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Embracing Pedestrians and Non-Motorised Transport Through TOD Concept In a Small City

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ABSTRACT

Walking is the only way for many people in developing nations to get around because of the high rates of urban growth, large, underprivileged populations, and high densities of metropolitan areas. Travel conditions for walkers and non-motorised vehicles may be dangerous, in poor shape, or non-existent. Many emerging cities are seeing a gradual loss of pedestrian space. The core of a sustainable city is the Transit-Oriented Development (TOD) concept, which includes a robust transit network and fresh insights into better integrating less automobile-dependent land use into planning and design. To revitalise a small city, TOD is a procedure that reintegrates land use and transportation by developing a new, alternative transit system that complies with its tenets. This paper examines the application of the TOD concept for a small town in embracing pedestrians and non-motorised vehicles. Using a simple random sampling technique, a Case Study method was applied using Rawang City for site observations and a questionnaire survey with 230 samples. The findings showed that walkers and non-motorised vehicles lack adequate amenities and connectivity, which compromises user comfort and safety. Bicyclists are discouraged from riding to Rawang City's railway station because it lacks amenities for them. The study concluded with recommendations for future enhancements that might be useful not only for Rawang City but also for other similar small cities. The recommendations from this study may serve as a guide for municipal governments looking to reduce carbon emissions by encouraging walkability and non-motorised transportation.

Keywords: TOD concept; small city; pedestrian; walkability; non-motorised vehicle

INTRODUCTION

In developing countries, many people live in urban areas due to job opportunities, facilities, and services, making urbanisation more rapid and causing overcrowded living conditions and poverty. Due to limited resources, a compact environment, inaccessibility to private vehicles, or affordability, walking has become many people's central mode of transportation. The growing urban population challenges the poor regarding socioeconomic availability, infrastructure, or essential services (Shah 2023; Navigate Mobility 2024).

The infrastructure issues for pedestrians and non-motorised transportation are considered unsafe, poorly maintained, or absent. Fragmented and poor integration of transport systems affects the coordination between different modes of transport like buses, trains and bicycles, causing disruptive transfers and longer trips (Shah 2023). Pedestrians are often more affected if facilities do not support walkability without pedestrian paths, sidewalks, crosswalks, lighting and safety measures (World Bank

2024). As cities grow, urban landscapes change, land use is focused on economic activities and pedestrian spaces are inevitably sacrificed when motorised transportation is given more attention. This situation slowly subsides the priority for a pedestrian-friendly environment, discouraging people from walking and cycling.

Transit-Oriented Development (TOD) is a strategy that aims to create sustainable urban environments by prioritising integrated land use and transportation planning. TOD creates compact, walkable, pedestrian-oriented, mixed-use land use and sustainable communities (Transit Oriented Development Institute 2024). The approach emphasises public transit systems, accessibility and connectivity and reduces dependency on private vehicles. The principle of mixed-use land use facilitates the creation of an environment that offers services, employment, and residential and leisure opportunities close to transit stations, consequently reconnecting land use and transportation. A strong transit network and new insights into better integrating less land use dependent on automobiles into planning and design are key components of the Transit-Oriented Development (TOD) strategy, the foundation for a sustainable city. Malaysia introduced the TOD application in 2005 after rail-based transportation was developed (Abdullah et al. 2023).

TOD is also viewed as a viable remedy for revitalising a small city. Revitalisation is reviving an inhabited urban area that has lost its functions over time (Wilczkiewicz and Wilkosz 2015). The Malaysian Twelfth Malaysia Plan suggested that urban areas adopt green mobility to facilitate the movement of people through public transport and active mobility. This aspiration encourages the public to switch from private vehicles to public transport. However, small cities like Rawang in the State of Selangor may require adjustments or enhancements to implement TOD with the green mobility concept. In addition, Rawang, an old urban area, is experiencing a lack of land use integration with public transportation facilities due to ad-hoc and piecemeal urban planning and concentrated built-up in the central business area (Majlis Perbandaran Selayang 2020).

Rawang is a small city in the District of Gombak in Selangor. There are two (2) Malayan Railway Limited (KTMB) railway stations in Rawang, namely Kuang KTMB Station and Rawang KTMB Station, along the Rawang-Seremban line. The nearest Mass Rapid Transit (MRT) terminal station is Sungai Buloh MRT, while the Gombak Light Rail Train (LRT) station is situated in the Gombak District. Rawang city centre, however, has long suffered from traffic issues like disruption in bus services, traffic congestion, poor street conditions and facilities for non-motorised. According to Rawang Local Plan 2030, the city still lacks infrastructure. With constant traffic congestion in the city area, the public prefers public transportation to work.

The people in the Rawang area, including school children, youngsters, and the elderly, opt to cycle or walk to the Rawang rail station or the city centre. Nevertheless, the ongoing conflict faced by cyclists and pedestrians in Rawang is due to the lack of a dedicated lane for cyclists and pedestrians to enable them to reach their destination, especially the rail station and the city centre. Also, it was indicated in Rawang Local Plan 2030 that the city lacks safety measures like a zebra crossing, closed-circuit television (CCTV) and ramps for the disabled.

Despite numerous studies on sustainable transportation and TOD, there remains a limited focus on the actual lived experiences of pedestrians and cyclists in small cities, especially within the Malaysian context. Most of the literature generalises TOD implementation without critically examining micro-level accessibility, safety, and infrastructure gaps that hinder active mobility. Moreover, the unique challenges small towns face, such as fragmented land use integration and inadequate last-mile connectivity, are underrepresented in current academic discourse. Addressing these gaps is essential to ensure that TOD is not only a theoretical model but a practical tool for fostering inclusive, low-carbon mobility in smaller urban contexts like Rawang.

This paper presents the outcome of a study that examines the application of the TOD concept in a small city, Rawang City, to accommodate pedestrians and non-motorised vehicles. The findings from this study may inspire the local authority to consider a more robust approach to TOD application for the town.

PRINCIPLES OF TOD THAT CONSIDER PEDESTRIAN AND NON-MOTORISED TRANSPORTATION

Recent studies on Transit-Oriented Development (TOD) have continued to emphasise the integration of pedestrian and non-motorised transport principles as central to its success. The recent literature builds on earlier work while incorporating innovations and responding to evolving urban trends. Firstly, pedestrian-centric design and safety. A focus has emerged on enhancing pedestrian infrastructure in TOD, emphasising pedestrian safety, comfort, and accessibility. Research has increasingly highlighted the importance of creating "pedestrian-first" environments where walking is the primary mode of transport (Abd Azman et al. 2024). Urban planners now prioritise pedestrian-friendly urban designs that include wider sidewalks, safer crosswalks, and reduced vehicle speeds around transit stations (Eon et al. 2024). The emphasis is on volume and creating safe, attractive pedestrian pathways that integrate seamlessly with public transport systems.

Secondly, bicycle integration and multimodal transport. Integrating bicycles with TOD systems has gained significant attention in recent years. Cities focus on providing bicycle lanes, bike-sharing systems, and secure bike parking facilities. TOD systems can become more effective when incorporating bicycle infrastructure, ensuring that non-motorised options are seamlessly linked with public transit (Zhang and Lee 2023).

Thirdly, accessibility and universal design. Recent literature emphasises the importance of ensuring TOD environments are accessible to all, including people with disabilities. Researchers have called for universal design standards, including barrier-free pedestrian routes and ensuring that public transport stations and vehicles are accessible to people with varying mobility needs (Kong & Pojani 2023).

Lastly, human-centred mobility. New TOD models reflect a shift towards "human-centred" mobility, where the emphasis is placed on pedestrians' and cyclists' experiences rather than just transportation efficiency. TOD principles in the post-2018 era are increasingly designed with a more holistic, community-focused approach that prioritises environmental sustainability and social equity, emphasising non-motorised options (Abdullah et al. 2022).

BENEFITS OF TOD FOR SMALL CITIES

While TOD's role in larger cities is well established, recent studies show that small towns and cities increasingly recognise TOD's benefits as a strategy for sustainable growth. TOD in small cities is being promoted to revitalise town centres and underutilised areas. Small cities can reduce suburban sprawl and encourage local development by clustering development around transit hubs. Small cities with TOD initiatives experienced economic revitalisation, including increased local business activity and attracting new investments, particularly when transit stations were integrated with mixed-use developments (Closs 2019). Meanwhile, in small cities where car dependency is typically higher, TOD provides an opportunity to reduce this reliance by offering alternative, accessible, and affordable transportation options. Small cities with TOD initiatives have seen increased transit ridership and reduced traffic congestion, contributing to more sustainable local mobility (Ahmad et al. 2022).

In addition, TOD has been shown to benefit disad-vantaged populations in small cities by providing greater access to affordable housing and transportation options. TOD can address social isolation in small towns by im-proving connectivity and providing access to services for those without cars. Furthermore, TOD's focus on pedes-trian and non-motorised transportation fosters environ-mental sustainability by reducing emissions and promot-ing a healthier lifestyle (Rosni et al. 2018).

More recent work has linked TOD with resilience-building in small cities, particularly in response to climate change. TOD's focus on walkability and public transit helps mitigate the effects of climate change by reducing car emissions and improving air quality. A recent study demonstrated how TOD could help small cities adapt to climate-related challenges by promoting green infrastructure and sustainable mobility (Olga, 2018).

TRANSPORTATION ISSUES IN SMALL CITIES

Despite TOD's advantages, small cities face significant transportation challenges, some unique to their context. Recent literature has emerged with several new perspectives and solutions. Due to financial constraints, many small cities still struggle with limited public transportation systems. Public transit options are often infrequent or non-existent in rural or suburban areas. Recent research suggests that smaller, more flexible transit solutions, such as micro-transit or on-demand services, can complement TOD by filling gaps where fixed-route transit is not feasible (Sorensen et al. 2021).

Moreover, one of the biggest challenges in small cities is the entrenched car-centric culture. Residents may still prefer private cars even in areas with available public transport. Overcoming this resistance requires strong community engagement, targeted education, and incentives for adopting non-motorised transport. Public awareness campaigns and the gradual introduction of TOD concepts (e.g., bike lanes and pedestrian zones) can help shift public attitudes towards more sustainable transportation choices (Rasca and Saeed 2022).

Additionally, low population densities in small cities make the economic feasibility of traditional TOD more challenging. Small cities may not have the ridership necessary to support large-scale transit operations. Some of the solutions to focus on smaller-scale TOD projects are like clustering walkable communities around transit hubs or park-and-ride facilities rather than large, centralised transit-oriented neighbourhoods (Wang et al. 2024). Small cities often face regulatory and zoning barriers that hinder TOD implementation. Revising zoning codes may allow higher-density, mixed-use development near transit hubs and remove restrictions prioritising car-oriented planning (Gu et al. 2024).

Some cities have also embraced form-based codes or flexible zoning to allow for more creative and adaptive land-use solutions. With the rise of shared mobility services, small cities are increasingly integrating these options into TOD plans. Combining shared mobility, such as carpooling or bike-sharing systems, with public transit can address last-mile connectivity issues, providing greater flexibility and coverage in small cities with lower densities (Din et al. 2023).

In conclusion, 3 key themes are identified in this literature study as being critical to the successful implementation of TOD in small cities: walkability, land use-transit integration, and infrastructure accessibility. These elements are interconnected: well-integrated land use promotes walkability; the quality of the infrastructure affects accessibility and user comfort; and transportation integration improves connectivity. With this combination, it creates a conceptual framework that directs the evaluation of non-motorised and pedestrian mobility near Rawang KTMB Station.

METHODOLOGY

The study applied a Case Study research design, using Rawang City as the subject matter. The city had undergone significant development and growth, transforming from a small town into a thriving urban area. The city was established in the early 19th century, primarily as a mining town during the tin mine boom in Malaysia. To cater for the growing population and needs, the town gradually transformed into a small city with business areas that combined socio-economic and other activities. The site was also selected due to the pressing need for convenient facilities for non-motorised vehicles within the perimeter of the Rawang railway station, as the transit station, known as the Rawang KTMB Station. Following the TOD guideline for a convenient walking distance of 400 meters (Department of Town and Country Planning, 2018) from the transit station, the specific boundary for the case study covers a radius of 400 meters from the Rawang KTMB Station (Figure 1).

Using the case study, the investigation involved a detailed literature review in interpreting the concept of TOD, understanding the preliminary issues of Rawang urban transportation, and identifying the indicators for the study based on the principles of TOD. From the initial study, the study then streamlined the indicators for investigations put forward by Abdi & Lamiquiz-Dauden (2022), targeting a micro-scale assessment framework that includes infrastructure and access, streets for walking and cycling, and imageability.

To analyse the settings and streetscape of the study area, site investigations were conducted on weekdays and weekends within a 400-meter radius of the Rawang KTMB Station, and photographs were captured as evidence. The qualitative component involved expert interviews with three key stakeholders: an academic expert, a private planning consultant, and a local authority representative. Purposive sampling was used to choose participants to gather knowledgeable opinions on the application of TOD in small cities. The expert interview questions were designed with open-ended questions concentrating on the application of TOD for Rawang and their viewpoints on the current scenario and development surrounding the transit station.

Responses were analysed using thematic analysis, which involved coding key ideas, identifying recurring patterns, and grouping them into themes such as infrastructure gaps, governance, and user accessibility. This approach provided structured insights to complement the survey findings.

A questionnaire survey was conducted to gather perceptions from the train users and the public at the KTMB Rawang Station. The data were analysed using descriptive statistics and inferential statistics, including Chi-square tests and cross-tabulations to examine relationships between variables. Cronbach's Alpha was used to validate the survey instrument's statistical reliability, and it demonstrated strong internal consistency across the majority of variables (overall $\alpha = 0.948$).

The sample frame was selected to represent the 112,133 population of Rawang according to the 2020 Malaysia Department of Statistics data (City Population,

2024). The decision to seek answers from the train users and the public at the train station is because they are the ones who experience the services and use the facilities around them, therefore facilitating the investigation with direct opinions. A total of 270 samples were initially targeted from the sampling calculation, taking into consideration a 5% margin of error, 90% confidence level and 50% response distribution. The survey was conducted physically at the transit station. However, only 230 completed the survey forms, which were then utilised for the analysis. During the survey, it was observed that many potential respondents could not participate or were reluctant to be interviewed since they were rushing for their trips and could not spend extra time answering the questionnaire.

The questionnaire survey was carried out on a weekend because the intention was not to compare the preference of users between weekdays or weekends nor to evaluate the number of users on weekdays or weekdays, but primarily to seek perceptions of the users and public's experience and thoughts about the infrastructure and access, facilities for walking and cycling and the image of the surrounding (which were the indicators employed for the investigation).

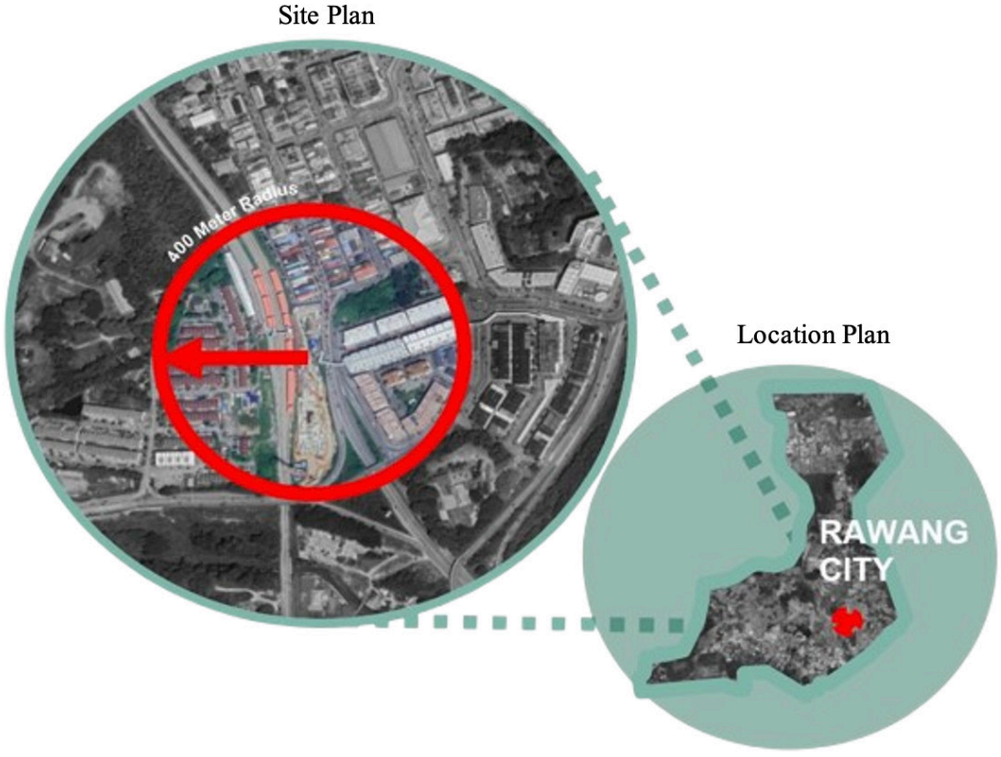

FIGURE 1. Rawang City, the case study

RESULTS AND DISCUSSION

RESULTS FROM SITE INVESTIGATION

The site investigations within the study perimeter discovered that the 400-meter radius of the railway station is made up of various land uses like residential areas, shop lots, a Sikh temple, parking spaces, road networks, and reserve land alongside the railway line. The station has a covered overhead bridge across the rail tracks to access the rail platforms. It has station facilities like side platforms, a customer service office, public toilets, car and motorcycle parking spaces, a ticket vending machine, an elevator, a drink vending machine, a prayer room, and small shops.

Seating, an information board, and signage are also apparent. Concerning the indicators applied for the investigations, the study revealed that the infrastructure aspect could be considered as provided by a road system, a drainage system circulating the study area, and the existence of telecommunications and basic infrastructure like electricity and water. There are also pedestrian facilities like an overhead bridge connecting the railway station to the shopping lots. The present construction activity for a future car park building next to the station disrupts pedestrians and affects the image of the area (Figure 2).

FIGURE 2. The construction site next to the transit station affects pedestrians and the scenery

Otherwise, pedestrian connectivity is not friendly for walking, even though accessibility is compromised due to the lack of pedestrian pathways, the disjointed design of paths and the lack of zebra crossings. This situation discourages walking due to safety concerns. Additionally, there is no dedicated path for cyclists, thus affecting the safety of cyclists, even though the presence of cyclists is evident among the elderly (Figure 3). Not only that, but the railway station itself lacks facilities for the disabled group, including ramps. Other weaknesses are the lack of CCTV and pedestrian safety elements, such as lighting, fences, and bollards.

Even so, people had no choice but to be at the station and use the train services. Regarding the image and vista of the area, it cannot be denied that the surroundings portray a typical old town with fewer attractions and no surprise elements that can charm visitors (Figure 4). The areas bordering the railway station are merely buildings for commercial activities and houses. The researchers felt that the image of the area could be enhanced by adding soft or hard landscaping and perhaps incorporating urban design or placemaking elements that can draw people's attention.

FIGURE 3. The absence of dedicated lanes for cyclists deters safety measures.

FIGURE 4. The image of the surrounding area

RESULTS FROM QUESTIONNAIRE SURVEY

The questionnaire survey provided valuable insights into how train users and the public perceived the area. Out of 230 respondents, the majority (225 individuals - 97.8%) identified as non-disabled, while only five (5) respondents (2.2%) reported having disabilities. This figure reflects the diverse community that relies on the facilities at Rawang KTMB Station. Although many users are non-disabled, the small percentage of disabled individuals represents an important group whose needs should be considered. By considering the experiences and perspectives of disabled and non-disabled users, improvements can be made to enhance safety, accessibility, and overall user experience. This will help create a welcoming and inclusive environment at the station where everyone feels valued and supported.

The highest percentage of transport modes used by people travelling to KTM Rawang is private cars (75.20%). This is likely due to the limited last-mile connectivity to public transport stations, making driving more convenient. Meanwhile, 14.80% arrived at the station by taxi or E-Hailing services. In areas with limited public transport, E-Hailing serves as an alternative. It is also often considered safer at night or in higher-crime areas.

Table 1 revealed a significant level of dissatisfaction with the existing infrastructure and facilities in Rawang. The data provides valuable insights for identifying pressing concerns and establishing priorities for improvement strategies. Notably, 30.4% of respondents expressed disappointment with the quality of pedestrian pathways, frequently encountering challenges such as inadequate safety features, including pedestrian crossings and poor street lighting. The lack of proper safety measures not only contributes to an increase in crime, such as theft, assault, and vandalism, but also fosters an environment that feels unsafe for both residents and visitors. Inadequate safety measures can also lead to more accidents and injuries, especially in areas with poor lighting, neglected infrastructure, and a lack of traffic control. Another 31.1% of participants highlighted the issues with the cycling infrastructure, identifying a critical area for improvement. Additionally, many respondents also expressed discontent with the current traffic calming measures. These components were perceived as inadequate in mitigating traffic-related risks and, in some cases, were considered to pose a potential hazard to users and the local community. Moreover, 36.5% of the respondents shared concerns about their safety in the area, emphasising the need for stronger, better-designed mobility infrastructure and more thoughtful urban planning.

TABLE 1. Satisfaction level of the existing infrastructure at Rawang City

Level of Satisfaction	Pedestrian Facilities	Cyclist Facilities	Traffic Calming Components	Potential Old Building as a Tourist Attraction	Safety Elements
	Percentage (%)				
1 Strongly Dissatisfied	20.30%	22.40%	18.70%	11.70%	17.00%
2 Dissatisfied	21.00%	24.60%	27.00%	17.00%	16.10%
3 Slightly Dissatisfied	30.40%	31.10%	29.60%	27.00%	36.50%
4 Slightly Satisfied	17.00%	12.30%	14.30%	23.50%	22.20%
5 Satisfied	5.70%	3.90%	5.20%	11.20%	5.70%
6 Strongly Satisfied	6.10%	5.70%	5.20%	9.60%	2.50%

Table 2 shows the satisfaction levels with the facilities at the Rawang KTMB Station, highlighting significant gaps in three key areas: service quality, parking availability, and the application of universal design principles. About 32.2% of respondents expressed slight dissatisfaction with the current state of the station's facilities, suggesting that the services do not fully meet user expectations. Parking was another major concern, with 29.6% of participants expressing dissatisfaction, particularly during peak hours when demand regularly exceeds available capacity (Figure 5). This shortage impacts the convenience of using the station and contributes to broader accessibility issues and congestion in the surrounding area. In addition, the station's design was recognised as a crucial area that needs attention. 34.30% of respondents mentioned that the station does not follow universal design principles, essential for creating an inclusive and accessible space. The lack of these features particularly impacts vulnerable groups, including individuals with disabilities, older adults, and families with young children.

Table 3 presents Cronbach's Alpha values and the number of items for various themes related to satisfaction levels of existing facilities within KTM Rawang Station. Cronbach's Alpha measures the internal consistency or reliability of a set of items used in survey questions. Most themes show strong to very strong reliability or consistency,

with Urban Children, Aged, Disabled, and Scavengers (0.859), Satisfied with Space (0.887), and Safety (0.863) achieving very high Cronbach's Alpha values. Meanwhile, Health Facilities (0.643) shows a moderate consistency, suggesting that the items within this theme might not be as internally consistent. The overall Cronbach's Alpha for all variables combined is very high (0.948), indicating that the entire set of items used across themes is highly reliable.

These findings emphasise the urgent need for strategic improvements in key areas, such as expanding parking capacity, upgrading service quality, and incorporating universal design features to ensure inclusivity. Comprehensively addressing these issues is essential for improving user satisfaction, ensuring fair access, and strengthening the station's role as a vital part of the TOD framework.

TABLE 2. Satisfaction level of the existing facilities within Rawang KTM station

Name of Variables (Themes)	Cronbach's Alpha	Number of Items
Health Facilities	0. 643	5
Gender Equality and Women's Empowerment	0.814	7
Urban Poverty and Slums Improvement	0.824	6
Urban Children, Aged, Disabled, and Scavengers	0.859	8
Transportation Availability	0.814	4
Satisfied with Space	0.887	4
Open Space	0.722	5
Social Capital	0.709	8
Safety	0.863	6
Social Justice	0.796	4
Education Facilities	0.756	5
All Variables Altogether	0.948	62

TABLE 3. Satisfaction level of the existing facilities within Rawang KTM station

Level of Satisfaction	KTM Rawang Station Services	KTM Rawang Parking Areas	KTM Rawang Universal Design
	Percentages (%)		
1 Strongly Dissatisfied	9.60%	29.60%	20.00%
2 Dissatisfied	14.80%	24.80%	24.30%
3 Slightly Dissatisfied	32.20%	24.80%	34.30%
4 Slightly Satisfied	27.00%	13.00%	15.20%
5 Satisfied	12.20%	6.50%	5.70%
6 Strongly Satisfied	4.30%	1.30%	0.40%

FIGURE 5. Parking issues at Rawang KTM station

A crosstabulation analysis was used to identify the relationship between the variable "Is there any connection from KTM Rawang to other pedestrian sp aces?" and the variable "Does the pedestrian way at Rawang City provide a comfortable environment for walking?" (Table 4). The results showed that the provision of a pedestrian lane at KTM Rawang and Rawang City is "No", which is considered uncomfortable (80.86%), compared to respondents who answered "Yes". This is because there is no provision of a proper and continuous pedestrian lane in the area. People are more likely to cross at a busy street, which increases the risk of accidents at KTM Rawang. In addition, the lack of safe pathways could create a stressful environment for passengers and negatively impact the overall travel experience.

The result from the chi-square test showed a significant value below 0.05, indicating a significant relationship between the connection of pedestrian lanes and a comfortable environment for walking (Table 5). Potential solutions for these issues include creating clear, designated paths for pedestrians, which significantly enhance safety and accessibility.

Meanwhile, a crosstabulation analysis was used to identify the relationship between the variable "Does the cycle lane at KTM Rawang provide a comfortable environment for cycling?" and the variable "What is the main problem that respondents face while cycling in Rawang City?" Table 6 shows that the provision of a cycle lane at KTM Rawang and Rawang City is perceived as comfortable. At the same time, the problems faced by cyclists are unpleasant cyclist facilities (77.39%), weather (hot, heavy rain) (4.78%), accident risk with vehicles (9.56%) and lack of safety aspects (4.34%). This is because there are no provisions for a proper and continuous cycle lane at KTM Rawang. Cyclists are forced to share the road with other modes of vehicles, which could increase the risk of accidents.

The chi-square test yielded a significant value below 0.05, indicating a significant relationship between the problem of cycling and a discomforting cycling environment (Table 7).

TABLE 4. Crosstabulation Analysis between Connection Pedestrians from KTM Rawang to other Pedestrians and Comfortless Environment Walking at KTM Rawang

		Does the pedestrian way at Rawang City provide a comfortable environment for walking		Total
		Yes	No	
Is there any connection from KTM Rawang to other pedestrian spaces	Yes	33 (14.34%)	64 (27.82%)	97 (42.17%)
	No	11 (4.78%)	122 (53.04%)	133 (57.82%)
Total	Count	44 (19.13%)	166 (80.88%)	230 (100%)

TABLE 5. Chi-Square test of the Relationship between Connection Pedestrians from KTM Rawang to other Pedestrians and Comfortless Environment Walking at KTM Rawang

Level of Satisfaction	Value	df	Asymp Sig (2 sided)
Pearson Chi-Square	24.040	1	.000
Likelihood Ration	24.245	1	.000
Linear-by-linear Association	23.936	1	.000
N of Valid Cases	230	-	-

Note: Pearson Chi-Square: 24.040 (a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 1.5), Significant: p<0.05, Phi and Cramer's V; 0.323, N:230

TABLE 6. Crosstabulation Analysis between Comfortless Environment Cycling at KTM Rawang and Problems while Cycling at Rawang City

		What is the main problem that you face while cycling at Rawang				Total
		Unpleasant Facilities	Weather (Hot, Heavy Rain)	Accident risk	Lack of Safety Aspect (CCTV)	
Does the cycle lane at Rawang City provide a comfortable environment for cycling	Yes	3 (1.30%)	6 (2.60%)	0 (0%)	0 (0%)	9 (3.91%)
	No	178 (77.39%)	11 (4.78%)	22 (9.56%)	10 (4.34%)	221 (96.08%)
Total	Count	181 (78.96%)	17 (7.39%)	22 (9.56%)	10 (4.34%)	230 (100%)

TABLE 7. Chi-Square test of the Relationship between Comfortless Environment Cycling at KTM Rawang and Problems while Cycling at Rawang City

Level of Satisfaction	Value	df	Asymp Sig (2 sided)
Pearson Chi-Square	48.277	3	.000
Likelihood Ration	23.355	3	.000
Linear-by-linear Association	.991	1	.320
N of Valid Cases	230	-	-

Note: Pearson Chi-Square:48.277 (a. 3 cells (37.50%) have expected count less than 5. The minimum expected count is 0.39), Signi icant: p<0.05, Phi and Cramer's V; .458, N:230

RESULTS FROM EXPERT INTERVIEW

The study gained many valuable discernments from the three (3) Expert Interviews. The first expert (ER1) mentioned that most people who use private vehicles face traffic congestion at peak hours and feel frustrated due to time delays and increased travel time. Furthermore, public transport users face difficulty with the first and last mile because the infrastructure for pedestrians and cyclists in Malaysia (including Rawang) is not fully comprehensive. Public transportation coverage in Malaysian cities, particularly outside of the Klang Valley, is often insufficient. Usually, commuters frequently struggle to reach their final destinations from transit points due to inadequate feeder services or pedestrian infrastructure.

The officer claimed that the infrastructure, such as roads, pedestrian, cycle lanes, and parking spaces at Rawang, is in poor condition. However, the officer agreed that local authorities also have a significant role in planning permission because developers must submit a detailed proposal, including transportation impact assessments, to the local authority. If approved, planning permission may come with conditions related to transportation improvements, such as upgrading access or contributing to public transportation. Meanwhile, the second expert (ER2) believes smart mobility should be in place. He described that most people living in the suburbs of Rawang had to commute to their workplace in Kuala Lumpur. However, there is a lack of rail facilities in Rawang, which causes them to use private vehicles, thus contributing to the frequent traffic congestion.

Apart from that, the expert also stated that Rawang City has similarities with Kampar and Ipoh City. Many choose to live in Kampar while working in Ipoh. This situation shows that the demand for jobs in Kuala Lumpur is high, and the housing prices around Rawang are still higher than in Kuala Lumpur. With the house price in Rawang city around RM 500,000.00 for a landed house, but not in Kuala Lumpur, people decide to reside in Rawang instead. The third expert (ER3) had a different opinion concerning public transportation in Malaysia. He discussed the deficiency of access to ticket purchase. He argued the limitation of the payment system whereby train passengers have only the online option through the Touch n Go medium. Furthermore, compared to Singapore, people can access all public transport, like the MRT or LRT, with a pass. Nonetheless, he praised the affordable price of train fares. He believes Malaysian public transport is still developing, especially in cities outside Kuala Lumpur. The integration of public transport between different modes is improving. However, it can be inconsistent compared to Singapore, which possesses a highly integrated and efficient public transport system with seamless transfers between MRT, LRT, and buses, making Singapore's public transport system well-planned, clean, and punctual.

Additionally, the experts were asked about implementing the TOD concept in Rawang, and ER1 highlighted that the TOD concept in Rawang can significantly reduce car dependency by improving public transport, walkability, and accessibility. It would lower transportation costs, reduce air pollution, and improve community health. Prioritising public transport for non-car owners, such as the elderly and low-income residents, could also ease their access to jobs and services. Majlis Bandaraya Subang Jaya (MBSJ)'s implementation of TOD focused on Transit Station Development, Transit Adjacent District, and Transit Environmental District, supports these goals by emphasising pedestrian and cyclist connectivity to transit hubs. ER2 and ER3 claimed that proper infrastructure is crucial in TOD planning. Pedestrian paths, bike lanes, and public spaces must be expanded to enhance safety and accessibility, encouraging non-motorised transport. These improvements will reduce car usage, support public transport ridership, and provide a sustainable urban mobility model. Also, TOD should foster high-density development around transit stations.

Meanwhile, aspects lacking in the practice of the TOD concept and areas for improvement were then identified. ER1 responded that one of the primary issues with TOD in Rawang is the lack of compact urban development. High-density, mixed-use developments are essential to maximise the use of public transport and encourage walking and cycling. Rawang needs to better integrate public transport systems, particularly with the LRT and MRT lines in nearby areas like

Selayang, to make the region more competitive. Achieving a high-density urban area requires energy-efficient buildings, improved stormwater management, and green infrastructure to enhance resilience. ER2 added that the key challenge in implementing the TOD concept is addressing Malaysia's diverse topography and climate, which complicate infrastructure development. Effective implementation should prioritise transit areas near B40 residential areas to support people without cars. However, this approach requires a multi-faceted strategy to overcome the physical barriers posed by the country's terrain. While Rawang has a good plot ratio for TOD, integrating mixed-use developments and high-intensity urban planning must still be fine-tuned for successful implementation. ER3 argued that a major gap in the TOD concept is the lack of connectivity for the "first mile" and "last mile" segments. These critical parts of the journey must be safe and convenient to encourage walking or cycling to transit stations. Rawang should create better pathways, bike parking, rest areas, and reliable transit services to make public transport more appealing. Ensuring accessibility, safety, and convenience will improve the adoption of public transit, moving Rawang closer to achieving sustainable urban development.

Regarding *criteria for good pedestrian and bicycle paths in Rawang*, ER1 claimed that to improve pedestrian paths in Rawang, key features include covered walkways to protect from weather, durable materials, and safety elements such as barriers between pedestrians and vehicles. Paths should be inclusive and accessible for people with disabilities, strollers, and the elderly, with street furniture and suitable softscapes to enhance comfort and usability. Meanwhile, ER2 added that for cycling lanes, the width should be between 1.5 to 2 meters, with protection to ensure cyclists' safety. Lanes should be marked with painted lines, symbols, and signage to guide road users. Integrating bike racks at transit stations and providing a safe, clear path alongside the streets is essential for encouraging cycling. In addition, ER3 agreed that good connectivity between transit stations and destinations is vital for pedestrians and cyclists. This helps make public transport more accessible and comfortable. Encouraging walking and cycling can promote physical activity, reduce car dependency, and improve air quality. Proper amenities like benches and lighting further enhance the user's experience.

The other aspect was the *roles and responsibilities of MPS in implementing TOD in Rawang*. As suggested by ER1, the local authority for Rawang (Majlis Perbandaran Selayang – MPS) plays a key role in implementing TOD by overseeing planning permissions and establishing clear guidelines for development. Each development must include facilities like pedestrian pathways, parking, and universal design. MPS ensures TOD projects align with broader sustainability goals, enhance connectivity, and reduce car dependence. By managing land use policies and zoning, MPS can regulate development and ensure new projects integrate with existing transit systems. ER2 agreed that MPS should encourage redevelopment and keep urban areas updated. For example, MPS can maintain and improve streets to meet TOD standards. This can include improving public spaces and infrastructure to support TOD objectives and ensuring better access to transit systems. Meanwhile, ER3 claimed that MPS must enhance public transport services to support TOD. This includes providing accessible and reliable transport for all residents, especially vulnerable groups like the elderly and low-income individuals. High-quality public transport enhances urban livability by reducing commute times and offering more convenient travel options, critical for TOD's success.

Regarding *community participation in ensuring the effective implementation of TOD*, ER1 claimed that community support is crucial for successfully implementing the TOD concept in Rawang. Local authorities can encourage participation through public consultations, workshops, and online surveys to gather feedback and educate the community about TOD's benefits. Involving the community in planning helps tailor the project to meet their needs and preferences. ER2 added that the success of TOD depends on the quality and availability of facilities. Providing well-integrated transit facilities, safe pedestrian paths, bike lanes, and public spaces like community centres and libraries is essential. These amenities promote public transport, walking, and cycling while reducing the need for car travel. A comprehensive mix of facilities makes the area more adaptable to changes, fostering social interaction and improving the quality of life. Also, ER3 highlighted that community participation can include initiatives like a car-free day program, which encourages public transit, cycling, and walking. This program helps reduce car dependence and supports local businesses by increasing foot traffic. Engaging the community early ensures the TOD project aligns with their needs and gains public support, ultimately leading to successful and sustainable development.

Lastly, the question concerns *recommendations for implementing a successful TOD concept in the study area*. ER1 suggests that Rawang's infrastructure needs significant improvements to support TOD. The area around KTM Rawang lacks essential facilities like pedestrian paths, cycle lanes, and adequate parking. Local authorities are crucial in ensuring that TOD projects meet local plans and transportation policies. Developers must submit detailed proposals, including transportation impact assessments, to guide development and create sustainable, transit-oriented communities. These plans should clearly outline criteria that foster sustainable growth and improve residents'

quality of life. ER2 claimed that a tailored approach addressing local challenges and opportunities is needed to implement TOD at Rawang KTMB Station successfully. Early stakeholder engagement, including residents and local businesses, must ensure all concerns are addressed and a consensus is built. With collaboration from KTM Berhad and other transit agencies, improving transit services and infrastructure will be key to aligning TOD goals and enhancing connectivity. Also, ER3 suggested that effective TOD planning requires a detailed analysis of the surrounding area, including land use, infrastructure, and transportation patterns. Improving pedestrian walkways, cycle lanes, and bike-sharing facilities will promote non-motorised transportation. Upgrading the KTM Rawang station's infrastructure to accommodate higher-density development and increased ridership while ensuring utilities can support this growth is critical for TOD's success.

In conclusion, all of the experts expressed a greater emphasis on a city's infrastructure, plot ratio, and radius TOD. The distance from a transit station where development is concentrated is known as the TOD radius. This radius is typically between 400 and 800 meters, or a five to ten-minute walk. By focusing on construction within this range, it will be possible to guarantee that locals, employees, and tourists can easily walk to public transportation, encouraging the use of public transportation and lowering dependency on private vehicles. Conversely, higher plot ratios make providing services and amenities possible without needing much travel since they can accommodate more people and activities in the same region.

Therefore, a well-planned infrastructure can accommodate high-density living and working environments by guaranteeing effective transportation, sufficient utilities, and access to public services. To implement a successful TOD in Rawang, it is essential to provide smooth connections between transit areas, improve infrastructure with safe pedestrian and cycling facilities, ensure adequate and complete amenities, and promote sustainable transportation options. These steps will enhance connectivity, support non-motorised transport, and foster a more sustainable, accessible urban environment.

Responding to the findings from all the investigations, the researchers then formulated an approach for enhancement at the Rawang KTM station. The concept had integrated the principles of TOD, which focuses on the density, mixed-use of land uses and accessibility. These three (3) components we addressed as the indicators for the study in assessing the current conditions of the area. Hence, a "verdant walk" concept was recommended, incorporating ideas from previous scholars (Zhang and Lee, 2023; Abdullah et al. 2022; Closs, 2019; Rosni et al. 2018) (Figure 6).

The human-centric urban transit theme focuses on designing and developing transportation systems that prioritise the needs, well-being, and convenience of people over vehicles and infrastructure. This approach aims to create transit systems that are inclusive, sustainable, and enhance the quality of urban life (Figure 7). The components of development include shared streets, an upgrading of the existing parking area, a drop-off and pick-up area, an improvement to the design of the station, a proposed area for food trucks, mural art along the streets, a designated new on-street parking for KTM users and an underground passage for pedestrians.

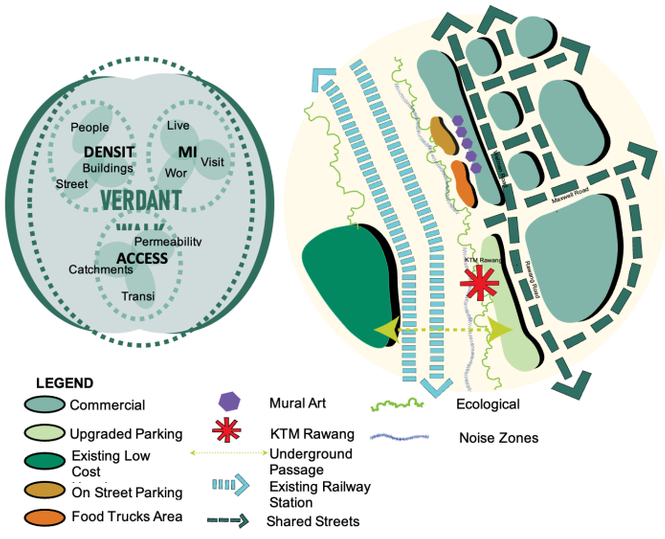

FIGURE 6. The concept for improvements at Rawang KTM station

FIGURE 7. The proposed development for Rawang KTM station

CONCLUSION

Rawang is a small city in the District of Gombak in Selangor. Two (2) Malayan Railway Limited (KTMB) railway stations in Rawang, namely Kuang KTMB Station and Rawang KTMB Station, are situated along the Rawang-Seremban line. The nearest Mass Rapid Transit (MRT) terminal station is Sungai Buloh MRT, while Gombak has the Light Rail Train (LRT) station. Rawang city centre, however, has long suffered from traffic issues like disruption in bus services, traffic congestion, poor street conditions and facilities for non-motorised.

The study focused on the Rawang KTMB Station, demarcating the study area to a 400-meter radius from the station. Using a Case Study research design, it conducted a questionnaire survey, site investigations, and expert interview procedures.

Results demonstrated that train users and the public value the importance of adequate infrastructure and highly appreciated facilities for pedestrians and cyclists near the transit station. The public also regards safety measures for pedestrians and cyclists as essential. Findings also revealed the importance of parking spaces, universal design that can accommodate the disabled, and quality services.

The site investigations discovered that the surrounding area of the transit station lacks an image and requires beautification. The safety of cyclists and pedestrians is also a major concern, even though access to the station is good. The ongoing construction project for parking spaces will solve parking issues in the future. Still, other facilities must also be evaluated to facilitate the disabled and perhaps create a dedicated lane for cyclists connecting to the station.

The overview of the three experts shows that rail transport, bus services, private vehicles, and non-motorised transport significantly impact Malaysia's urban transport issues. Planning for public transport in Malaysia involves a multifaceted approach to address the needs of its growing urban population, reduce traffic congestion, and promote sustainable transport. The integrated public transport network includes Light Rail Transit (LRT), Mass Rapid Transit (MRT), monorail, and commuter rail. Integration between these modes is essential for a smooth journey. Therefore, to realise a successful implementation of the TOD concept in Malaysia, opinions from expert interviews will be taken into account in the TOD concept proposal in Rawang.

The outcome of this study is believed to be useful for consideration in future interventions by local authorities experiencing similar rail transportation issues in small cities like Rawang. The findings may guide the Rawang authorities in any development attempts for urban transport improvement.

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DECLARATION OF COMPETING INTEREST

None.

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