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TRANSIT ORIENTED DEVELOPMENT (TOD) FOR EARLY-BUILT RAIL-BASED TRANSIT STATIONS: POSSIBLE OR PLAUSIBLE?

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Abstract

Transit Oriented Development (TOD) embraces many principles, and is believed to be beneficial in tackling the issues of urban transportation. Some of the main dilemmas are urban accessibility, traffic congestion, and the efficacy of the public transportation system. In Malaysia, the TOD concept was introduced in 2005, much later after Calthorpe embarked on the idea. Rail-based public transport emerged much earlier in Malaysia to meet the demands for public transportation. To date, it is still debatable whether these transit stations deliver on the principles of TOD. Hence, to determine that, this study examined two transit stations that were developed way before the TOD concept was executed in the country. The aim was to evaluate the core areas of Subang Jaya Commuter Station and Tun Sambanthan Monorail Station, based on their components and features, in relation to TOD principles, and to examine the possibility of these early-built transit stations in becoming an ideal TOD. The study evaluated the land use components using the Case Study Method, together with the existence of several principles, namely "connectivity", "facilities", "safety" and "comfort". Results indicated that both transit stations reflect some of the TOD measures, but these are not comprehensive throughout the 400m radius of the core areas. The stations have potential, but require a systematic approach to achieve TOD ideals since both areas are saturated with development, and making changes to land use may not be straightforward.

***Keywords**:* Transit Oriented Development (TOD), Rail-Based, Transit Station, Land Use, Public Transportation

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BACKGROUND

Accessibility has become one of the many urban issues in developing countries including Malaysia. Among those issues are the perpetual traffic congestion, and weak public transport systems (Tsumita et al., 2023). Tsumita et al. (2023) also mentioned that Transit Oriented Development (TOD) is important alongside rail corridors in order to achieve equitable rail transit accessibility to all areas. They also believe that the efficiency of the transport system relies on not only the system itself, but also mixed land use. Additionally, TOD plays an important role in solving the issue of urban sprawl, which often affects the municipal budget, environment, transportation, and housing (Mathur & Gatdula, 2023). However, the question of how effective TOD is in Malaysia is raised especially since it is considered a new effort.

The basis of TOD is its direct connection to a transit station within one-half of a mile (Mathur & Gatdula, 2023), hence encouraging walking and cycling, and discouraging the use of private vehicles. Nevertheless, implementing TOD requires improvements in transit ridership, carbon emissions, and traffic congestion. Thus, to reduce the need for private vehicles, there is much need for the integration of the public transport system and land use (Yen, Feng & Lee, 2023). Even though TOD is claimed to be an effective tool for sustainable development, obtaining funding may be a challenge.

TOD and Land Use

TOD is believed to be a planning approach that incorporates land use with public transportation, which considers the development surrounding the stations (Yen, Feng & Lee, 2023). It was claimed that, when it was introduced in the 90s, land use, density, and walkability were the three (3) key strategies in the TOD design. In addition, Boarnet and Crane (2001) mentioned that TOD's paramount transportation objective is coordinating land use policies to facilitate transit stations.

When TOD was introduced, the idea was to pay greater attention to sustainable community development surrounding the transit stations. TOD therefore combines various forms of development, including housing, commercial or retail, offices, recreational areas, and public facilities (Chen et.al, 2023). Additionally, Abdullah et al. (2022) agreed that land use planning is imperative when designing a TOD as it will influence the performance of the TOD. The land use arrangement of a TOD affects people's movement patterns, and by walking, it ensures that a variety of activities are also accessible. Scholars suggest that the essential principles of TOD consider the elements of connectivity, walkability, safety, distance, mixed-use, comfort, density, transit, cycling, compactness, active activities, and facilities (Mathur & Gatdula, 2023; Transit Oriented Development Institute, 2021; The World Bank Group, 2021;

Alter, 2020; Institute of Transportation and Development Policy, 2013; Reconnecting America Organization, 2008).

The aim of this paper was therefore to investigate the existing components and features of transit stations in Malaysia that were developed before the TOD concept was introduced, and to examine the possibility of these areas becoming an ideal TOD. To achieve this, several indicators were identified for investigation as described in the methodology section below.

METHODOLOGY

This study aimed to examine the transit stations in the country that were built before the TOD concept was introduced for TOD criteria and indicators. The purpose was to evaluate whether the transit stations reflect and possess the elements of an ideal TOD. Hence, to create a functional TOD, it is suggested that the peripheral areas around the transit stations be considered for any future new area development or revitalisation. In Malaysia, the application of TOD was first mentioned in 2005 in the Malaysia National Physical Plan, and later encouraged again in the National Physical Plan 2010 (Azmi et al., 2021; Ministry of Urban Wellbeing, Housing and Local Government Malaysia, 2016).

The study employed a Multiple Case Study design with two (2) transit stations in the Klang Valley, i.e., Tun Sambanthan Monorail Station, and Subang Jaya Commuter Station. The reason for having two (2) different transit stations was to examine the similarities and differences of rail-based TOD, and to capture the distinct features of each of these stations that were established long before the idea of TOD was put forth in Malaysia.

Subang Jaya's spatial arrangement started in 1974 when Sime UEP Properties Berhad transformed the rubber plantations into a new township. However, the railway connecting Kuala Lumpur to Klang had already been built in 1886. The Subang Jaya Commuter Station itself was opened in 1995. Meanwhile, the urban surroundings of the Tun Sambanthan Monorail Station (including Brickfields) had emerged during the colonial era when the British brought in the Indians to build the railways. The Tun Sambanthan Monorail Station began operations in 2003. Through conventional planning, the area eventually became developed though the concept of TOD was not implemented as it had not yet been introduced then. The Subang Jaya Commuter Station, and Tun Sambanthan Monorail Station were therefore designed to meet the current demands at the time, especially public transportation.

In conducting the investigation, aside from the specifications, criteria, and standards outlined by other scholars, the study referred to the essential TOD guideline by the Malaysian Department of Town and Country Planning (2018) since it addresses the local context, urban settings, and requirements. The main indicator in this study was the boundary of the study area. The approach was to

conduct a detailed investigation at the sites by assessing the land-use components within a 200-metre, and 400-metre radius from the transit stations.

According to the Department of Town and Country Planning (2018), a 400-metre span from the transit station is considered the core area of a TOD, or classified as the *Transit Influence Zone*, whereby it has an impact on the surrounding areas. The 400m zone is also identified as a high-intensity territory, and should therefore be the centre of economic, administrative, employment, residential, and cultural activities (Figure 1). Demarcating this perimeter was necessary to evaluate the facilities closest to the transit stations.

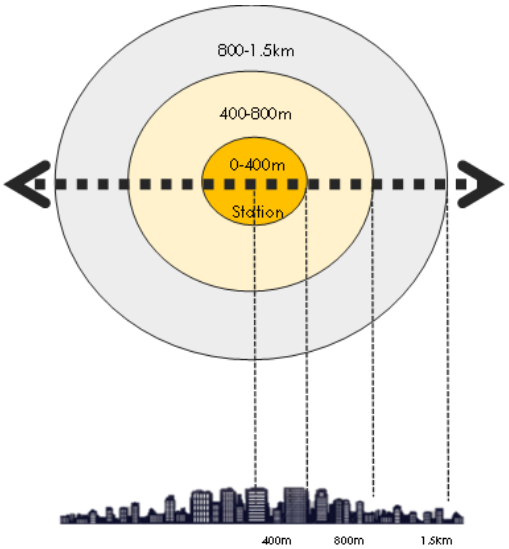

Figure 1: The radius of the study area covers the 400-metre territory from the transit station classified as the "Transit Influence Zone"
Source: Department of Town and Country Planning (2018)

The guideline also suggested the provision of feeder bus services equipped with the supporting facilities. In this manner, several indicators involving the type of land use, in accordance with the guideline, were applied for assessment, including residential areas in proximity, commercial buildings, and public facilities. According to scholars, there are many principles and criteria for an ideal TOD (Figure 2). However, for this study, in order to evaluate the functionality of the transit station facilities, only four principles were selected, namely "*connectivity*", "*facilities*", "*safety*", and "*comfort*" since transit stations are deemed ideal if the elements meet these specific needs of users. These four (4) principles were chosen because they influence human emotions, senses, and

satisfaction. Subsequently, these principles were then itemised according to indicators (attributes).

The inspection limit of this site investigation was a radius of 400 metres from the transit stations, which constitutes the Transit Influence Zone as referred to in the local TOD Guideline. The analysis of these sites was divided into two (2) parts. The first part targeted the composition of the land use within the 400-metre boundary. This included evaluating the supporting facilities and amenities in the vicinity of the stations. The second part evaluates the extent of their compliance to and weaknesses in the TOD (in terms of the existence of indicators) as put forward by the Department of Town and Country Planning (2018). For this study, the existence of these elements within the radius of 100m, 200m, 300m, and 400m was investigated. By doing so, the outcome of this study would convey the potential of both transit stations in achieving ideal TOD practice. For each transit station, the site investigations involved observation and inspection of the existence of the four (4) principles within the 400-metre radius.

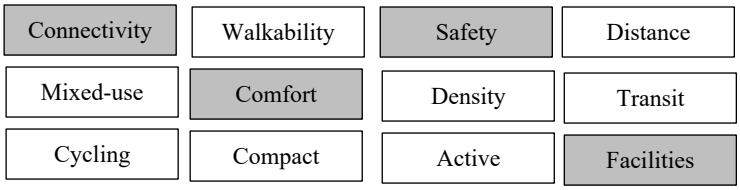

Figure 2: The TOD principles selected for the study – Connectivity, Facilities, Safety, and Comfort

Source: Mathur and Gatdula (2023), Transit Oriented Development Institute (2021), The World Bank Group (2021), Alter (2020), Institute of Transportation and Development Policy (2013), and Reconnecting America Organization (2008)

FINDINGS AND DISCUSSION

Existing Composition of Land Use Surrounding the Transit Stations

With reference to the TOD Guideline by the Department of Town and Country Planning Malaysia (2018), the study revealed several similarities and differences between the Subang Jaya and Tun Sambanthan transit stations. Since the spatial arrangements for both areas were made before the transit stations were built, it is no surprise that development was focused on housing and commercial.

For both stations, residential areas were one of the land use components. However, Subang Jaya only has medium and high-cost houses, while Tun Sambanthan only has low-cost houses (Table 1). This does not indicate an ideal TOD concept since TOD should promote inclusivity, whereby for example, in Subang Jaya, even though there are apartments, clusters, and terraced houses, there should be more variety in the types of housing available in the core areas.

Apart from residential areas, both the transit stations cater to a variety of business activities. However, both stations do not have food and beverage shops, and Tun Sambanthan does not have a shopping centre close to the station, but has more commercial areas with retail, and professional and private services. In reference to the TOD guideline too, one of its principles is having a variety of commercial activities that provide more options for the people, and it seems that Tun Sambanthan meets this requirement to a certain extent. Nevertheless, further investigations could be made on the supporting facilities surrounding both these core areas in terms of the compactness of the design and implementation. The following discussion determines whether the two stations match the ideal.

Figures 3 and 4 below demonstrate the land use composition within 400 metres of both transit stations. From the site observation, it was found that Subang Jaya only has a recreational area beyond the 200m range whereas Tun Sambanthan has public facilities nearby, and a recreational area and public space at the 200m and 400m range respectively. The Subang Jaya Commuter Station is surrounded by residential areas, and commercial and recreational areas throughout the 400-metre radius with 40% of the total land use taken up by commercial buildings. Meanwhile, the Tun Sambanthan Monorail Station has more public facilities instead of housing and commercial. Nonetheless, both stations do not have administrative institutions, but have core areas taken up mostly by commercial establishments in Subang Jaya, or public facilities in Tun Sambanthan. In this sense, it cannot be concluded that both stations portray a good mix of activities since only certain activities are concentrated within the core areas.

Table 1: Land-Use Components

LAND USE COMPONENTS		**Subang Jaya Commuter Station**		**Tun Sambanthan Monorail Station**	
		200m radius	400m radius	200m radius	400m radius
Housing	Bungalow	X	X	X	X
	Cluster	X	/	X	X
	Terrace	/	/	X	X
	Low-cost apartment	X	/	X	/
Category of Housing	Low-cost	X	X	X	/
	Medium-cost	X	/	X	X
	High-cost	X	/	X	X
Commercial	Retail	X	/	/	/
	Private services	/	X	/	/
	Professional services	/	X	/	/
	Food & beverages	X	X	X	X
	Shopping centre	X	/	X	X

LAND USE COMPONENTS		Subang Jaya Commuter Station		Tun Sambanthan Monorail Station	
		200m radius	400m radius	200m radius	400m radius
Administrative Institutions		X	X	X	X
Public Facilities	Education	X	X	/	/
	Health	X	X	X	X
	Safety / Emergency	X	X	X	X
	Religious	X	X	X	/
	Community hall	X	X	X	X
	Recreation	X	/	/	X
	Public space	X	X	/	X

Note: / Exists X Non-Existence

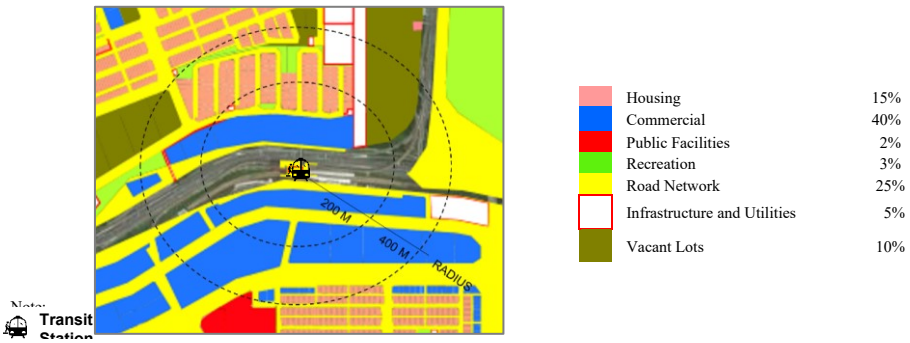

Figure 3: Subang Jaya Commuter Station
Source: PLAN Malaysia (2016)

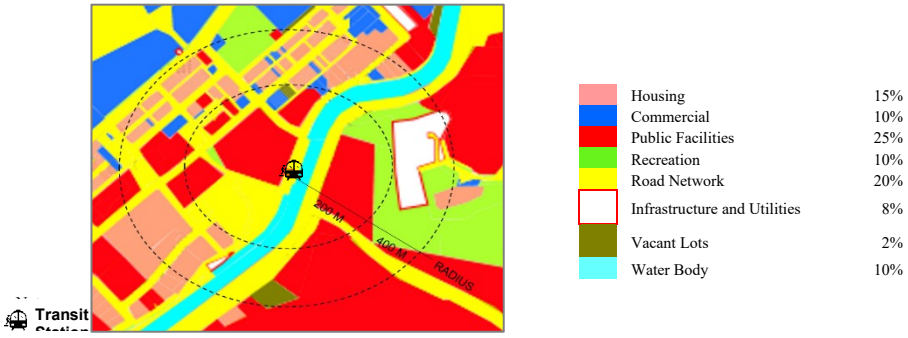

Figure 4: Tun Sambanthan Monorail Station
Source: PLAN Malaysia (2016)

Facilities for Pedestrians

The investigation included an assessment of the facilities for pedestrians at both stations. The existence of store sidewalks, walkway zones, special pedestrian walkways, covered paths, walkways, pedestrian bridges, and subways was evaluated (Table 2). Results showed that, within the radius of 300m, Subang Jaya transit station has more pedestrian facilities, but these become fewer after the 300m boundary. On the other hand, Tun Sambanthan has more variety of pedestrian facilities and paths closer to the station (within the 200m territory). For both stations, subways for pedestrians are not provided throughout the whole 400m span. Nevertheless, overall, pedestrian walkway zones are considerably adequate (Figures 5 and 6).

Besides paths for pedestrians, the results confirmed that there is also a lack of facilities for cyclists. In fact, Subang Jaya transit station does not cater well to cyclists, whereby bicycle lanes, and supportive facilities for cyclists are not provided within the 400m area. Meanwhile, Tun Sambanthan transit station only has bicycle lanes within the 300m range of the station (Table 2). In relation to the principles of TOD highlighted in Figure 2 earlier, these pedestrian paths and bicycle lanes are part of the four (4) principles, i.e., walkability, connectivity, facilities, and cycling. However, the two transit stations are observed to be far from achieving those principles. In order to embrace the TOD principles, the Subang Jaya Commuter Station, and its core area require improvement for pedestrians and cyclists. Tun Sambanthan, on the other hand, should concentrate on improving related facilities for cyclists since it already has on-road bicycle lanes with pedestrian paths side-by-side within its core area.

Table 2: Facilities for Pedestrians

FACILITIES FOR PEDESTRIANS	Subang Jaya Commuter Station				Tun Sambanthan Monorail Station			
	Metre Radius							
	100m	200m	300m	400m	100m	200m	300m	400m
Types of Pedestrian Paths								
Store pedestrian sidewalks	X	X	X	X	X	X	X	/
Walkway zones	/	/	/	/	/	/	/	/
Special pedestrian walkways (outside malls)	X	X	X	X	/	/	X	X
Covered pedestrian paths	/	X	X	X	/	/	/	/
Walkways	/	/	/	X	/	/	/	X
Pedestrian bridges	/	/	/	X	/	/	X	X
Subways for pedestrians	X	X	X	X	X	X	X	X
Existence of Indicators	4/7	3/7	3/7	1/7	5/7	5/7	3/7	3/7
Types of Bicycle Lanes								
Off-road bicycle lanes	X	X	X	XX	X X	X X X	X X	X X
Pedestrian paths and bicycle lanes (side by side)	X	X	X	X	/	/	/	X
Separated bicycle lanes	X	X	X	X	X	X	X	X
Controlled pathways (striped)	X	X	X	X	X	X	X	X
On-road bicycle lanes	X	X	X	X	/	/	/	X

FACILITIES FOR PEDESTRIANS	Subang Jaya Commuter Station				Tun Sambanthan Monorail Station			
	Metre Radius							
	100m	200m	300m	400m	100m	200m	300m	400m
Shared pathways	X	X	X	X	X	X	X	X
Existence of Indicators	0/6	0/6	0/6	0/6	2/6	2/6	2/6	0/6

Note: / Exists X Non-Existent

Figure 5: Subang Jaya Commuter Station offers more pedestrian facilities within the 100m to 400m radius

Figure 6: Tun Sambanthan Monorail Station has fewer facilities for pedestrians compared to Subang Jaya Commuter Station

Conforming to the Principles of Connectivity, Facilities, Safety, and Comfort

Apart from the composition of land use, and the provision of facilities for pedestrians and cyclists, the appraisal also included analysing other principles, which are "connectivity", "facilities", "safety", and "comfort". As described earlier in the methodology section, there are many principles for an ideal TOD that have been quoted by scholars. However, for this study, only several principles were adopted for evaluation. This is acknowledged as a limitation of the study that is due to the limited capacity of the researchers, and the intended purpose of the study.

Table 3 below conveys the results of the assessment. For each principle, specific indicators were referred to for the evaluation. For "connectivity" and "facilities", the indicators measured were the continuity of pedestrian paths, accessibility, and facilities for connectivity. Results revealed that, for both stations, the pedestrian paths have good connectivity, and easy accessibility. Also, both transit stations have a bus stop at each range of distance (100m to 400m radius). However, Subang Jaya has additional issues because it does not have any bicycle lanes or ramps, or parking spaces for cyclists. Tun Sambanthan, on the other hand, has bicycle lanes, but does not provide parking space for bikes. Moreover, the cycling lanes within Tun Sambanthan's core area only cover the 300m span (also stated in Table 2 earlier).

Table 3: Existence of *Connectivity, Facilities*, *Safety,* and *Comfort* indicators

INDICATORS (EXISTENCE OF)	**Subang Jaya Commuter Station**				**Tun Sambanthan Monorail Station**			
	Radius (metre)							
	100	200	300	400	100	200	300	400
CONNECTIVITY AND FACILITIES								
Indicators								
Continuity of pedestrian paths	/	/	/	/	/	/	/	/
Easy access	/	/	/	/	/	/	/	/
Bus stops	/	/	/	/	/	/	/	/
Bicycle lanes/bicycle ramps	X	X	X	X	/	/	/	X
Parking areas (for bicycles)	X	X	X	X	X	X	X	X
Connecting/Overhead bridges	/	X	/	X	/	/	X	X
Total Indicators	4/6	3/6	4/6	3/6	5/6	5/6	4/6	3/6
SAFETY								
Indicators								
Pathways without obstacles	/	X	/	/	/	/	/	/
Signage	/	/	/	/	/	/	/	/
Warning signs	X	/	/	/	/	/	/	/
Pedestrian traffic lights	/	/	X	/	X	/	/	/
Striped tracks	/	/	/	/	/	/	/	/
Refuge islands/cut through the median	/	/	/	/	X	/	X	X
Bollards	/	/	/	/	/	X	X	X

INDICATORS (EXISTENCE OF)	Subang Jaya Commuter Station				Tun Sambanthan Monorail Station			
	Radius (metre)							
	100	200	300	400	100	200	300	400
Streetlights	/	/	/	/	/	/	/	/
Diverse pathways	/	/	/	/	/	/	/	/
Universal design	/	X	X	X	/	/	/	/
Dedicated lanes for cyclists	X	X	X	X	/	/	/	X
Total Indicators	9/10	9/10	9/10	9/10	8/10	9/10	8/10	8/10
COMFORT								
Indicators								
Covered pedestrian paths	/	/	/	X	/	/	X	X
Wide paths	/	/	/	/	/	/	/	/
Clean environment	/	/	/	/	/	/	/	/
Landscape	/	/	X	X	/	/	X	/
Waiting area at the focus point	/	/	/	/	/	/	/	
Pocket parks/rejuvenate points	X	X	X	X	/	/	/	X
Seating	/	X	X	X	/	/	X	X
Art and information	/	/	X	X	/	/	X	X
User-friendly elements	/	X	X	X	/	X	/	/
Attractive design of facilities	X	X	X	X	X	/	X	/
Flat pathway surface	/	/	/	/	/	/	/	/
Total Indicators	9/11	7/11	5/11	4/11	10/11	10/11	6/11	6/11

Note: / Exists X Non-Existent

In terms of the "safety" aspect, both stations feature almost all the indicators within the 400m boundary (Table 3). For both stations, signage, striped tracks, and streetlights are scattered throughout the core areas. Thus, generally, the safety aspect is not a striking issue for both although the only major change might probably be for Subang Jaya's core area to focus on universal design. When analysing "comfort", the results proved that comfort was lacking beyond the 300m distance from the stations because many elements (facilities) do not exist further from the stations, like seating, art and information, and covered pedestrian pathways (Table 3). This applies to both stations, but they differ in terms of the indicators. Subang Jaya Commuter Station revealed more non-existing indicators than Tun Sambanthan, with a lack of pocket parks, seating, user-friendly elements, and attractive design facilities. Despite that, the study cannot label Subang Jaya as an unpleasant place or space because the judgement very much relies on the users' preference, which was not part of the scope of this study. Nevertheless, in general, it can be concluded that, based on the site observation, Tun Sambanthan Monorail Station's core area offers more comfort compared to Subang Jaya Commuter Station.

The Potential of Early-Built Transit Stations to Become Ideal TOD

Subang Jaya Commuter Station and Tun Sambanthan Monorail Station, to some extent, depict the fundamental principles of a TOD. Both stations indicated the presence of many features of a Transit Oriented Development. However, until proven, both transit stations cannot be claimed as bearing the ideal concept of a TOD. Clearly, both stations were built to meet the demands for public transportation during those days, much earlier before the rise of the TOD concept in Malaysia. The railways were part of the transportation network built alongside other development. And when the railways were built, housing and commercial activities were part of the urban setting, which is why these land uses are evident in the areas surrounding the stations.

With regard to whether the transit stations function according to the TOD guideline, it is noted that some elements do correspond with TOD indicators. Results substantiated the existence of mixed-use activities at Tun Sambanthan and Subang Jaya, whereby the living environment is combined with the commercial and work environments. The provision of land use, and the connections between them and the transit stations were seen as prearranged and interactive although the development of these areas were not originally designed as a TOD. Even though the TOD concept came much later, both Tun Sambanthan and Subang Jaya stations had already developed their own urban form and profiles to meet the demands and requirements of the public, hence the provision of facilities and other elements that make up its urban composition. By coincidence, those urban structures and components mirrored the principles of a TOD. It cannot be denied that, based on the findings, the transit stations portrayed the image of TOD based on some of the elements (indicators studied), with mixed-use development that is equipped with facilities although there was insufficient attention on facilities for pedestrians and cyclists. Nevertheless, most importantly, both transit stations have the characteristics of connectivity and facilities, safety, and comfort.

Regarding the potential of the two transit stations to become ideal TOD areas, the study has explored the current conditions of the stations, and while they have their strengths, they still require improvements in certain aspects. Subang Jaya Commuter Station, for example, critically needs bicycle lanes and their supporting facilities as they are required safety measures for cyclists. Apart from that, the station also requires some changes to transform the current environment into one that is more comfortable for the users. For now, Tun Sambanthan Monorail Station beats Subang Jaya in terms of facilities for cyclists, and comfort. Both Subang Jaya Commuter Station and Tun Sambathan Monorail Station can be upgraded, and transformed to become the ideal TOD. Currently, some of the key characteristics of TOD are visible. Both stations showed the essential features of density, compactness, activity, walkability, and others. In short, both stations

have the potential to be TOD, but require a systematic approach to achieve it since both areas are saturated with development, and making changes to the land use may not be straightforward. Alternatively, approaches like revitalisation and enhancement may stimulate the transformation of early stations to meet the requirements of the TOD concept.

CONCLUSION

This study has examined the TOD potential of transit stations that were built in the past before the concept was realised in Malaysia. The study evaluated the existence of certain TOD principles at the stations within a 400m boundary, which then saw the function and potential of those stations to become an ideal TOD. Subang Jaya Commuter Station and Tun Sambanthan Monorail Station were selected based on their backgrounds, which fit the purpose of the study.

Both stations underwent several appraisals. The investigation involved assessing the land use within the study perimeters, and the provision of facilities for pedestrians and cyclists. In terms of land use, both transit stations portrayed several characteristics of a TOD: mixed-use of the land, and the existence of residential areas, with a range of choices of housing costs even though not comprehensive, as well as walkability, density, connectivity, and facilities. However, none of the stations totally conformed to all indicators tested. Subang Jaya lacked facilities for cyclists. On the other hand, Tun Sambanthan had facilities for both pedestrians and cyclists, but had issues with comfort. Both transit stations may reflect several features of an ideal TOD, but require further enhancement or revitalisation to meet its standards. To sum up, the two early stations have the potential to be considered TOD, but need a rather robust approach to achieve it. Therefore, it is suggested that further studies focus on the users' preferences and demands, with detailed studies on the land use to incorporate other elements like bicycle lanes, or pedestrian paths for more connectivity and accessibility. Besides that, future studies can also include the role of authority in enforcing this transformation for the purpose of upgrading public transportation, and its environment.

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