TRANSIT-ORIENTED DEVELOPMENT (TOD) PLANNING ANALYSIS BY INTEGRATING GEOGRAPHIC INFORMATION SYSTEM (GIS) APPROACH

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ABSTRACT
The development of TODs in Malaysia is still unclear because of no specific development and planning guidelines relating to TOD have been gazetted at the federal level. The objectives for this study are; (1) identifying land-use dimension to determine the potential of TOD development, (2) to analyse the potential of rail-based stations for TOD purposes based on five land-use dimension analysis, (3) to rank TOD typology of rail-based stations using GIS-MCDM technique and (4) to recommend the use of geospatial approach as a transportation planning solutions. The area of analysis will be within 400 meters radius from the rail-based stations in Shah Alam City Council. The analysis of research was evaluated on the land-use criteria comprising of coverage area, land availability, gentrification potential, density and diversity. The finding shows that the KTM Padang Jawa was identified as the most potential stations with scores of 80%. The least potential station is Skypark Link Subang Airport with scores of 40%. Result shows that the typology for two stations are determined as' second-highest TOD intensity' and 'third-highest TOD intensity'. This study will provide a better understanding of how the land-use dimensions of TOD potential analysis are integrated into GIS application which is significant in many ways.

Keywords: Land-use, Transportation, Transit-Oriented Development (TOD), GIS-MCDM.

INTRODUCTION
Cities are facing a number of issues that are related to environmental issues. It is increasingly affecting the industrialized world, including urban development, inadequate resource utilisation, and land redistribution, traffic congestion and atmospheric emissions. Land-use and transport planning inevitably linked to the development of working, energy-efficient and people-oriented urban areas (Kodukula, 2018). It is a solution that is commonly suggested and can lead to be more sustainable development in the future. In the meantime, the concept of accessibility as an interface between transport and land-use interactions is one of the first approaches that has provided a useful framework for the integration of transport and land use planning (Fard, 2013). A generally accepted definition is a complex form of high population size, mixed and dispersed urban land use in an accessible area around a transit stop (Calthorpe, 1993). Malaysia was also no exception to seize the opportunity to introduce TOD, which was proven to be successful in other countries. The TOD also meant integration of land use and transportation, which can accelerate a fast-growing trend towards creating vibrant, livable and sustainable communities (Transit Oriented Development Institute, 2018). Meanwhile, TOD has also become the dominant land-use planning model. It is one of the key aspects of accessibility assessment and the key to urban environmental design. Planning of land-use for stations should be integrated as early as possible, according to Cervero (2006). In such a rational manner, transport and land-use are connected (Waddell, 2011). One aspect will influence the other. The improvements in existing land-use are needed to achieve desired outcomes (Salat & Ollivier, 2017). It is possible to reconfigure land-use through effective land-use planning. Analysis of land-use features plays an important role in the development of a successful area TOD. In terms of land-use changes, it is about increasing densities and mixing

functions. Whereas, in terms of transport change it is a case of improving the competitiveness of alternatives to the car, by increasing its flexibility and making door-to-door speed efficient. Multi-Criteria Decision Making (MCDM) techniques are commonly used in transport planning to provide their inputs to various evaluation criteria in a comparative assessment of alternative developments (Figuera et al. 2005). Multicriteria analysis is widely used because of the practicality with which non-marketable effects and qualitative criteria are taken into account for these purposes (Delle & Filippi, 2011). As an evaluation method for transport projects, MCDM has gained prominence, the use of these methods rises day by day in evaluating transport projects such as passenger and freight transport, infrastructure investments, location decisions, etc. (Pérez et al. 2015, Macharis & Bernardini, 2015). Singh et al. (2014) performed the first study on TOD planning. They developed a spatial TOD index for evaluating TOD levels across the whole study area. MCDM is a common method for solving problems that require several uncertainties and able to be used to address the TOD challenge. Therefore, this research aims to demonstrate a straightforward method on assessing land-use dimension to the rail-based stations in determining the potential station that can be employed as TOD concept by using GIS-MCDM approach. Seventeen (17) stations within Shah Alam City council administration boundaries have been selected with the five land uses dimensions that have been analysed such as coverage area, land availability, gentrification potential, density and diversity. The evaluation criteria have been further developed in order to rank the potential stations for TOD concept based on its typology categories.

THEORETICAL OF TRANSIT ORIENTED DEVELOPMENT (TOD)

There are various definitions of transit-oriented development (TOD). One of the most popular definitions of TOD came from Peter Calthorpe, 1993. Through his publication in "The Next American Metropolis: Ecology, Community, and The American Dream", it becomes a catalyst of the further exploration on TOD. Its follow by Cervero and other authors all around the world. Recent study was conducted by Gomez, Lyu and Li in 2019 stated that TOD is a land-use approach that focuses on improving accessibility by encouraging the creation of compact, high density and mixed uses within walking distance of the transit station. A typical TOD neighbourhood has a walking distance of 2000 feet (400 metres) which is equivalent to 10 minutes walk (Calthorpe, 1993). The concept of TOD was also endorsed by Bernick and Cervero (1997) and Still (2002). Furthermore, many common elements for TOD have been discovered for most abstract concepts, such as mixed design, height, pedestrian, and good mobility (Cervero et al., 2002; Belzer & Autler, 2002).

TOD, some principles need to be adhered to for implementation following with best practices from abroad and adapted to the local environment. Calthorpe (1993) proposed seven principles of planning. Meanwhile, Cervero and Kockelman (1997) proposed the principles of 3D planning which are high density, diversity and rational design. The principles of TOD planning in Malaysia shows similarities to those stated by early researchers such as Calthorpe (1993), Cervero and Kockelman (1997). Existing policies in Malaysia regarding TOD are only available in the state of Selangor. The Selangor State Transit-Oriented Development Planning Policy is the first of its kind to involve the TOD concept in Malaysia. The TOD principles adopted for this TOD Planning in Malaysia are the planning principles outlined in the Garis Panduan Pelaksanaan Transit-Oriented Development (PLANMalaysia, 2016). There are two additional planning principles from the study of the Pelan Induk Perancangan Bersepadu Guna Tanah dan Pengangkutan Awam Laluan MRT Selangor – Kuala Lumpur, 2016.

Calthorpe (1993) made a distinction between TOD in housing and work-generating. These normative typologies are applied by Dittmar and Poticha (2004) with a delineation between cities and suburbs. Hancock et al., (2014) defined five (5) types of TODs for strategic planning. The types classified by Higgins and Kanaroglou (2016) as "Normative TOD Types" define the characteristics of the diverse TOD contexts, such as sizes, accommodation and transit networks. The main benefit of providing TOD typology is that it can reduce complexity in the management and planning of this development and enable the good action plan in identified areas by taking into account the advantages and disadvantages (Zemp et al., 2011). The technology used in transit is an important aspect that distinguishes a type of TOD. Transit technology and transit service characteristics affect the riding capacity as well as the station area design. In determining the TOD area, there are approaches and determination of different quantitative measurement criteria. According to Bernick and Cervero (1997), TOD can be determined within a walking distance range of 400metres from the station. They define TOD as a compact, mixed-use development community, centred around transit stations with designs that encourage residents, workers, and buyers to reduce car usage and switch to public transport. However, the typological criteria in determining TOD have ideological differences. Each planned area or existing TOD area has different development intensities (high intensity, medium and low intensity) as well as differences in the context of station location, station type, public transport services offered (Intermediate bus, Transit Rapid Bus, LRT, MRT, HSR and bike lane) and development potential.

GIS and Multi Criteria Decision Making Application

GIS and technical decision support are a good combination of perfectly complementary methods (Sanchez-Lozano et al., 2013). GIS offers the possibility of analysing, managing, storing and visualising all geospatial information to decision-makers. Based on these functions, the MCDM offers a range of techniques and procedures that allow decision problems to be organized and alternatives to be evaluated (Malczewski, 1999). Since they were released, the GIS–MCDM have been used in numerous studies of territorial planning such as urban planning and urban infrastructure (Sanchez-Lozano, et al., 2013). It is past efforts to combine the capabilities of GIS and MCDM to provide decision support in choosing alternatives for transport (Malczewski, 1999). Alternative site selection cannot be treated as a single-criterion decision-making problem that focuses only on coping with environmental awareness issues because the decision-making process takes into consideration various aspects (Özkan et al, 2019). These two particular research areas, GIS and MCDM, will benefit from one another (Malczewski, 2006). On the other hand, GIS procedures play a critical role in evaluating the decision problems.

Consequently, GIS is generally recognised as a decision support system for the integration of spatially referenced data. On the other hand, MCDM produces a wide range of methods for building decision problems and weighing and ranking alternatives. At the highest fundamental level, GIS-MCDM can be seen as a mechanism that transforms and combines spatial data and value judgments to obtain decision-making information (Malczewski, 2004). These spatial MCDM techniques can enhance the transparency and analytical rigour of land-use decisions (Mosadeghi et al., 2015). Mosadeghi et al. (2015) used a case study to compare the results of the Analytical Hierarchy Process (AHP) and Fuzzy AHP in urban land-use planning for the northeastern Gold Coast in Queensland. GIS-MCDM was not a new approach in urban planning especially in transportation sector. GIS and MCDM can assist policy makers and planning authorities in getting a better overview of the tools they had to bring forward with less harm to the environment and farmland.

STUDY AREA

The study area was in Shah Alam, which is also the state capital of Selangor. It is situated within the Petaling District and a small portion of the neighbouring Klang district. The rail transit service in Shah Alam was initially just a commuter service involving the station and now, the LRT and MRT services are rapidly expanding in the Shah Alam area. Three modes of 17 stations in Shah Alam City Council consist of Keretapi Tanah Melayu (KTM) that served line from Port Klang to Tanjung Malim. Light Rapid Transit (LRT) Gombak to Petaling Jaya; LRT3 Bandar Utama to Klang and Mass Rapid Transit (MRT) from Sungai Buloh to Kajang have been selected. The four stations functioning as a hub, which integrates two types of rail service and as interchange or connecting stations (Figure 1).

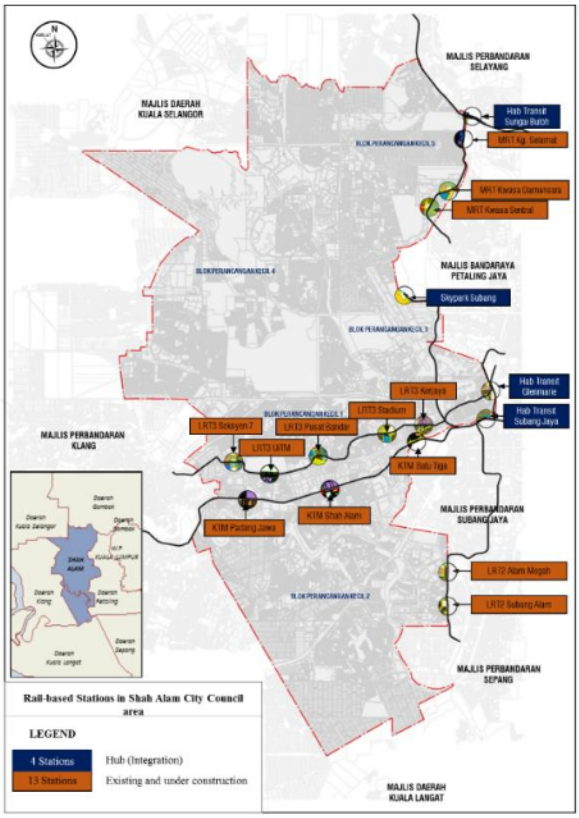

Fig. 1 The study area of Rail-based Stations in Shah Alam City Council area
(Source: Shah Alam City Council, 2020)

RESEARCH METHODOLOGY

This study requires both primary and secondary data to complete the research in the allocated time. The primary data for this study are obtained from site survey which, further digitised and stored in GIS database. The data collected has been analysed and further evaluated in determining TOD potential stations. The equipment required for this method collection are checklist sheet and plans. An observation at each of rail stations will be done to get to know the current situations of the site. From the site observation, the potentiality of TOD implementation will be analysed based on the land-use features that have been finalised as an indicator for this study. The criteria that most depending on this method is gentrification potential analysis. The current situation of a residential area and commercial area within a 400-meter radius of the stations will be observed and evaluated

for redevelopment and improvement potential evaluation.

Next, for the counting method, it is involved the counting of household units in the study area. The number of the household will be counted manually at the site to assist the density analysis of the stations. The number of household units counted will be multiplied with household rate from Department of Statistic Malaysia (4.1). Site inventory and the land-use have been analysed in detail to complete the stations' profiles. The elements involved are residential, commercial, industrial, public facilities, community features, neighbourhood design, land-use activity, availability of parking space, and the access mode. Secondary data is the data that have been collected by and readily available from other sources. In this study, the secondary data obtained from Shah Alam City Council, Department of Statistic Malaysia, and document from PLAN Malaysia. The data needed include GIS database of Shah Alam, *Garis Panduan Pelaksanaan Transit Oriented Development (TOD)* and household rate.

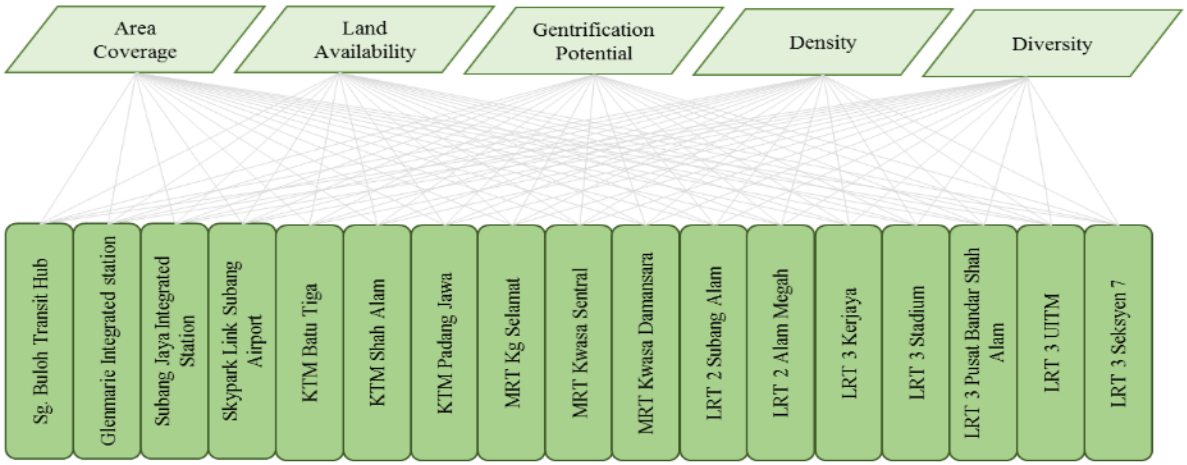

Fig. 2 Bipartite network graph of relation between criteria and alternatives

The analysis has been conducted in order to rank the potential of rail-based stations as TOD through MCDM technique. There are five criteria's and 17 alternatives for this study. All the criteria scores of the alternative station was overlaid MCDM technique as show in Figure 2. Data analysis aided with the use of MapInfo Pro V17 software. In addition to that, the findings and the data collected during the site survey have also been integrated into GIS database. Before continuing with the TOD evaluation, the data need to update and key in into GIS database. The verification of land-use information from each station was conducted and further stored in digital in GIS databases. The acreage of land-use parcel was calculated using GIS features and tools. All 17 stations have been evaluated by using separate methods for each criterion to attain the existing situation of stations' area. The stations will score for each criterion based on respective values from the previous analysis. The overall score for stations will be obtained by overlaying all fives score criteria in GIS software. Based on the overall score, TOD potential performance ranking will be justified. All 17 stations will be ranked from high potential of TOD to the least potential. The last step will be determining the TOD typology of the stations based on JPBD guidelines. The potential of the stations will be analysed based on its existing land-use within a 400-meter radius from the stations. To identify the TOD potential station and its opportunity in the Shah Alam City Council area, it needs suitable criteria. Therefore, the criteria will be determined through an extensive review of TOD literature. For this study, there will be five criteria involved in analysing the TOD potentials. All the criteria are focusing on land-use dimension analysis. The study is focusing on Shah Alam

Municipal Council area. For the area coverage criteria, only the part of areas within 400-meters radius from the stations that under Shah Alam City Council jurisdiction will be analysed. The area coverage is then evaluated by percentage for each station. Land availability criteria for TOD potential for this study will include a vacant land and an agriculture land within a 400-meter radius. Based on the existing land-use, the total acreage of these two elements will be summed up and calculated in a hectare.

Gentrification potential is defined as an old development area that allows redevelopment and improvement to take place to achieve TOD principles. The evaluation is through the site survey on surrounding of the stations and the analysis on existing land-use. It will concentrate on residential and commercial areas that have the potential to increase population density. The criteria will be analysed by using a range of potential level comprise of low, moderate and high. The findings for the stations was manually inserted into GIS database. On the density aspect, the total number of household unit will be counted manually at site. Then, the household rate of 4.1 from Department of Statistic Malaysia was used for this analysis. The total estimated population will divide into the total coverage of the station. The unit of evaluation for this criterion is people per hectare. The diversity analysis was evaluated based on mixed-use development around the stations. The availability of land-use types within a 400-meter radius was examined and this criterion was evaluated based on the total number of land-use types in the area. The higher the total number of land-use types, the higher the score stations' record. The number of existing land uses type was counted in GIS and validated by site survey. TOD potential assessment matrix was set based on the evaluation criteria as shown in Table 1.

Table 1 Definition and Score of TOD Potential Evaluation Criteria

No	Criteria	Description	Unit	Score			
				0	1	2	3
1.	Area coverage	Coverage within 400 meter radius from the station	% Coverage	0	<25%	26% - 50%	51% - 100%
2.	Land availability	Vacant land and agriculture land	Hectare	0	<5 ha.	6–10 ha.	>10 ha.
3.	Gentrification potential	Existing development area that allows redevelopment and improvement to take place in order to achieve TOD principles	Potential level	No	Low	Moderate	High
4.	Density	Population density [(No. of household unit x household rate) / Hectare]	People / Ha.	0	1-100	101-300	301-500
5.	Diversity	Total number of land use type	No. of land use types	0	1-2	3-4	> 4

The table provides information related to scoring definitions including the score criteria, description of score criteria, score units, and scores. Generally, there are 5 criteria for assessing the TOD potential that was previously created. Throughout the assessment, each criterion is rated 0-3 to indicate the level of achievement of the criterion. For the TOD evaluation score, the analysis was conducted by using GIS "*simple select"* tool in updating column for stations' criteria score. From the simple select, the selection of group range set up was selected and valued by using *update column feature*. This step repeated for all five (5) criteria group score and the result were mapped in thematic map features with score ranges of the stations. The score for each criteria is then overlaid

by using an "*overlay"* tool extension in MapInfo. The file extension Overlay.mbx has been registered before start the analysis in *Tool Extension feature*. From this technique, the findings for each criteria had been compressed in a single layer for the purposes of calculating total score. This stage involved the use of the MCDM technique for analysing the stations' performances. This step was repeated for the other five (5) criterias score. After that, the process was continued to update column for total score as shown in Figure 3. Each value from the criteria had been sum up for total score. Furthermore, based on this analysis, the percentage of the total score have also been calculated. From the score percentage, the potential level of station as TOD could be determined whether its low potential (0% - 50%), moderate potential (51% - 75%) or high potential (75% - 100%). The analysis of each station was ranked from the highest score to the lowest score from the total percentage that obtained through MCDM technique. The level of the ranking also been produced. This rank was produced by rearranging the total score from the highest mark to lowest. Based on that analysis, the highest and the lowest potential TOD stations can be identified. The top position among the stations were also noticed. The chart and map were produced to show the illustration of the result. The last stage for this study is determining the TOD typology for each station. Based on the ranking result of the TOD potential analysis, stations typology specification referred to *Garis Panduan Pelaksanaan Transit Oriented Development* prepared by PLAN Malaysia. The findings of each station analysis will be compared to TOD typology guidelines prepared by PLAN Malaysia comprise of Highest TOD intensity'- T1, 'Second highest TOD intensity'- T2, 'Third highest TOD intensity'- T3 and 'Specialised TOD'- T4.

RESULTS AND DISCUSSIONS

The research involved three analyses, which are land-use dimension analysis, TOD potential rank analysis and TOD typology determination. The first part of the analysis focused on the land-use dimension analysis. This analysis is vital in getting to know the current condition of 400-meter radius from the stations by scoring each land-use evaluation criteria defined by using MCDM technique. The second part of the analysis emphasised on TOD potential rank analysis. The analysis is vital in determining which stations scored the highest and lowest potential. The third part of the analysis was concerned on TOD typology determination. The analysis is to identify which TOD typology the stations categorised based on TOD guidelines from PLAN Malaysia.

1. Land use Dimension Findings for 17 Stations

The finding shows that eight stations form 100% of 400-meter radius coverage which included all five under construction LRT3 stations, four stations covered 50% to 100% and remaining five stations covered below 50% of the area. It shows that more than half of the stations are located near to the Shah Alam City Council boundary. The land availability shows that only three stations have more than 10 hectares of vacant land and agricultural land which are KTM Padang Jawa station, MRT Kwasa Sentral Station and MRT Kwasa Damansara with 14.65 ha, 32.87 ha, and 12.17 ha, respectively. Three stations have between six and 10 hectares of land availability while five stations comprise below six hectares of land availability. For the remaining six stations, it does not have any land availability for new development. For gentrification potential, eight of the stations have high potential to improve or redevelop to meet the TOD principles requirement. Whereas seven stations are moderately potential and two stations which are Subang Jaya Integrated Station and LRT3 UITM Station have a low potential for gentrification.

The density analysis shows that only three stations (KTM Shah Alam, MRT Kg. Selamat, and LRT2 Alam Megah) comprise of moderate population density which is range between 100 to

200 people per hectare. However, nine of the stations have a low population density. While for MRT Kwasa Sentral, MRT Kwasa Damansara, Skypark Link Subang Airport, LRT3 Kerjaya, and LRT3 Pusat Bandar Shah Alam currently there is no population. For diversity, only KTM Shah Alam and LRT 3 UiTM have five types of land uses in their 400-meter radius area. Followed by 10 stations contain three or four land uses in its area while Sg. Buloh Transit Hub, MRT Kg. Selamat and MRT Kwasa Damansara consist of two types of land uses. However, there are two stations not diverse at all (Skypark Link Subang Airport and MRT Kwasa Sentral).

Table 2 Finding of five (5) land use dimension score analysis

	Sg. Buloh Transit Hub	Glenmarie Integrated Station	Subang Jaya Integrated Station	Skypark Link Subang Airport	KTM Batu Tiga	KTM Shah Alam	KTM Padang Jawa	MRT Kg Selamat	MRT Kwasa Sentral	MRT Kwasa Damansara	LRT 2 Subang Alam	LRT 2 Alam Megah	LRT 3 Kerjaya	LRT 3 Stadium	LRT 3 Pusat Bandar Shah Alam	LRT 3 UITM	LRT 3 Seksyen 7
Area coverage	66%	64%	40%	64%	52%	100%	100%	48%	100%	86%	48%	48%	100%	100%	100%	100%	100%
Land availability (hectare)	1.33	7.52	1.41	0	8.64	0.6	14.65	2.39	32.87	12.17	0.56	0	3.84	4.72	8.74	0	0.28
Gentrification potential	Moderate	Moderate	Low	High	High	High	High	High	High	High	Moderate	Moderate	Moderate	Moderate	High	Low	Moderate
Density (person/ hectare)	3.091	4.5	27.45	0	25.54	186.22	43.7	273.33	0	0	92.25	182.792	0	11.48	0	4.92	89.06
Diversity	2	3	3	0	4	5	3	2	0	2	3	4	4	3	3	5	4

2. Result on Scoring

Table 3 shows the score for each station for each evaluation criteria analysed. The score will be 0, 1, 2 or 3. For area coverage, the stations scored only for group range 2 and 3. The 13 stations scored 3; and the remaining four stations scored range 2. In the context of land availability, the stations scored all the score group range. The highest score is KTM Padang Jawa, MRT Kwasa Sentral and MRT Kwasa Damansara with a score of 3. While for gentrification potential, the score is between 1 to 3. The most score range 3 recorded by the stations with 8 station in total, five stations have recorded in score 0 because of no population. Nine stations with score 1; and three stations score 2. On the diversity analysis, there two out of all stations score 0 which are Skypark Link Subang Airport and MRT Kwasa Damansara. Three stations scoring 1 and the rest of the stations score 2 except two stations scores 3.

Table 3 Score result for TOD analysis of 17 stations

	S1: Sg. Buloh Transit Hub	Glenmarie Integrated Station	Subang Jaya Integrated Station	Skypark Link Subang Airport	KTM Batu Tiga	KTM Shah Alam	KTM Padang Jawa	MRT Kg Selamat	MRT Kwasa Sentral	MRT Kwasa Damansara	LRT 2 Subang Alam	LRT 2 Alam Megah	LRT 3 Kerjaya	LRT 3 Stadium	LRT 3 Pusat Bandar Shah Alam	LRT 3 UITM	LRT 3 Seksyen 7
Area coverage	3	3	2	3	3	3	3	2	3	3	2	2	3	3	3	3	3
Land availability (hectare)	1	2	1	0	2	0	3	1	3	3	0	0	1	1	2	0	0
Gentrification potential	2	2	1	3	3	3	3	3	3	3	2	2	2	2	3	1	2
Density (person/hectare)	1	1	1	0	1	2	1	2	0	0	1	2	0	1	0	1	1
Diversity	1	2	2	0	2	3	2	1	0	1	2	2	2	2	2	3	2

Score 0 | Score 1 | Score 2 | Score 3

3. TOD Potential Analysis

Based on the five evaluation criteria analysis, the total score has been produced for each stations through process of overlaying technique using MCDM. Figure 3 shows the result of the analysis. The stations have been grouped into three category which are low, moderate, and high potential as TOD. The result shows that only KTM Padang Jawa station has high potential as TOD with the highest score of 12. Three stations which are Subang Jaya Integrated Station, Skypark Link Subang Airport, and LRT 2 Subang Alam has resulted in the low potential to implement TOD while remaining stations were in the moderate group.

Overall, it can be concluded that all three KTM stations placed at the top. KTM Padang Jawa marked the top position. The station also the only one that has high potential as TOD. For second place, it shares between KTM Shah Alam and KTM Batu Tiga. Next, for third place, it was Glenmarie Integrated Station, LRT3 Pusat Bandar, and MRT Kwasa Damansara. Whilst for fourth place, three stationshave been identified: MRT Kwasa Sentral, LRT3 Stadium and MRT Kg Selamat. For the fifth position, the stations are LRT3 Kerjaya, LRT3 UITM, LRT3 Seksyen 7, LRT2 Alam Megah and Sg Buloh Transit Hub. However, three stations have been identified as having a low potential to be developed as TOD. Skypark Link Subang Airport was the least potential.

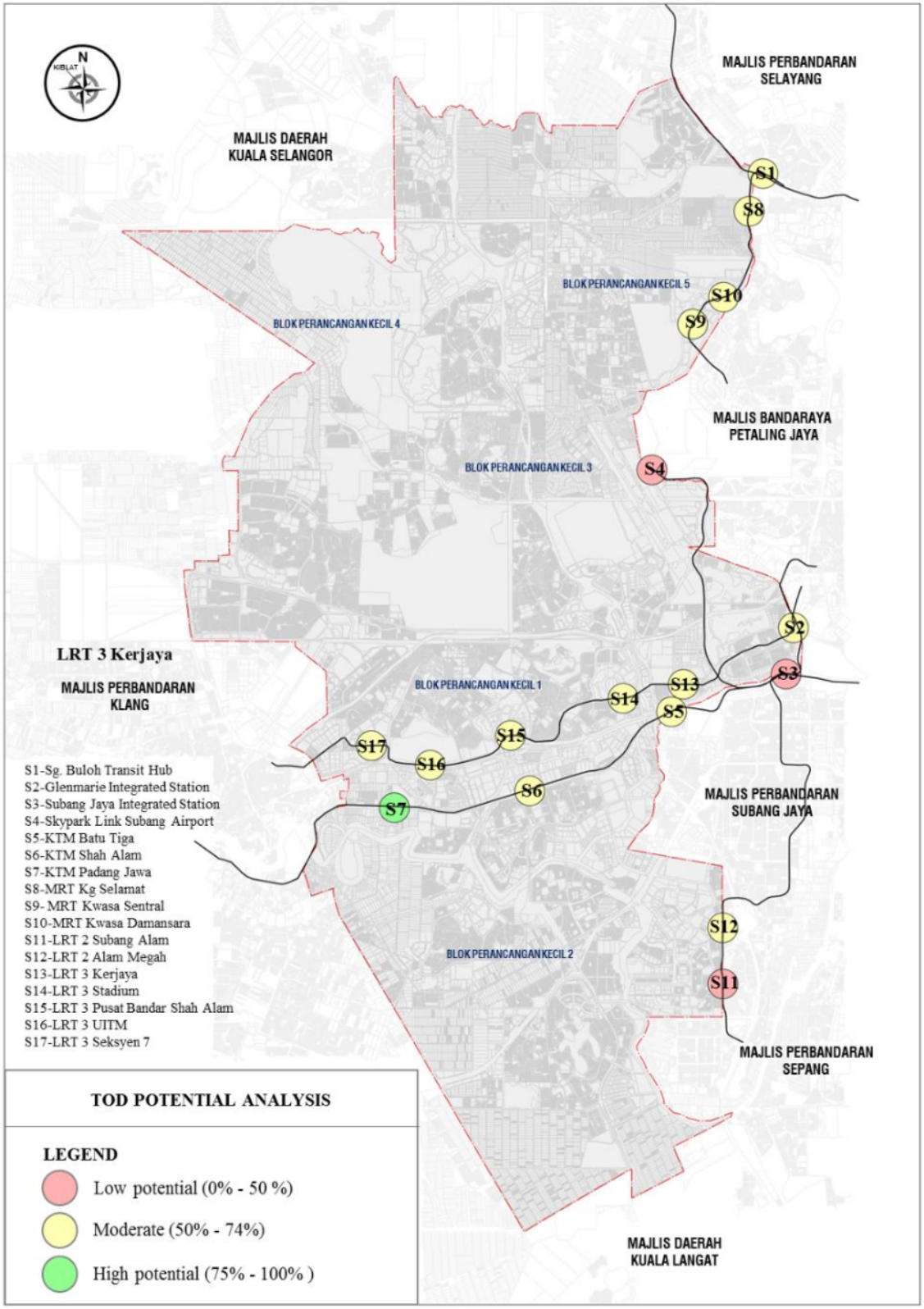

Fig.3 Result of TOD Potential Analysis of 17 Stations

4. TOD Typology

From the rank analysis result, KTM Padang Jawa station has been identified as the highest potential to develop TOD as in top position and been used as benchmark for the highest typology for Shah Alam City Council. KTM Padang Jawa station was classified under T2-TOD typology with none of station under T1-TOD typology. In addition, another five (5) stations also were included in this T2-TOD which make a total TI-TOD typology are six (6) stations. Meanwhile, only LRT 3 UITM Station was classified for T4-TOD which special TOD station as the station was purposely for the university population catchment. The remaining 10 stations are classified as T3-TOD. TOD station in Shah Alam City Council area only involved three typologies which are 'second highest TOD intensity', 'third highest TOD intensity' and 'specialised TOD' as shown in Table 4.

Table 4 TOD Typology of the Stations

	Sg. Buloh Transit Hub	Glenmarie Integrated Station	Subang Jaya Integrated Station	Skypark Link Subang Airport	KTM Batu Tiga	KTM Shah Alam	KTM Padang Jawa	MRT Kg Selamat	MRT Kwasa Sentral	MRT Kwasa Damansara	LRT 2 Subang Alam	LRT 2 Alam Megah	LRT 3 Kerjaya	LRT 3 Stadium	LRT 3 Pusat Bandar Shah Alam	LRT 3 UITM	LRT 3 Seksyen 7
Highest TOD intensity																	
Second highest TOD intensity		■			■	■	■			■					■		
Third highest TOD intensity	■		■	■				■	■		■	■	■	■			■
Specialised TOD																■	

DISCUSSION

Based on the analysis, the land-use dimension used as the analysis criteria was particularly important. For area coverage, 13 of the stations scored 3 and the remaining four stations scored 2. It shows that there will be conflict in terms of the TOD development plan for the stations that score 2 because the area coverage for 400 meters is less than 50% in the Shah Alam City Council area. It needs collaboration between two local authorities that share the station's benefit in order to make TOD successful. Next, for land availability, the highest score is KTM Padang Jawa, MRT Kwasa Sentral and MRT Kwasa Damansara with a score of 3. These stations have the highest opportunity to infill the respective development in order to achieve TOD principles within the station area. However, six of the stations do not have land availability (agriculture land or/and vacant land) in the TOD area. Theses station will face some difficulties and challenges to develop as TOD. While, for gentrification potential, the most score recorded by the stations is 3 which is eight out of 17 stations. Gentrification potential had looked at the opportunities of the stations to impose redevelopment or improvement in the area. For eight stations that have high potential for gentrification to take place, it also will face the challenges of the land acquisition process that involves cooperation among the residences. For density, all stations need to increase the total population number. Based on the analysis of the existing condition, no station scored 3, which is more than 300 people per hectare. Five stations have recorded with score 0 because of currently no population. Density is the most important element to achieve successful TOD. Shah Alam City

Council needs to plan for the increasing population within the 400-meter radius of the station. For diversity, two stations are not diverse at all for an existing condition which is Skypark Link Subang Airport and MRT Kwasa Damansara station. Skypark Link Subang Airport station only comprise of the parking lot. While for MRT Kwasa Damansara station, it was an ongoing project around the station. Most of the stations comprise of three or two number of land-use types.

CONCLUSION

The findings from this study show that almost all stations had the potential to be developed using the TOD concept. However, the difference potential levels of TOD in each station was based on the nature of the stations, areas, and challenges that need to be met in the implementation. There are several issues regarding TOD have been identified in the study area. Firstly, almost all stations are constructed on the existing built-up area. It can give challenged for TOD concept development within a 400-meter radius. The rejuvenation and infill development will be occurred instead of a new development plan around the stations. Planners need to integrate the existing condition with new development in terms of its connectivity, diversity, density and all TOD principles. Next, public transportation services are not being developed concurrently with land-use. It is caused the location of the stations becomes not strategic for TOD development. Also, the private vehicle use becomes high due to uncontrolled development plan. On top of that, the city turns out to be unsustainable. Furthermore, a low understanding of TOD among the community itself causes some problems. It will make the TOD concept not being delivered and applied successfully. The community also does not feel the benefit of TOD development and it's more influenced by perceptions.

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