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To cite this article: Y A Abdullah *et al* 2023 *IOP Conf. Ser.: Earth Environ. Sci.* **1217** 012025

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Rail-Based Transit-Oriented Development (TOD) From the Public's Perspectives in the Klang Valley, Malaysia

Y A Abdullah^{1,2}, N S Khalid^{1,2}, F N Nawawi¹, M A Marzuki¹, Z Ahmad Zaki¹
and O L H Leh¹

¹College of Built Environment, Universiti Teknologi Mara, Malaysia

²Responsive Environmental Development (RED) Research Interest Group, Universiti Teknologi Mara (UiTM), Cawangan Selangor, Malaysia

E-mail: yusfida@uitm.edu.my

Abstract. Malaysia faces the challenges of increased private vehicle ownership, which may draw negative impacts in the long run. Public transportation systems and land use must be integrated and strategised to reduce private transport dependency. The government has emphasised promoting a shift to public transport. Rail-based Transit-Oriented Development (TOD) is part of the government's efforts. To encourage the use of public transport, the system must support mobility and continuous accessibility of services. This study, therefore, aims at investigating the factors that may influence the use of rail-based public transport and to reflect the experience of rail-based users in TOD design. A multiple-case studies method was employed, and a questionnaire survey was performed through simple random sampling at five rail stations in the Klang Valley, Malaysia. Results demonstrated that TOD for rail-based public transportation requires the provisions of certain facilities, which may increase the public's preference in choosing rail-based as their commuting medium.

1 Introduction

One of the most prevailing issues in urban areas is traffic congestion, parking space, longer commuting duration, public transport inadequacy, difficulties for non-motorised transport, and high infrastructure maintenance costs [1]. Transportation is believed to be the second largest contributing factor to increased carbon emissions [2]. In Malaysia, the public is inclined to use their private vehicles for commuting due to the purchasing power of vehicles [2]. This has been continuing. Previous scholars in 2014 also mentioned a similar issue from their study conducted in the Klang Valley in Malaysia, which showed nearly 83% of 7.23 million daily trips are by private transport; most are made by single occupancy drivers [3].

The ratio of private and public vehicles is still alarming, and the government has drawn a target to reduce the number of private vehicles by shifting to public transport. To overcome urban issues such as congestion and urban sprawl, the need for urban policies to promote Transit-Oriented Development (TOD) [4] as a concept that can integrate land use and transportation in terms of compactness, mixed uses, and 5 to 10 minutes walking to the transit station. TOD is a compact mixture of land use comprising residential, commercial, offices, entertainment, and public spaces, which encourages walkability and is pedestrian-oriented. TOD is designed for low dependency on private vehicles, thus promoting sustainable living and working conditions in the community. TOD concept can ease urban transport issues, promote shifting from private transport users to public transport, and improve the surrounding land use and its value around transit stations. It should integrate urban places and be well connected to



transit stations of public transportation. The fact that the trains are moving on designated tracks and separated from other vehicles makes rail-based more attractive for commuters to escape road congestion, especially during peak hours.

In recent years, TOD has gained increasing significance in urban development. The concept of TOD benefited the development in many ways. Prioritising the movement of people using sustainable transport modes rather than cars delivers vast benefits for the health of citizens and the prosperity of cities. From spatial and environmental to social benefits, TOD brings a complete community living environment towards a liveable, healthy, and convenient place. Transit-oriented development aims to produce practical, blended-use, pedestrian-friendly urban neighbourhoods that incorporate travel, lodging, schools, parks, and other social and monetary enhancements, benefitting various associated groups [5]. TOD can provide a high level of access and thus higher quality of life, especially for disabled people and those who cannot afford their vehicles [6]. Therefore, this paper shares the findings of a study that investigates the factors that may influence the use of rail-based public transport. Thus, reflect the experience of rail-based users in TOD design and determining the provisions of certain facilities, which may increase the public's preference in choosing rail-based as their commuting medium.

2. Transit-Oriented Development (TOD) and Rail-Based Public Transport

In an extensive and fast-growing urban area, most urban dwellers drive a car to reach their destination. Most of the city is designed for vehicles, and the urban area is built with more roads, attracting traffic to the urban area. To encourage the use of public transport, the system must support mobility and continuous accessibility of services [7]. Calthorpe first introduced the initial TOD idea in 1993. Although numerous studies on TOD can be referred to, the evaluation of TOD studies based on the different themes can be distinguished. It explained why TOD studies required different approaches and methods across other geographic boundaries. TOD concept influences the urban character by prioritising accessibility and mobility, unlike conventional planning, which usually focuses on land use arrangement and is followed by transport planning. The idea of transit-oriented development (TOD) with mixed development of residential, commercial, and facilities within walking distance helps reduce the need for vehicles to travel. Other than encouraging public transport and non-motorised such as walking and cycling, the TOD idea also helps ease the uncontrolled urban sprawl.

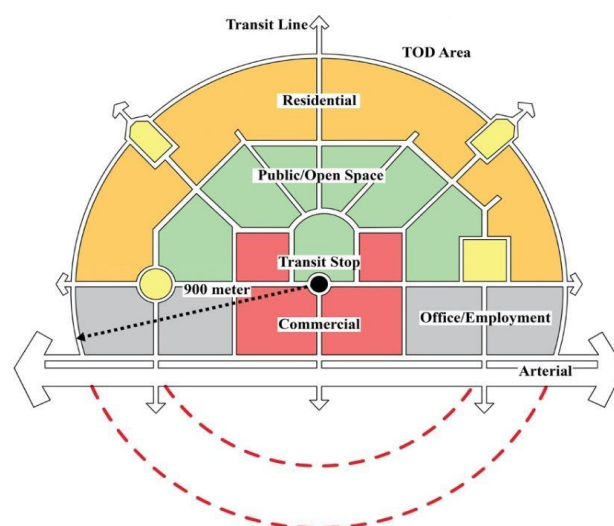


Figure 1. The TOD Concept
Source: Huang et al. (2021)

A TOD concept can maximise the efficiency of transport services by concentrating urban development around transit stations [8] (Figure 1). The purpose of TOD is basically to organise

settlements around transit nodes as centres of urban life [9]. In addition, TOD is described as land-use and transport planning that makes sustainable transport modes convenient and desirable and maximises the efficiency of transport services by concentrating urban development around transit stations [9].

2.1 Rail-Based Public Transport

The extension and development of a rail-based network may grow the potential of TOD implementation due to the growing interest in mixed-use commercial and residential projects specifically designed to maximise access to transit stations. TOD concept gains more interest from the government, developers, urban transport, urban planning, and users. Still, the question raised on how to ensure the negative impact derived from uncontrolled development due to the advantages of TOD without considering the application suitability in the local aspect hindrance the idea of achieving the benefit of TOD. It raises a concern about how the TOD would be able to meet the target group, notably those who will use public transport regularly. Proper study and planning are needed before the urban transport problems are locked in and become challenging to overcome later.

Rail-based transit is one of the urban transport improvement strategies to reduce urban issues such as congestion, enabling positive impacts from high-density and mixed-land use. Transport and land-use issues are derived from urbanism, and it is suggested that TOD is planned through transport and land-use integration [10]. TOD concept links to transport and land-use planning and creates sustainable urban development. The integration between transportation and land use is broadly agreed that lead to potential private car dependency in urban area [11].

Multiple public transport modes are already provided within Klang Valley and Greater KL. The provision includes rail-based transit systems such as MRT, LRT, Commuters, and Monorail. The provision of public transport is integrated and connected. The Klang Valley Integrated Transit System includes three (3) light rapid transit (LRT) lines, two (2) commuter rail lines, one (1) monorail line, one (1) bus rapid transit line, one (1) mass rapid transit (MRT) line and three (3) airport rail links, two (2) to the Kuala Lumpur International Airport and one (1) to the Sultan Abdul Aziz Shah Airport.

- Mass Rapid Transit (MRT)

The MRT has been operating since December 2017. Currently, the line is known as MRT Sungai Buloh-Kajang Line. It connects the major town and residential area within Klang Valley. Meanwhile, MRT 2 (Putrajaya Line) will be fully operated at the end of 2021. The line consists of 31 stations for the MRT Kajang line and 35 stations for MRT Putrajaya Line.

- Light Rapid Transit (LRT)

Operated since 1996 and consist of three (3) major line, which is the LRT Ampang line and LRT Sri Petaling Line (both 36 stations), and LRT Kelana Jaya Line (37 stations). Similar to MRT, this rail system connects the major town centre and residential areas in the Klang Valley. Currently, the project for LRT 3, namely Shah Alam, is still under construction and consists of 26 stations around the Klang Valley region.

- Keretapi Tanah Melayu (KTM)

Commuters are rail services in Kuala Lumpur (KL) and the suburbs of Klang Valley. In the central area, there are three (3) lines operated for commuters, namely as Seremban line (26 stations), Port Klang Line (34 stations), and Skylark Link (3 stations). Under the KTM services, there are also KTM Intercity, and Electric Train Service (ETS) or inter-city rail explicitly operated for long journeys through peninsular Malaysia.

- Express Rail Link (ERL)

This system is an airport rail link and consists of two (2) train services known as the KLIA Express (direct airport rail service directly from KLIA to KL Sentral) and KLIA Transit (commuter rail service with three additional stops between KLIA and Monorail KL Sentral). There are six (6) stations through the ERL system.

- Monorail

The Kuala Lumpur (KL) Monorail is an intra-city public transit system that links many key destinations within KL. The KL Monorail link is 8.6 km long and has 11 stations. It is one of the

components of the Klang Valley Integrated Transit System. It is an elevated railway system and shorter than LRT or MRT.

Most agencies related to transportation or local authorities responsible for land planning have mentioned Transit-Oriented Development (TOD) to optimise land use planning while integrating effective urban transportation systems. PLAN Malaysia, one of the major agencies responsible for land planning in Malaysia, justified that TOD is a land-use solution emphasising accessibility, compact development, high density, and mixed-use development near the transit station [12]. The agency added that a typical TOD neighbourhood usually has a diameter of a quarter to half a mile (400m-800m), representing pedestrian scale distances (5-10 minutes-walk). One of the most important parts of implementing TOD is the existence of public transportation system, especially a rail-based type of public transportation. In line with this research, this section will give an overview of the rail-based public transportation system operated within the Klang Valley.

Many other cities throughout the world demonstrate the excellent practices of TOD. A good example of the TOD concept can be seen from our neighbouring country, Singapore, which has similar characteristics to Malaysia in terms of climate, culture, beliefs, and way of life. Singapore has proven that their practice of connectivity for pedestrians from the TOD design is effective. The TOD planning and development in Singapore prioritise the right balance between buildings and spaces for social activities, but most importantly, adequate parking and traffic management for cars, motorcycles, bicycles, and other vehicles. Also, TOD in Singapore focuses on convenient pedestrian connection and accessibility to the transit stations from the nearby residential areas.

In Singapore, the implementation of TOD follows the basic principles of TOD, including the combination of diverse mixed-used land use with development intensity near the transit stations, provision of convenient public transportation, and infusion of space, comfort, safety, and greenery. The Raffles Station in Singapore is an excellent example of the TOD design. Situated within the Central Business Area (CBD), the provision of MRT is served by bus and taxi services along with parking areas and bicycle facilities. The Climate Leadership Group, which consists of experts from various countries, named Singapore City an excellent example of TOD implementation, which sees the integration of urban design into development and concentrates on pedestrian links. Singapore's fundamental elements and practices can be a good reference to Malaysia.

3. Methodology

TOD integrates mobility and land use which is different from conventional planning, where the transit options come later after spatial planning. The extension and new development of train networks in GKL/KV, such as Light Rail Transit Line 3 (LRT 3) and Mass Rapid Transit (MRT), are expected to pave the way for TOD implementation nearby the station area. The local transport operator Prasarana Malaysia Bhd will apply the TOD concept to maximise the function of land nearby train stations [13]. The establishment of rail infrastructure through TOD implementation has also positively impacted property values and attracted transit property developers to sell the TOD idea on their land near the station area [14].

The study applies a multiple case study approach using five (5) rail-based stations in the Klang Valley, Malaysia, as the case studies. These transit stations involved Surian Mass Rapid Transit (Surian MRT) in Petaling Jaya, Putra Heights Light Rail Transit (Putra Heights LRT), Subang Jaya Komuter (Subang Jaya KTM) in Subang Jaya, Tun Sambathan Monorail in Kuala Lumpur, and Salak Tinggi Express Rail Link (Salak Tinggi ERL) in Sepang. The selected transit stations were picked based on the objective of investigating the public's requirements for rail-based public transport and determining the factors that may induce the public to use public transport. Also, the types of services were diverse to enable the researchers to understand the uniqueness of each rail-based transportation and how the users perceive them. In addition, users tend to change the commuting medium from one type of service to another following their travel route and not necessarily stick to the same service since the rail-based stations serve numerous locations throughout the Klang Valley. One may need to switch to another rail-based transport to travel from one point to another.

The samples were calculated from the Klang Valley estimated population of 7,200,000 for 2016 [15], with a 5% margin of error, 95% confidence level, and 50% response distribution resulting in 385 samples representing the population for the study. The respondents were selected using the Simple Random Sampling approach, but the study only received 202 receptive participations for the questionnaire survey. Nevertheless, the total responses are considered adequate based on the calculation and the response rate. The samples were selected within 400 meters of the selected stations, and each station is targeted at 77 respondents. The respondents were only interviewed if they were the users of the transit stations and were willing to participate. The survey, therefore, managed to obtain completed questionnaire forms from 36 respondents (Salak Tinggi ERL), 52 respondents (Putra Heights LRT), 28 respondents (Tun Sambathan Monorail), 45 (Subang Jaya KTM) and 41 respondents (Surian MRT). The survey was carried out during the peak hours in the afternoon (12.00 pm – 2.00 pm) during a whole week (Monday to Friday) to gather a varied group of people and also because the transit stations are situated within the Central Business District (CBD) areas. It allows chances of getting diverse respondents instead of the rush hours in the morning or the evening (when most people of working group age). The completed questionnaire forms were then analysed using the IBM SPSS Statistics software, concentrating on correlation analysis since the study requires understanding certain relationships between variables to investigate the factors that influence the users. Figure 2 below summarises the flow of the study.

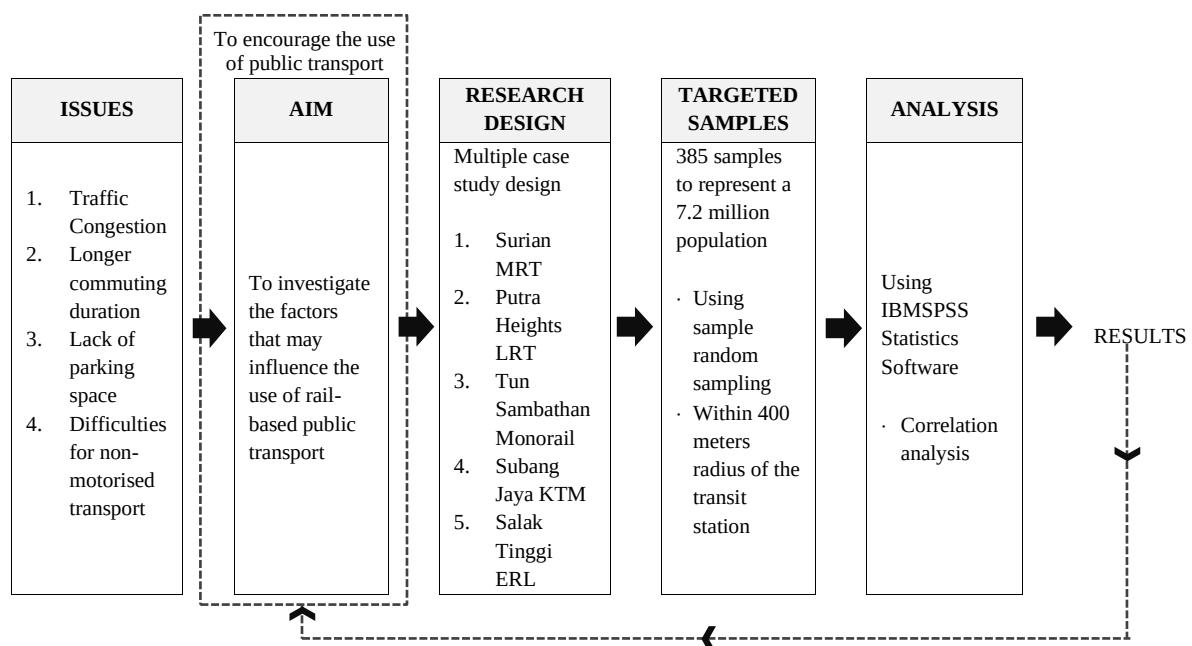


Figure 2. Flow chart of the Study Approach

4. Results and Discussion

This study only accepts respondents inclined to participate in the survey and train users (not individuals at the transit stations with other purposes or intentions). Since the study involved rail-based transit stations in the CBD areas, the researchers had anticipated that it would not be straightforward to get engagement from the public. It is accepted that usually, at transit stations, people are there to commute and are on the move. Nevertheless, the researchers managed to gain 202 responses. From the background analysis, 131 respondents were females, and 71 were males. Most respondents fall into the age group of 21 to 30 years (46.5%), followed by those between 31 to 40 years old (26.7%) and respondents below 20 years old (19.8%), 41 – 50 years old (5.9%) and above 50 years old (1%). This study cannot assume that most of the younger generations (21 – 30 years old) prefer to travel by rail-based public transport

and use the transit stations during weekdays at peak lunch hours. But observations and situations during the approach survey informed that these respondents are more likely to partake even though they are at the stations for the same purpose of commuting as compared to the other age groups.

When understanding the respondents' occupation, the study managed to receive 39.6% of the respondents working in the private sector, 29.7% students (contributing to the portion of the 21-30 years of age group), 14.9% self-employed, 11.9% from the government sector and 4% fall into another category (which include as a housewife). The study also explored whether the respondents that use rail-based transportation have possession of a vehicle, and it was revealed that most of the respondents (60.4%) have ownership of a vehicle. The rest do not have ownership of a vehicle. Based on the study, it was exposed that the respondents preferred the trains to reduce their travel costs (Figure 3).

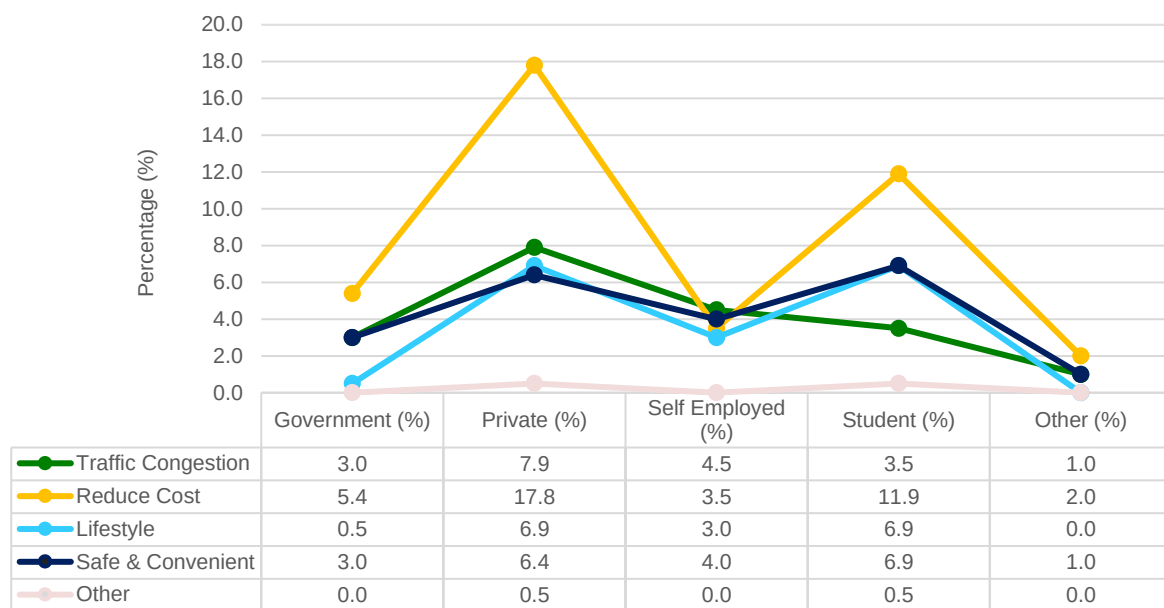


Figure 3. The Motive of Using the Public Transport by Occupation

Figure 3 demonstrates that part of the reasons for using the trains includes reducing costs, avoiding traffic congestion, safety, convenience, lifestyle, and other reasons. When asked further, most respondents from the private sector claimed that public transport could reduce the cost of monthly commitment to pay for their private vehicle mortgages and save traveling time by avoiding traffic congestion.

The study looked at the frequency of using public transport by age group to understand further the number of trips made by each respondent in a week. The results indicated that those from the age group of 21 to 30 years old travel daily by train (6.9%) or frequently (3 to 5 times) in a week (Figure 4). These respondents chose public transport because they are students or young adults with jobs and are in the phase of achieving financial stability. This is why most respondents that travel by train decided that using the train may reduce the cost of traveling

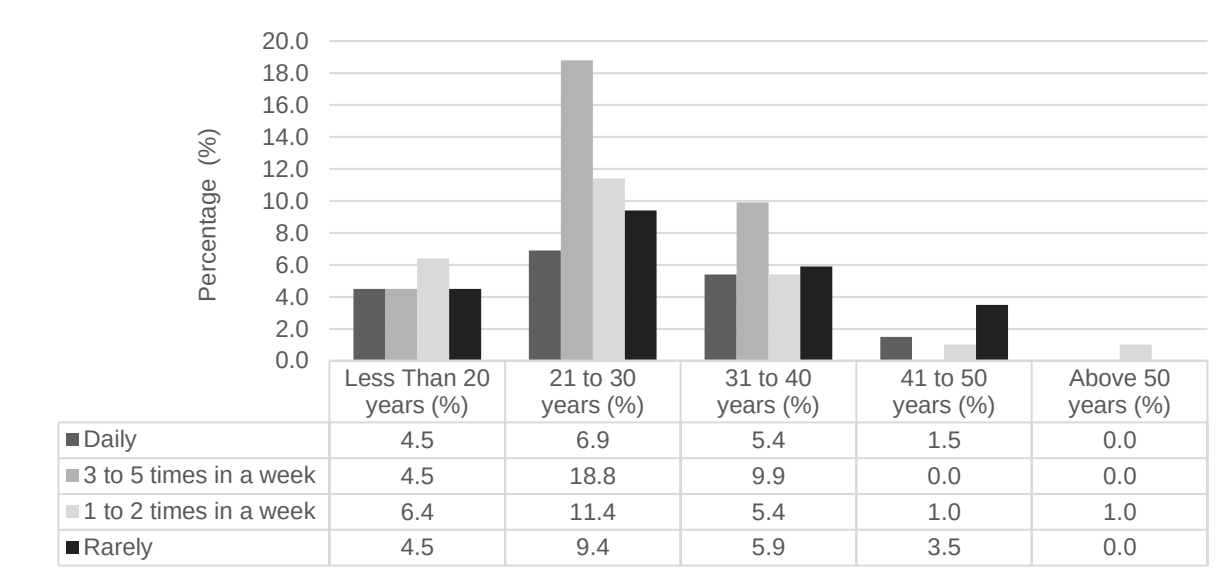


Figure 4. The Frequency of Using the Trains by Age Group

The researchers also conducted the ‘origin and destination analysis to identify the users’ travel patterns. They discovered that more than half of the respondents (59.4%) arrived at the transit stations from home, while 16.8% came from a shopping mall or shops, and the rest were from offices or other places. And when asked where they were going from that transit station, most users were heading to shops or shopping malls (Table 1; Figure 5).

Table 1. Users’ Origin and Destination

COMPONENT	TRANSIT STATION										TOTAL OVERALL	
	SURIAN MRT		PUTRA HEIGHT LRT		TUN SAMBATHAN MONORAIL		SUBANG JAYA KTM		SALAK TINGGI ERL			
	User	%	User	%	User	%	User	%	User	%	User	%
1. Travelling from origin to transit station												
Home	22	53.7	39	75.0	9	32.1	30	66.7	20	55.6	120	59.4
Office	6	14.6	8	15.4	3	10.7	4	8.9	9	25.0	30	14.9
Shops/Shopping Malls	12	29.3	1	1.9	10	35.7	9	20.0	2	5.6	34	16.8
Institution	1	2.4	4	7.7	5	17.9	1	2.2	4	11.1	15	7.4
Other	0	0	0	0	1	3.6	1	2.2	1	2.8	3	1.5
Total	41	100	52	100	28	100	45	100	36	100	202	100
2. Travelling from transit station to the destination												
Home	14	34.1	5	9.6	6	21.4	11	24.4	14	44.4	50	24.8
Office	12	29.3	20	38.5	4	14.3	19	42.2	6	16.7	61	30.2
Shops/Shopping Mall	15	36.6	21	40.4	10	35.7	7	15.6	16	38.9	69	34.2
Institution	0	0	6	11.5	5	17.9	8	17.8	0	0	19	9.4
Other	0	0	0	0	3	10.7	0	0	0	0	3	1.5
Total	41	100	52	100	28	100	45	100	36	100	202	100

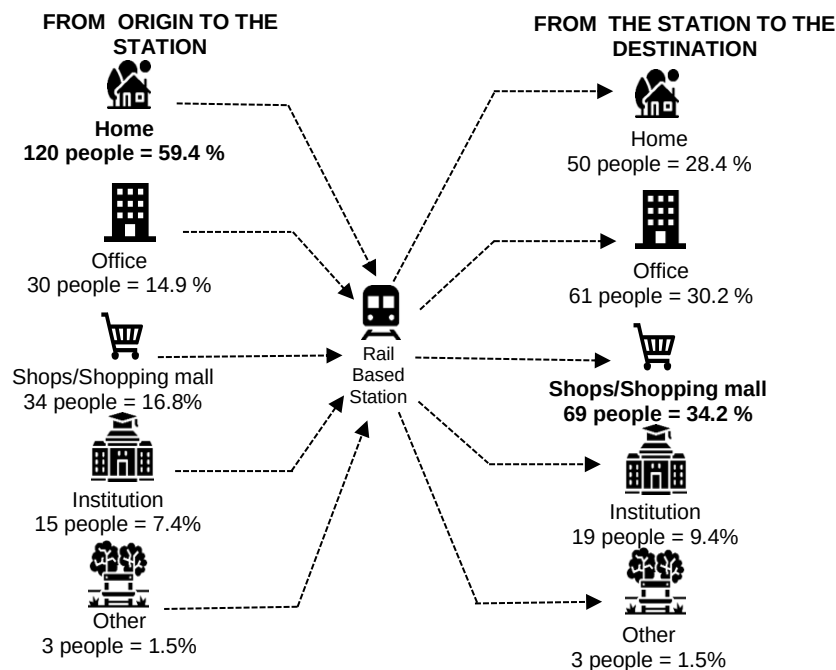


Figure 5. Results of Origin-Destination Analysis

In addition, the survey also identified the mode of transportation from the origin to the transit station by the respondents, whereby 49% used their private vehicle to reach the transit stations, and 39.1% came by other public transport. Meanwhile, most users will take another train ride from the transit stations to the next destination, while 21.8% decided to walk from the stations to the following location. Thus, it can be shown that the provision of pedestrian walkways along the station and the connectivity between public transport services are important to encourage people to use the active transport mode efficiently and use public transport regularly (Figure 6; Table 2).

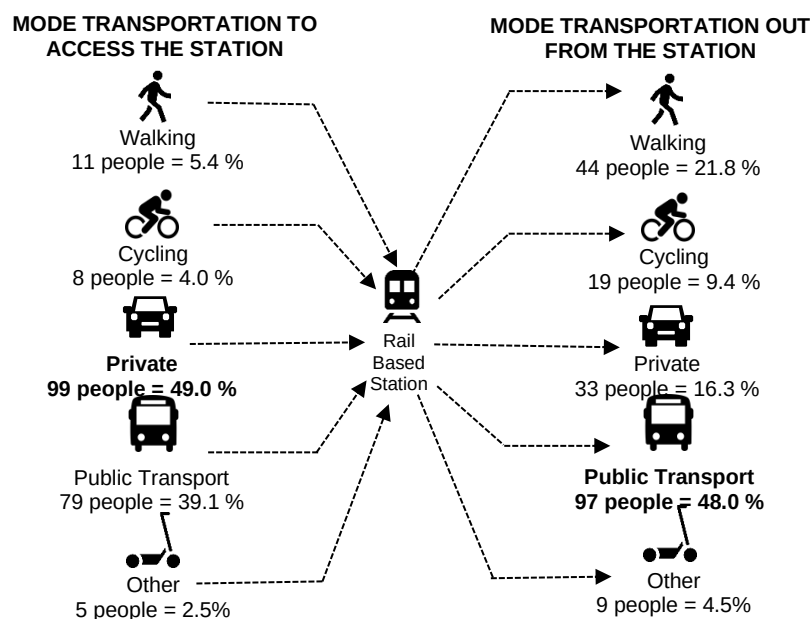


Figure 6. Results of Mode of Transportation from Origin/Station to Station/Destination

Table 2. Mode of Transportation (Origin/Station to Station/Destination)

COMPONENT	TRANSIT STATION										TOTAL OVERALL	
	SURIAN MRT		PUTRA HEIGHT LRT		TUN SAMBATHAN MONORAIL		SUBANG JAYA KTM		SALAK TINGGI ERL			
	User	%	User	%	User	%	User	%	User	%	User	%
3. Mode of transportation from origin to the transitstation												
Walking	0	0	3	5.8	1	3.6	5	11.1	2	5.6	11	5.4
Cycling	6	14.6	0	0	0	0	2	4.4	0	0	8	4.0
Private Vehicle	19	46.3	35	67.3	3	10.7	23	51.1	19	52.8	99	49.0
Public Transport	16	39.0	12	23.1	24	85.7	13	28.9	14	38.9	79	39.1
Other	0	0	2	3.8	0	0	2	4.4	1	2.8	5	2.5
Total	41	100	52	100	28	100	45	100	36	100	202	100
4. Mode of transportation from transit station to destination												
Walking	0	0	18	34.6	9	32.1	10	22.2	7	19.4	44	21.8
Cycling	16	39.0	1	1.9	1	3.6	1	2.2	0	0	19	9.4
Private Vehicle	6	14.6	6	11.5	1	3.6	7	15.6	13	36.1	33	16.3
Public Transport	19	46.3	21	40.4	17	60.7	26	57.8	14	38.9	97	48.0
Other	0	0	6	11.5	0	0	1	2.2	2	5.6	9	4.5
Total	41	100	52	100	28	100	45	100	36	100	202	100

4.1 Analysis of the Three (3) Main Criteria for TOD (Rail-Based Public Transport's User);

Connectivity, Comfort, and Safety

The analysis then focused on the three (3) main criteria for TOD in assessing the respondents' views and suggestions. Following the essential criteria retrieved during the literature review that showed the importance of "connectivity", "comfort", and "safety" in TOD concept and design, therefore the study evaluates the perceptions of the users from these three (3) aspects.

a. Connectivity

The analysis showed that 74.3% of the respondents agreed that the transit stations offer connectivity from the surrounding area to the station, while 72.3% appreciate that other public transports also exist. In addition, 53% of the total respondents thought that the bus stop enables connectivity and the transit stations are easily accessible (Figure 7)

b. Comfort

When asked about the various aspects of "comfort", respondents gave their perceptions accordingly by answering from the most preferred facility to the least required. Most respondents from all transit stations (78.2%) are happy that the transit stations are equipped with information boards that inform the vital requirement at a transit station that should be able to provide information to the users. Otherwise, the second preference, with a majority of 72.8% of respondents, decided that the numerous types of business activities give them comfort, followed by the stations' exciting and attractive surrounding conditions (65.8%). 59.4% chose time and walking distance as other important comfort elements. Additionally, 55.4% mentioned the importance of waiting areas for comfort, and 53% felt comfortable because of the variety of activities besides business at the transit stations. From the analysis, it was noticed that 96% of the total respondents agreed that the facilities for cyclists are not necessary and are not part of the major requirements at transit stations. However, the most intriguing finding was that from

all the respondents at each station, the Tun Sambathan Monorail was selected by most of its respondents as a comfortable transit station.

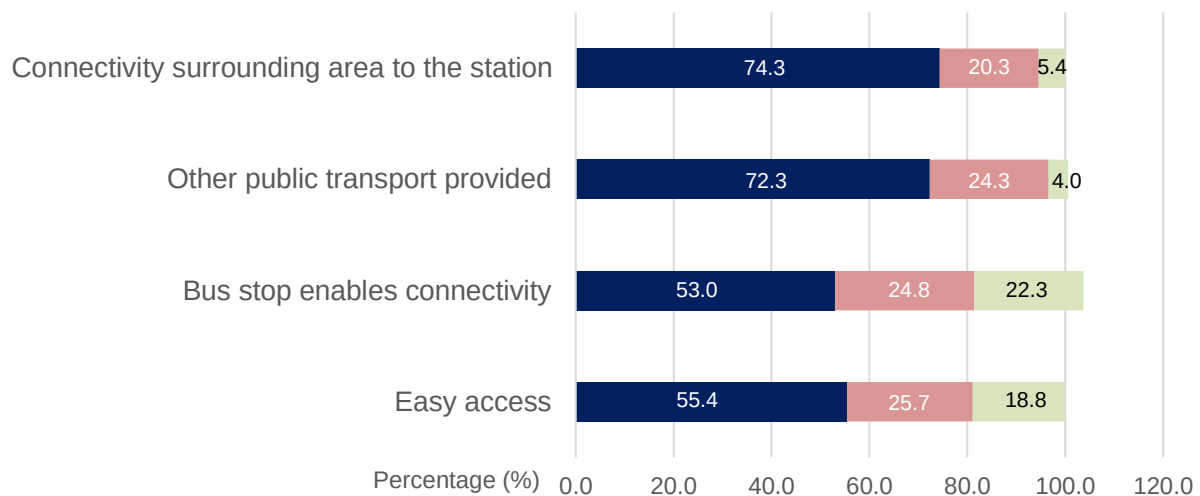


Figure 7. The Element of Connectivity

c. Safety

Other criteria were the 'safety' aspect. The researchers discovered that the first most essential safety measure was highlighted as the provision for disabled facilities (71.8% of respondents chose this aspect), and the second aspect was to have safe waiting areas at the transit stations.

4.2 Requirements by the Users in Relation to the Concept & Design of TOD

The investigations also recognised the requirements of the train users with the concept of design of TOD. The first design requirement was the suitable walking distance to the transit stations. The majority of the respondents (49.5%) thought that an ideal distance to walk to the stations would be between 100m to 200m, and many others believed that a suitable distance would be less than 100m (31.7%), 17.3% (200m – 300m) and only 1.5% chose more than 400m. The result indicated an ideal walking distance for the local climate is 100m to 200m. This result may not match the suggested principle of a distance between 400m to 800m since the recommended distance is widely accepted worldwide. But considering the hot and humid weather, the locals felt walking shorter distances was more comfortable. Additionally, most respondents (53%) thought the perfect walking duration would be between 5 to 10 minutes only. However, 29.7% thought walking in less than 5 minutes of transit stations is better, while 17.3% perceived an ideal walking time as between 10 and 15 minutes.

When asked about a list of additional requirements at the transit, the respondents provided numerous suggestions for the transit stations or within the surrounding areas. Some suggestions are worth considering when designing the concept of TOD for the local people as these recommendations may encourage more to use trains as a way of commuting. Many respondents (28.2%) responded that an assortment of businesses at transit stations would be the first additional element to be added. Another 16.8% of the respondents prefer working places or offices near the stations, 15.8% would like affordable housing at the stations, and 11.4% chose comfortable pedestrian pathways. Others suggested recreation facilities (10.4%), easy access to walkways (10.4%), active environment (5.4%), and finally, additional public space & landscape (1.5%). These suggestions remind us of designing for the people, which signifies the pulling factor to encourage the public to use public transport.

5. Conclusion

Transit-Oriented Development (TOD) is supposed to reduce urban transportation issues by encouraging public transport usage for commuting. TOD is said to prioritise people's movement by using sustainable transport modes, thus promoting environmental and social benefits. The TOD concept can maximise the

efficacy of transport services by paying attention to the development and supporting facilities around transit stations. The extension and development of a rail-based network may grow the potential of TOD implementation due to the growing interest in mixed-use commercial and residential projects specifically designed to maximise access to transit stations. In Malaysia, there are various modes of rail-based transit, including monorail, light rapid transit, rapid mass transit, express rail link, and commuter. This study focused on rail-based TOD users and selected five (5) transit stations in the Klang Valley, Malaysia, intending to examine the factors that may influence the use of rail-based public transport. Results revealed that during the weekdays (peak hours of lunchtime), primarily those with their vehicles chose to ride the train to reduce the cost of traveling. Also, rail-based passengers decided that trains could avoid traffic congestion. Additionally, most users traveled to the transit station from home using their vehicle and continued their journey to other destinations using the train. Most importantly, most users claimed that the transit stations offer connectivity to other places. Nevertheless, “connectivity”, “Comfort”, and “safety” are among the essential factors that can influence and encourage the public to use rail-based public transport. This study also highlights some of the major features suggested by the local rail-based users to increase the comfort level of users at transit stations. Users claimed that the existence of information boards will influence the comfort level of train users, and the provision of varieties of businesses at transit stations, as well as a shorter walking distance to the transit stations. Otherwise, another important aspect is the provision of facilities for the disabled for the purpose of safety measures. These elements may provide ideas for consideration when designing new TOD or improvements to existing transit stations. Future research is suggested to examine the link between land use planning and TOD to determine the consequences of land use towards TOD.

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Acknowledgements

The authors wish to thank Universiti Teknologi Mara (UiTM) for funding this research under the “Geran Penyelidikan Khas” (600-RMC/GPK 5/3 (057/2020)) and would like to thank UiTM Research Management Centre (RMC) and the College of Built Environment, UiTM Shah Alam for supporting the study.

Paper Contribution to Related Field of Study

This paper highlights the factors that influence the users of rail-based public transport and demonstrates the essential requirements in TOD planning. The findings can guide transit-oriented development since the users’ preferences are the key to adequate public transportation.