequent public transport alternative to private car usage. Experience from Kuala Lumpur's LRT and MRT systems has demonstrated that rail-based public transport can successfully divert a substantial proportion of car commuters, especially when services are competitively priced, punctual, and conveniently accessible (Ayan et al., 2025). Ridership studies from Kuala Lumpur indicate that rail services have contributed to a significant reduction in peak-hour traffic volumes along major arterial roads, particularly in the city center and its surrounding suburbs. Applying these insights to Penang, the LRT system could play a transformative role in redistributing travel demand away from congested road networks. By connecting high-density residential areas, industrial zones, tourist attractions, and the Penang International Airport, the LRT would provide a viable alternative for both residents and visitors. Additionally, integrating the LRT with existing bus services, park-and-ride facilities, and non-motorized transport infrastructure could enhance multimodal connectivity and further encourage modal shift. While precise congestion reduction outcomes will depend on system alignment, pricing strategies, and service reliability, regional evidence suggests that Penang could achieve noticeable traffic flow improvements following LRT implementation.

4.2 Boosting the Tourism Sector

The tourism sector is a crucial component of Penang's economy, with attractions such as George Town's UNESCO World Heritage Site status, lively cultural festivals, rich culinary traditions, and diverse natural landscapes, all of

which attract substantial numbers of domestic and international visitors each year. Despite this, tourists frequently express concerns about the challenges of navigating the island, which are compounded by inadequate public transportation coverage in several areas, traffic congestion, and a lack of integrated and efficient transportation services. (Redzuan et al., 2025). The absence of a rapid transit system diminishes the visitor experience and limits the geographic spread of tourism activity. An LRT system could address these issues by enhancing the ease, safety, and reliability of tourist mobility. The proposed alignment, linking key nodes such as George Town, the airport, the southern industrial zone, and the northern beaches, has the potential to streamline tourist travel and reduce dependence on taxis, rental cars, and tour buses. International precedents, particularly from Bangkok's BTS Skytrain and Singapore's MRT system, provide compelling evidence of how efficient rail transit systems enhance tourist access to cultural landmarks, shopping districts, and hospitality hubs (Bura & Dhirathiti, 2020; Bautista et al., 2025). In Bangkok, for example, the BTS has not only facilitated faster movement between tourist hotspots but also spurred the development of hotels, shopping malls, and entertainment venues in proximity to stations, thereby reinforcing the city's attractiveness as a tourism destination. For Penang, enhanced mobility could extend tourist stays, increase visitor expenditure, and promote dispersal to under-visited areas, reducing pressure on overcrowded central sites. Moreover, integrating the LRT system with heritage tram services or shuttle routes within George Town's heritage zone could maintain the historic character of the city while improving accessibility. In doing so, Penang would be better positioned to strengthen its competitive advantage within Malaysia's and Southeast Asia's increasingly dynamic tourism markets.

4.3 Enhancing Urban Livability and Sustainability

Beyond addressing transportation-specific challenges, the proposed LRT system aligns closely with broader sustainable urban development goals and the creation of a more liveable urban environment in Penang. Urban liveability encompasses dimensions such as environmental quality, access to public services, safety, social inclusiveness, and opportunities for recreation and cultural engagement (John et al., 2025; Jodder et al., 2025). Penang's growing car dependency has contributed to deteriorating air quality, noise pollution, and the fragmentation of public spaces, detracting from residents' overall well-being. A fully operational LRT system, if effectively integrated into Penang's urban fabric, could deliver significant environmental and social benefits. By reducing the number of private vehicles on the road, the system would lower vehicular emissions, thereby contributing to improved air quality and public health outcomes (Jiao et al., 2025). Additionally, reductions in traffic congestion and vehicle use would likely diminish noise pollution and free up road space for non-motorised and pedestrian-friendly infrastructure. Equally important is the potential for the LRT to catalyze transit-oriented development (TOD) along its corridor. TOD is an urban planning approach that promotes high-density, mixed-use, pedestrian-friendly neighbourhoods centred around public transport stations. Singapore's experience with TOD, particularly around MRT station areas, has demonstrated how such models can create vibrant, self-sufficient urban nodes with integrated residential, commercial, and recreational facilities (Desta, 2024). In Penang, adopting a similar approach could revitalise underutilised urban areas, reduce urban sprawl, and enhance access to affordable housing near transport nodes. Furthermore, by enhancing public transport accessibility for marginalised groups such as the elderly, students, and lower-income communities, the LRT system would play a critical role in advancing social equity objectives. An inclusive public transport network is essential for fostering equitable urban environments, ensuring that mobility opportunities are not constrained by socio-economic background or residential location.

In the long term, the integration of the LRT system into Penang's broader urban development framework presents a valuable opportunity to position the state as a leading example of a sustainable, livable, and economically competitive medium-sized city within Southeast Asia. However, the realisation of these benefits will depend on careful consideration of factors such as system design, fare affordability, coordinated land use planning, and effective stakeholder engagement, to avoid the shortcomings experienced by less effective urban transport initiatives elsewhere.

5. Conclusion

In conclusion, the proposed Penang Light Rail Transit (LRT) system signifies more than just a transport infrastructure project; it represents a strategic intervention with the potential to transform the island's urban mobility, environmental sustainability, and socio-economic development. As Penang confronts persistent challenges of traffic congestion, environmental degradation, and unequal access to mobility, the introduction of a high-capacity, reliable, and sustainable rail-based transit option is both timely and imperative. Drawing insights from successful regional models such as Singapore, Kuala Lumpur, and Bangkok, the Penang LRT is anticipated to reduce private vehicle dependency, improve travel efficiency, enhance tourism connectivity, and catalyze transit-oriented development (TOD) along its corridor. This, in turn, could enhance air quality, reduce noise pollution, support inclusive public spaces, and promote social equity by extending transportation accessibility to marginalised groups. However, achieving these outcomes will require coordinated land-use and transportation

planning, active stakeholder engagement, and sustained investment in multimodal connectivity to avoid the shortcomings observed in less effective projects. Future research should adopt empirical, data-driven approaches to measure public perceptions, simulate traffic and environmental outcomes, and assess the socio-economic impacts of the system to ensure its long-term viability and responsiveness. Ultimately, the LRT offers Penang a valuable opportunity to position itself as a model for sustainable, livable, and economically dynamic medium-sized cities in Southeast Asia, provided it embraces an integrated, people-centred, and forward-looking approach to urban transport development.

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Conflict of Interest

The authors declare that they have no conflict of interest regarding the publication of this paper.

Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Amri Sulong; **data collection:** Amri Sulong; **analysis and interpretation of results:** Amri Sulong; **draft manuscript preparation:** Goh Wei Siang. All authors reviewed the results and approved the final version of the manuscript.

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