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ASSESSING THE CURRENT IMPLEMENTATION OF COMPACT AND MIXED-USE DEVELOPMENT WITHIN PUBLIC RAIL TRANSIT STATIONS IN MALAYSIA

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Abstract

In the past years, the concept of Transit-Oriented Development has been adopted in cities and countries including Malaysia and Singapore. The integration of land use and public transport stations through Transit Oriented Development (TOD) as part of urban and cities strategy is highly acclaimed in promoting sustainable development concept in cities development. To understand the performance of TODs implementation in Klang Valley, this study has selected eleven stations in of Mass Rapid Transit (MRT) Putrajaya Line as case studies. This paper aims to evaluate the current implementation of TODs in Malaysia, benchmarked against the TOD land use composition and percentage from Singapore's model. The findings show that Raja Uda, Ampang Park and Persiaran KLCC stations show significant performance. However, Bandar Malaysia North station displayed poor result with the lowest percentage of residential and commercial components. All stations did not achieve the ideal TOD value for residential land use and eight out of eleven stations recorded higher than the ideal TOD value for roads. However, highest number of stations achieved the ideal TOD value for mixed-use and commercial land uses. These results would help policymakers to improve the current implementation of TODs in Malaysia.

Keywords: Transit-Oriented Development, Ideal TOD, Land Use Composition and Percentage

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INTRODUCTION

The provision of the train-based mass transportation system effectively tackles the challenges faced by cities such as traffic congestions, environmental problems and urban sprawl. These problems are intensified by the absence of land use planning and an effective transportation system (Belzer & Autler, 2002). The concept of Transit Oriented Development (TOD), which is the integration of land use and transportation that can accelerate a fast-growing trend towards creating vibrant, liveable and sustainable communities, is one of the potential solutions to these problems.

TOD can be defined as a vibrant development concept that promotes seamless connectivity within transit distance with the compactness of land activities (Patnala, Parida, & Chalumuri, 2020). TOD is seen as the most effective urban renewal approach to uniform the segregated land use sprawl of the city, to integrate with the walkable district, high density, transit, non-motorised dependency, shifting mode, mix-use of land, and dense street and path network. The essential elements of TOD are their proximity to the place of employment, school, health services and public transport, thereby enhancing mobility and productivity of the urban population. When a mixed development project is located close to a transit station, it can maximise public transport ridership, support local businesses and make the neighbourhood a vibrant place to live and work in. TOD focuses on urban growth around transit facilities and leverages on transit investments in creating compact and sustainable urban development in cities.

TOD serves as an option for high-density Asian cities to tackle urban problems under the condition of limited land resource in urbanisation. Currently, the Mass Rapid Transit (MRT) is being implemented as one of the transit systems in Malaysia. Phase 1 of the transit network construction focuses on Klang Valley. By 2020, 70% of the work has been completed. The line is expected to be fully operational in 2023.

This study aims to evaluate the performance of Malaysia's TOD implementation at the MRT line. Eleven MRT stations along the MRT Putrajaya Line were selected as case studies; Damansara Damai, Metro Prima, Kentonmen, Sentul Barat, Titiwangsa, Raja Uda, Ampang Park, Persiaran KLCC, Conlay, Chan Sow Lin and Bandar Malaysia North. The land use composition of the MRT stations are then compared to the relatively successful model of TOD project in Singapore.

LITERATURE REVIEW

Land Use-Transportation in The Planning of TOD

Transit oriented development is a great tool to mitigate the urban sprawl phenomenon by focusing on density, proximity of locations between residences

with jobs, retail and public transit facilities, mixed use and urban design guidelines and design features to discourage automobile (Freilich, 1998). The concept of TOD is developed through an integration of transit system and pedestrian-oriented that creates an environment with convenience, security, and walkable pedestrian environment (Iamtrakul & Zhang, 2014). The combination of activities generates shorter trips and faster journey, which attracts commercial area centre, offices, retail, services, and localities with a population density of medium to high density (Wey, 2015). Directly, this will create a livelier urban environment and healthy competitiveness in development.

From transportation point of view, TOD involves the urban inhabitants in everyday interaction and reduced auto-oriented activities. With TOD, inhabitants who have limitations in using private vehicles (due to economic, age or other reasons) still have access to facilities to meet their needs (De Vos, Van Acker, & Witlox, 2014). This can be contributed through the design for compact and mixed-use development, which creates a high-quality pedestrian-oriented environment, and utilize the street grid to connect and provide direct access to commercial. Pongprasert and Kubota (2019) claimed that land use planning for TOD could significantly help to increase the community's reach for services within walking distance to the stations. It is believed that a significant number of people who have their residence and office in or near the transit route are more likely to ride than those who are not on the route (Dittmar & Poticha, 2004).

METHODOLOGY

Study Area

The Putrajaya Line is the second line of the Klang Valley MRT Project to be developed. It will serve a corridor of around two million people stretching from Kwasa Damansara, a new township development in northwest Kuala Lumpur to Putrajaya, Malaysia's federal administrative centre.

The alignment will have a length of 57.7km, consisting of 44.2km of elevated track and 13.5km running through underground tunnels. It will have 36 operational stations of which 27 are elevated and 9 underground. A further 4 stations have been provided for the future. There will be 10 interchange stations and connecting stations, making it much easier for commuters to transfer from the Putrajaya Line to existing and future rail lines. Sixteen of the stations will have park and ride facilities.

Figure 1: MRT Putrajaya Line consists of 36 stations in total

Eleven MRT 2 stations in Klang Valley were selected for this study. These stations are under two different local authority; one station under the Petaling Jaya City Council and the rest under Kuala Lumpur City Hall. The selected stations were classified as Urban TOD by *Pelan Induk Perancangan Bersepadu Guna Tanah Laluan MRT Sungai Buloh-Serdang-Putrajaya* (SSP).

This study evaluated the TOD performance of the stations within their 400 to 800 metres radius, which is the recommended distance according to PLANMalaysia as it represents pedestrian scale distances of 5 to 10 minutes' walk.

Table 1: Brief profile of the selected stations

Local Authority	**Station**	**Form**	**Population within 800 metre radius**
Majlis Bandaraya Petaling Jaya	Damansara Damai	Elevated	18,513
Dewan Bandaraya Kuala Lumpur	Metro Prima	Elevated	19,134
	Kentonmen	Elevated	12,807
	Sentul Barat	Underground	14,483
	Titiwangsa	Underground	18,734
	Raja Uda	Underground	15,294
	Ampang Park	Underground	23,211
	Persiaran KLCC	Underground	25,851
	Conlay	Underground	17,410

	Chan Sow Lin	Underground	15,209
	Bandar Malaysia Utara	Underground	130

Source: *Kajian Pelan Induk Perancangan Bersepadu Guna Tanah Laluan MRT SSP*

Data Collection and Analysis

To gauge how well MRT Putrajaya Line TODs conform with TOD principles, benchmark study was needed for comparison. This study utilized several data sources to attain benchmark references such as papers, reports, websites and articles of the ideal and suggested model for land uses surrounding TOD. However, due to availability of data and suitability of context, comparative analysis was then conducted between land use compositions and percentage of the Singapore's model and Malaysia's MRT Putrajaya Line model to determine deviations from the benchmarks.

To obtain insights on the MRT Putrajaya Line TOD performance, data regarding selected stations were gathered from primary and secondary data sources. The statistics on the land use composition of the stations were collected from *Draf Kajian Induk Perancangan Bersepadu Guna Tanah Laluan MRT Sungai Buloh-Serdang-Putrajaya*. Additional information on the stations were gathered from news articles, reports and development plans prepared by the local authorities.

FINDINGS

Four models of ideal and suggested land use types surrounding TOD stations were identified based on the literature review from benchmarking studies. The models varied from cities in the United States, China and Singapore in Southeast Asia. To maximize transit ridership, these cities have proposed their idealised mixed use land use composition for area surrounding TOD stations as means to achieve an optimization of land use allocation.

Calthorpe's model is derived from the idea of redevelop able and urbanizing sites should complement existing on-site and surrounding uses, yet seek to achieve a proportion of uses that will stimulate pedestrian activity and create mutually reinforcing land use patterns (Calthorpe, 1992). Public, core commercial and residential uses must be provided as minimum requirements.

Ideal TOD model for Shen Zhen is based on the urban TOD, which revolves around the idea of land should be mainly used for commercial and office purposes. Other land use types, such as public service, public open space, and a small amount of commercial residential land is needed to support the development (Zhou & Dai, 2017). However, it did not recommend purely residential land use and the proportion of road land is higher.

The third model of TOD implementation focused on station planning and real estate development processes. However, according to Wood and Brooks (2009), the federal funding formula based on this model are disconnected from real estate market forces. Urban, walkable, and mixed-use TOD projects is overburdened with additional costs when compared to competing real estate investments. The cost of developing TOD is significantly higher than other suburban or infill real estate product.

The last ideal TOD model was identified from Singapore. The land use component compared were residential, mixed-use and commercial, public facilities and amenities, green area and open space, roads, or transportation.

<table>
<tr><th>No.</th><th>Composition and Percentage of Land Uses</th><th>Sources</th></tr>
<tr><td>1.</td><td><table>
<tr><td>Public</td><td>10%</td></tr>
<tr><td>Core</td><td>30%</td></tr>
<tr><td>Housing</td><td>20%</td></tr>
</table></td><td>Calthorpe, A. (1992). Transit-oriented development design guidelines (Resolution no. R-280480). San Diego: Planning Department. City of San Diego.</td></tr>
<tr><td>2.</td><td><table>
<tr><td rowspan="2">Residential</td><td>Purely residential area</td><td>-</td></tr>
<tr><td>Hybrid area of commerce and residence</td><td>10-15%</td></tr>
<tr><td rowspan="2">Commercial office</td><td>Commercial retail area</td><td>0-5%</td></tr>
<tr><td>Business office area</td><td>20-40%</td></tr>
<tr><td colspan="2">Public service</td><td>5-15%</td></tr>
<tr><td colspan="2">Public open space</td><td>10-20%</td></tr>
<tr><td colspan="2">Land of roads</td><td>25-30%</td></tr>
</table></td><td>Zhou, Q., & Dai, D. (2017). The evaluation of transit oriented development of metro station areas using node place index in Shenzhen China. In *inaugural World Transport Convention. Beijing, China*.</td></tr>
<tr><td>3.</td><td><table>
<tr><td rowspan="2">Residential</td><td>Housing</td><td>10%</td></tr>
<tr><td>Affordable housing & senior housing</td><td>10%</td></tr>
<tr><td rowspan="2">Commercial</td><td>Retail</td><td>15%</td></tr>
<tr><td>Office</td><td>25%</td></tr>
<tr><td colspan="2">Institution & public amenities</td><td>10%</td></tr>
<tr><td colspan="2">Open space</td><td>10%</td></tr>
<tr><td colspan="2">Infrastructure & transportation</td><td>20%</td></tr>
</table></td><td>Wood, D., & Brooks, A. (2009). Fostering Equitable and Sustainable Transit-Oriented Development. *Overview of Briefing Papers, Boston University*.</td></tr>
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<tr><td>Residential</td><td>30-60%</td></tr>
<tr><td>Mixed Land Use and Commercial</td><td>7-30%</td></tr>
<tr><td>Public Facilities and Amenities</td><td>7-11%</td></tr>
<tr><td>Open Space and Green Area</td><td>2-8%</td></tr>
<tr><td>Roads and Infrastructure</td><td>17-18%</td></tr>
</table>
</td>
<td>Niu, S., Hu, A., Shen, Z., Lau, S. S. Y., & Gan, X. (2019). Study on land use characteristics of rail transit TOD sites in new towns—taking Singapore as an example. Journal of Asian Architecture and Building Engineering, 18(1), 16-27.</td>
</tr>
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Based on the table above, the benchmark model to compare the TOD performance of MRT Putrajaya Line was synthesized from properties of the TOD model in Singapore. Singapore, being one of the successful models of urban development, is known for its efficient public transportation system with pragmatic policies on TOD implementation (Joshi et. al, 2017). Next, Singapore shares many similarities and challenges with urban centre in Klang Valley, Malaysia due to their locations being in the Southeast Asia. Other than that, both Singapore and Klang Valley realised the needs for TOD when it could no longer expand the road infrastructure to accommodate more cars, hence, focusing more on the urban renewal through the expansion of the transit network (Yusoff et. al, 2021).

TOD benchmark can be used to discover and demonstrate the performance of a city's specific TODs and how effectively regions are steering development growth to the areas around the transit stations. The benchmark can be used to identify the gaps in the current TODs implementation.

Singapore's Benchmark Model

This study examines the relatively successful TODs of Singapore city as it is known to be a pioneer in urban development and ecological city construction among other Asian cities (Curien, 2017). Transportation has always played an essential role in the economic and physical development of modern Singapore. Cervero (1998) recognised Singapore's urban transportation infrastructure as one of the most influential Transit Metropolis, a city designed to be especially conducive for sustainable public transit modes. Singapore's short development into a futuristic and for being the first for many landmark policy initiatives contributes to its recognition by Newman and Kenworthy (1999), Schwaab and Thielmann (2002), and many other scholars.

Given its limited land, planning for a compact city with maximised land use utilisation is critical for Singapore. Since land use is one of the prime determinants of movement and the propensity of trip-making, it is important to integrate the planning of transport systems with the land use system to minimise

travel demand and the need for more transport infrastructure. The TOD mode of planning has created a flattening effect of the population density distribution in Singapore urban development (Chin & Fong, 2006). This can be seen through the unique mode of planning and urban development trend in Singapore which relies heavily on the public transit system. According to Niu et al. (2019), Singapore's urban planning policy, density distribution and urban design were all driven by the TOD principles to realise a more compact layout due to land scarcity.

In the new towns of Singapore, a land use pattern oriented to transit villages is gradually developed in TOD station areas. To some degree, land use pattern in Singapore realises a balanced usage of residence, retail, catering, public services and parks and green space.

In terms of land use composition of the selected five TOD station, residential land occupies the most area, ranging from 30% to 60%. Meanwhile, mixed and commercial land use ranges from 7% to 30% according to the different locations and positioning of the stations. In addition, proportions of the land for public service facilities, parks and green space, and roads are roughly the same, ranging from 7% to 11%, 2% to 8%, and 17% to 24%, respectively. Table 2 below shows the land use composition and their percentages.

Table 2: Ideal land use composition of TOD stations in Singapore

Land Use Composition	**Percentage (%)**
Residential	30-60
Mixed Land Use and Commercial	7-30
Public Facilities and Amenities	7-11
Open Space and Green Area	2-8
Roads and Infrastructure	17-18

Source: (Niu et al. 2019)

Comparison of land use percentage between study area and benchmarking model

The land use within a radius of 800 metres of the eleven selected MRT Putrajaya Line TOD stations were determined and compared to the benchmark TOD model of Singapore's. The results are as shown in Table 3 below.

Table 3: MRT Putrajaya Line TOD Performance

No	**Land Use Types**	**Residential 30-60%**		**Mixed Land use and Commercial 7-30%**		**Public Facilities and Amenities 7-11%**		**Green Space and Open Area 2-8%**		**Roads 17-24%**	
1	Damansara Damai	23.15	L	10.77	I	8.41	I	8.22	H	37.09	H
2	Metro Prima	18.63	L	10.34	I	3.24	L	3.35	I	37.28	H
3	Kentonmen	20.19	L	2.10	L	29.17	H	0.69	L	26.09	H
4	Sentul Barat	24.82	L	4.27	L	7.81	I	14.14	H	35.15	H
5	Titiwangsa	17.96	L	12.63	I	27.06	H	2.14	I	28.10	H

6	Raja Uda	27.99	L	10.55	I	19.48	H	4.84	I	19.37	I
2	Ampang Park	26.58	L	14.73	I	7.92	I	7.92	I	24.12	
8	Persiaran KLCC	18.23	L	22.85	I	14.33	H	4.94	I	21.84	I
9	Conlay	12.54	L	22.77	I	9.4	I	17.37	H	27.07	H
10	Chan Sow Lin	9.74	L	18.59	I	11.66	H	2.42	I	35.39	H
11	Bandar Malaysia North	1.33	L	0.47	L	20.63	H	1.49	L	17.57	I

L	**Lower than the Ideal TOD**	**I**	**Within Ideal TOD**	**H**	**Higher than the Ideal TOD**

While the detail TOD performance of each of the selected stations on the MRT Putrajaya Line differs between one another, several important across-the-board trend can be seen from the results presented in Table 3. For instance, percentage of residential land use at all of the selected stations were below the ideal benchmark percentage of 30-60%. The low percentage of residential land use could mean that future demand for services at the stations could also be low. However, this can be offset by high-rise, high density residential development within the TOD radius.

Unlike residential land use, many of the stations registered significantly higher than the benchmark ideal in terms of roads. Only three out of the eleven stations were with percentage of roads within the ideal benchmark value of 17-24%. High percentage of roads within the 800m TOD radius of the stations could indicate high dependency on motorised, especially private, vehicles. This could undermine the very objective of developing a TOD, that is to encourage walking and to provide high quality of walking environment to and from transit station.

Compared to other land uses, the percentage of mixed and commercial land use within the 800m radius of the stations conformed better to the ideal benchmark value, which is 7-30%. In general, majority of the stations, except for three stations, registered mixed and commercial land use percentage within the benchmark range.

In the context of TOD performance of individual stations, Raja Uda, Ampang Park and Persiaran KLCC are the stations with better TOD performance compared to the others. This is because the percentage of three of their land use components were within the ideal benchmark range. Meanwhile, Kentonmen performance is the poorest without any of the land use components fall within the ideal benchmark range.

DISCUSSION AND RECOMMENDATIONS

The comparative analysis between MRT Putrajaya Line stations with the Singapore's TOD model revealed the less than average TOD performance of the stations. Only three of the stations managed to score three categories of land use

within the benchmark ranges. The rest of the stations only managed to score two or less land use categories conformance to the benchmark ranges.

To improve the TOD performance of the stations, future development within the TOD radius of the stations must be optimised to conform to the TOD benchmark model. Vacant land that is available within the TOD radius (Table 4) must be developed in a way that strategically enhance the TOD performance of the stations.

According to the *Kajian Pelan Induk Perancangan Bersepadu Guna Tanah Laluan MRT SSP*, the land use zoning of vacant land for the MRT Putrajaya Line TOD sites are planned to be converted to accommodate TOD-inclined future development. Potential developers are free to decide on the mix of uses for each vacant land as long as it follows the land use class order from the development plan, and it does not exceed the permissible density or plot ratio for the area.

Table 4: Vacant land within the TOD radius of the stations

Station	**Percentage of vacant land in 800m radius**
Damansara Damai	1.95
Metro Prima	16.98
Kentonmen	8.99
Sentul Barat	11.29
Titiwangsa	3.78
Raja Uda	8.84
Ampang Park	10.36
Persiaran KLCC	16.60
Conlay	10.31
Chan Sow Lin	10.36
Bandar Malaysia North	42.72

Source: *Kajian Pelan Induk Perancangan Bersepadu Guna Tanah Laluan MRT SSP*

Nevertheless, from the findings, almost all stations are constructed on a matured and existing built-up area, with limited vacant land (Table 4) available. Thus, it can be challenging to ensure the development surrounding the stations follows TOD principles and improve the TOD performance of the stations. Despite the limited vacant land, TOD-inclined rejuvenation process and infill development can be undertaken where possible.

The roads percentage for the stations was recorded as among the highest land use components at the stations. Incremental increases in road and parking supply create more dispersed land use patterns, hence, increasing the travel distance required to achieve a given level of accessibility. This favours automobile travel and reduces the utility and efficiency of other transport modes. Planners and policymakers need to put together transport planning decisions that

encourage smart growth such as improving pedestrian and cycling, installing traffic calming and traffic speed reductions, transit service improvements and encouragement strategies, and mainly reducing roadway capacity and speeds.

CONCLUSION

In conclusion, the results of this study provide some academic insights into the current implementation of TOD under the MRT Putrajaya Line project compared to the Singapore model. This study, however, is limited to the perspective of utilisation and composition of land uses of TOD sites. The findings from this study show that Raja Uda, Ampang Park and Persiaran KLCC stations display a better TOD performance with three out of five land use components were within the ideal benchmark ranges. Overall, all the stations failed to conform to the minimum or ideal recommended values of 30-60% for residential land use. More residential development is required, not only to increase TOD performance of the stations, but also to provide population catchment to the services at the stations. At the same time, with high roads percentage in the TOD sites, planners and local authorities need to consider implementing a street design that encourages smart growth. This can be implemented through improving pedestrian and cycling lane provision, install traffic calming and traffic speed reductions, transit service improvements and encouragement strategies, and mainly reducing roadway capacity and speeds.

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