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Interrelation of Transit-Oriented Development with Land Use Planning

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Abstract

The ineffectiveness of public transport discourages participation from the public. Thus, the transportation systems and land use planning need to be more practical. This study explores the land use criteria that need to be considered while planning rail-based transit-oriented development (TOD). The method systematically reviewed the land use characteristics for transit-oriented development. Thematic Analysis was employed by applying scoping techniques. The result showed a network mapping of the interrelation between land use planning and Transit-Oriented Development and various land use criteria used as indicators in gauging TOD regions.

Keywords: Transit-Oriented Development (TOD); land use integration; land use criteria

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1.0 Introduction

Calthorpe firstly introduced the initial Transit-Oriented Development (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. Notably, for TOD rail-based development, although all rail-based station area is the potential for TOD implementation, the levels of accessibility are different from one rail-based station to another. Therefore, transport and land use planning should not be done in isolation (Vale, Viana, & Pereira, 2018). This research discovered several studies on TOD model development that focused on land use (Vale, 2015; Ma, Chen, Li, Ding, & Wang, 2018; Hasibuan, Moersidik, Koestoer, & Soemardi, 2014; Sahu, 2018). A study from Niu et al. (2019) recommends that to achieve sustainable development in the economy, environment, and society at the local level, mixed-use development around the TOD station area, should be customised to the local character. TOD's purpose is to organise settlements around transit nodes as centres of urban life (Ibraeva, Correia, Silva, & Antunes, 2020). It was claimed that TOD involves intense, mixed development around transit nodes (Yang & Pojani, 2017). Land use planning is believed to be an essential aspect when designing TOD, which can induce the performance of TOD. The development pattern of TOD will ideally allow residents to quickly and conveniently reach a variety of activities by walking or using public transport without needing a private automobile (Duncan, Gladwin, Wood, Torres & Horner, 2021). The definition of TOD is supported by

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the study from Kamal (2019), which mentioned TOD as encompassing walking, compact, high density, mixed-use development in a close range of public transport and facility. It allows a mix of residential and commercial and ensures walking and cycling while providing livable communities (Kamal, 2019).

Similarly, TOD is also defined as an approach to transport and land use planning that makes walking, cycling, and transit use convenient and desirable and that maximises the efficiency of existing public transit services by focusing on development around public transit stations and stops (Hrelja, Olsson, Pettersson-Löfstedt & Rye, 2020). In addition, TOD is described as land use and transport planning that makes sustainable transport modes convenient and desirable and maximises transport services' efficiency by concentrating urban development around transit stations (Ibraeva, Correia, Silva, Antunes, 2020). Besides the definitions mentioned above, TOD can be seen as an effective strategy for achieving environmental and economic sustainability while reducing social exclusion (E. Papa, 2017). TOD also can be integrated into land use through economic and transport planning. Integrating TOD with land use planning can promote happier, healthier, and more prosperous cities with less traffic congestion (Linton & Bray, 2019).

In Malaysia, the TOD concept is mainly applied in the urban area, especially within Kuala Lumpur and Klang Valley, to the availability of the public transportation system. The Malaysian government has highlighted this concept through the National Physical Plan since 2005. The policy stated that "*Transit-Oriented Development shall be promoted as the basis for urban land use planning to ensure the viability of public transport*". Through the strategy indicated in the Third National Physical Plan, the Malaysia Government strives to improve urban public transport by clearly stating that TOD is one of the development concepts encouraged to be built in the central urban area (PLAN Malaysia, 2016). Besides policies, PLAN Malaysia has established a guideline framed purposely for TOD in Malaysia, namely Transit-Oriented Development, which covers all the essential parts of TOD as comprehensive guidance (PLAN Malaysia, 2018).

Based on the notion that land use influences the efficiency of movement and accessibility and promotes the convenience of people's movement, this study aims to investigate the interrelationship of transit-oriented development (TOD) and land use planning. The objectives of this study are to examine the concept and features of TOD and review the criteria of land use for the efficacy of TOD. This paper will start by presenting the introduction and describe the issues of the TOD concept, followed by some discussions on the idea and features of TOD. After that, the authors describe the approach and procedures to research methodology and share the findings from the study, which will achieve the second objective (i.e., to unfold the criteria of land use and their interrelationship with TOD to accomplish an effective TOD development).

2.0 Literature Review

2.1 The issues and challenges of TOD

There appeared to be several issues and challenges concerning TOD. TOD is not just a concept but is meant to promote a new condensed development to tackle the problem of urban sprawl and growth (Abdullah & Mazlan, 2016). To attain a practical implementation of TOD, the design and development of TOD require careful integration with the land use surrounding its network. An ideal TOD development should be functional and able to accommodate the users in terms of walking distance, promote comfort, and, most importantly, encourage people to ride the public transport instead of using private vehicles. Yet, TOD faces issues and is claimed to be costly in terms of maintenance, influences environmental and health conditions, and increases the land value in urban areas (Saidan Khadei, Bakeri & Abd Shukor, 2021). In terms of the connection between TOD and land use planning, it is believed that the practice of making independent decisions for transit and land use development may result in ineffective optimisation of land uses. Also, zoning and land use restrictions can deter the element of compactness, comfort, and walkability, thus encouraging the use of private vehicles. Moreover, transit corridors are suggested to be planned from a regional perspective and not just within a local level since TOD comprises transit corridors involving coordination between local government and state government (Saidan Khadei, Bakeri & Abd Shukor, 2021).

2.2 The concept and features of TOD

Most agencies and researchers from various countries and studies will list the criteria based on the principles of TOD. The criteria seen through an integrated development (Rahmat et al., 2016) required 10-minutes of walking around a central transit station. The requirements are determined by density, design, and diversity (Curtis, Renne, & Bertolini, 2009). Characteristics of TOD include six (6) main elements such as a mix of use, moderate to high density, pedestrian orientation or connectivity, transportation choices, reduced parking, and high-quality design (Lambert, 2014). The Queensland Department of Transport and Main Road (2021) prioritised the integration between effective land use and transport in designing TOD areas in order (i) to increase the accessibility to the public transport network; (ii) provision of public space to encourage the walkable environment and; (iii) develop high-density area. The United States of Transit Oriented Development Institute (2020) highlighted three (3) matters that should be well taught while planning for TOD areas, including (i) priority toward pedestrians; (ii) creating walkable places; (iii) all needs are nearby. Based on these, the criteria need to be considered, including a 5-10 minute walk between the rail station and surrounding land use, the provision of public space, mix-use activities in one area, a quality pathway for pedestrians and cycles, human-scale architecture, and active ground floor retail (United States National Association of City Transportation Officials, 2013).

Meanwhile, the United Kingdom of Urban Transportation (2021) emphasises providing quality transit at the centre of the development area and shall be integrated. Thus, the indicators need to be infused into the development involving high-density properties around the transit and walking and cycling as the primary mode of neighbourhood mobility (Linton & Bray, 2019). Likewise, four (4) criteria that the planners should not overlook while planning, as Motieyan & Mesgari (2017) suggested, are the densities, the diversity, the design of the

area, and the social-economic development. Meanwhile, other researchers also mentioned similar essential measures, such as dense and mixed-use land, pedestrian-friendly, adjacent to the transit, and adequate self-contained parking (Ewing, Tian & Park, 2015).

PLANMalaysia, through its specific Transit-Oriented Development Guideline, has outlined four (4) criteria in defining a TOD area comprising (i) the transit shall be act as an interchange station or transportation hub; (ii) the area must be a rail-transit station in the urban area or specialised area; (iii) an area without natural disaster risk or pollution and; (iv) an area with existing or planned infrastructure (PLAN Malaysia, 2018). REHDA Institute (2016) highlighted nine (9) characteristics that priorities are toward pedestrians by enhancing walkable design, train station completed with a supporting transportation system as the prominent feature of the city, provision of public space, a mixture of land use in close proximity, high-density buildings, cycling facilities, reducing parking area, and accessible specialised retail at the transit station. Petaling Jaya City Council(2020) emphasises several criteria covering (i) mixed-use of activities and land use near the transit; (ii) high density or intensities development to support the TOD; (iii) support transportation facilities in each development within the radius; (iv) safety features and comfortable surroundings; (v) pedestrian and cycling is the ultimate mobility mode and; (vi) public space as the centre of community interactions.

2.3 The integration between land uses planning with transit planning

In land use planning, assessment and decision-making are required before allocating specific land-use activities (Cao, 2018). This research reviews several studies to summarise the significant criteria to incorporate in TOD planning. Land use is usually seen through the type of activities: agriculture, residential, vacant land, or any built-up (Ullah & Mansourian, 2016). Other than these, Ullah & Mansourian (2016) added that land use for TOD could be determined by the proximity to the nearest community facilities. Similarly, land use may be distinguished through its compactness, mixed-use activities, access to urban services, and preservation of natural features (Ostojic & Glazar, 2014). Several criteria are required other than those mentioned above, which are; the proportions, plinth areas, plot ratio, gross floor areas, building intensities, design of the blocks and road, building uses, landscaping, and the provision of facilities (Selangor Town and Country Planning Department,2010).

Huang et al. (2021) mentioned that the parameters to be considered while planning the land for TOD are maximising land use, infusing compactness in the area, creating commercial accessibility, and emphasising the factors contributing to the ridership volume. Likewise, Huang et al. (2021) and Liu et al. (2020) highlighted the significance of compactness in the area by outlining high density as one of the land-use features. Besides this, the diversity of the land allocation, site design, distance to the transit, and destination accessibility are other parameters to be considered Liu et al. (2020). In the same year, a study by Liang et al. (2020) emphasised circle-level development, walkability, access to urban services, and the availability of housing types. Previous studies have mentioned three (3) main attributes that mentioned land development within the transit-oriented development radius must take into consideration on the matter such as densities and mixed land while planning land for transit development which are (i) density, (ii) diversity, and (iii) distance as the most critical part to be considered (Sohu, 2018, Motieyan & Mogeswari, 2018, Singh, 2014, Jamal, 2011 and Curtis, Renne, & Bertolini, 2009). However, Sohu (2018) added that, besides these three (3) main features, the area's design, accessibility to the targeted destination, and demand management are also important while designing the land. At the same time, Motieyan & Mogeswari (2018) added that economic factors must be considered while allocating land use. Taki & Maatouk (2018) stated that land use activities should efficiently integrate transportation elements, facilities services, and urban and economic development. Rahmat et al. (2016) outlined essential matters in designing land for transit purposes: use, distribution of facilities, distance to walk, provision of car parks, type of housing built within the area, and plot ratio.

Furthermore, Singh et al. (2014) highlighted urban design elements and considered the economic level in that area. Correspondingly, Jamal (2011) emphasised the development scale or neighbourhood level, accessibility, and type of transit provided. Berawi, Ibrahim, Gunawan & Minaj (2019) highlighted the TOD characteristics such as density, diversity of the land use, design, destination accessibility, and distance to the transit as the benchmark in evaluating the integration between transport and land use planning.

A study conducted by Shah, Abdullah & Rashid (2020) has shown an example of the relationship between land use planning and transit-oriented development. It seeks to know the level of TOD stations based on land use and the Public Transportation Accessibility Index (LUPTAI). The purpose is to measure how easy it is to access the common destinations (various land use activities) through walking or public transport. The study found that the land use pattern within 500 meters of the transit stations at one of the major cities in the Klang Valley area was dominated by commercial, residential, and mixed-use spaces. Shah, Abdullah & Rahid (2020) concluded that the combination between commercial, residential, and provision of public facilities within the radius increases the ridership level at the transit station.

A study by Yupho, Jomsueb, & Pujinda (2017) indicates that optimising the surrounding land around transit also allows optimum movement of peoples, goods, or services between locations and increases the socio-economic benefit. The researchers also highlighted the need for appropriate land use tailored to the transit nexus. Also, a previous study by Nasrudin, Mohd Noor & Abdullah (2018) revealed that people are not willing to travel around the city by walking or cycling. They prefer using their transport instead of using public transportation. This result was influenced by factors such as age, gender, and income level. Concerning this study, integrating practical land and transport planning may support and encourage the participants to use public transport and create a sustainable transport system through integrated planning.

As TOD is one of the approaches to reaching sustainable development, Marzhuki, Omar & Leh (2018) mentioned the challenge of integrating the concept through good governance support, weak coordination between authorities and land office, and implementation of related regulations. If the guideline complies, an integration between land use planning and urban transportation will be achieved. Arifin & Zahari (2018) also highlighted the importance of walkability to reach sustainability. The planning for TOD must consider this aspect by enhancing accessibility between the areas. Due to this, the planning must reflect pedestrian ability and comfort while designing a place to

encourage the walkable setting within the site. Adjusting TOD characteristics into suitable land activities allows an effective urban environment to support the TOD area's growth. From other perspectives, Sham, Hussein & Ismail (2018) highlighted the safety elements while using public transportation concerning on design of the urban environment. The researchers emphasised the necessary infrastructure and urban environment, especially for transit users. The characteristic of TOD usually infuses the element to solve these issues. Thus, mixing all the needed land use activities in one area creates a better urban environment.

3.0 Methodology

The data required for this study were obtained from previous studies and scholars demonstrating the integration between land use and transit planning. The analysis employed the Thematic Analysis by applying Scoping Techniques to identify research trends on the subject matter. This method aims to identify the themes like the data pattern required to address the research matters (Maguire & Delahunt, 2017). Thus, this study needs to know how to define Transit-Oriented Development's character. Henceforth, scoping reviews are suitable techniques to investigate a broad area and trends of the topic (Grant & Booth, 2009), especially in defining the land use characteristic suits for TOD.

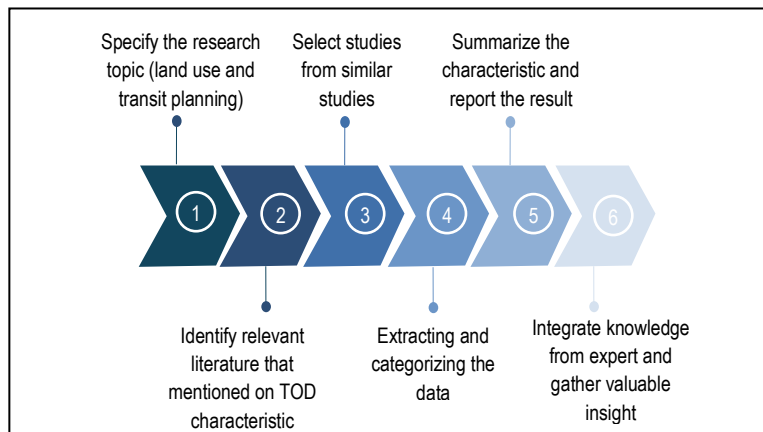


Fig. 1: Method of study
(Source: Westphaln et. al, (2021))

The application of the method mainly referred to Arksey and O'Malley (2007), but the process employed for this study was adapted from Westphaln et al. (2021) since the researchers have enhanced the previous method. Figure 1 above shows the scoping review process adapted from Westphaln et al. (2021) used for this study. To gather the related literature, the researchers first searched articles using the keywords "Transit-oriented Development". The study obtained thousand and twenty-one (1,021) indexed and non-indexed articles using the keywords. From there, the researchers had to study the content of those articles to retrieve and capture similar studies with this study and had obtained four hundred and forty (440) articles that mentioned TOD and that have a relationship with land use. During this time, the researchers used "Transit-oriented Development" and "Land use Planning" as the keywords. Any articles that present TOD without the subject of land use or vice versa will be eliminated. This procedure had left the articles to seventy-three (73) pieces. After that, the study narrowed down the search to different keywords, i.e., "Characteristics of TOD" and "Criteria of TOD", also "Parameters of TOD" and "Indicators of TOD". Finally, after scheming through the articles and exploring the content, the researchers had reduced the articles to twenty-seven (27) works of literature that relate primarily to the study, that concentrates not only on TOD and land use but also on the criteria of land use development for transit-oriented development. The data collected were then thematically categorised into priorities starting from the characteristic of the transit-oriented development into the land use criteria that suit the concept. Finally, the subject required the equations for land use planning in the transit-oriented area. It was extracted by identifying the relevant keywords from the most extensive scope into specific subject matters. The criteria of TOD show similar indicators to the principles used in designing the transit development. Land use also required specific enhancement while configuring the area in other parts.

4.0 Findings and Discussions

The study revealed that the cause of road congestion results from the high volume of private vehicles on the road. However, this is inevitable because people tend to choose their vehicle as their mode of transport due to the ineffective service of public transport and the placement of TOD with land use. This behaviour cannot be avoided since the public believes that using their vehicles will make them reach their destination faster and, most importantly, more accessible. Some transit stations require the people to commute to the station by feeder bus or their own vehicle to continue their journey on the rail. This will increase their travelling time and more hassle. Therefore, it is imperative to avoid the disconnection of land use with the location of transit stations. Integrating the land use with the TOD planning will possibly change the public's behaviour in accepting public transport as the primary mode of travel. Thus, this shift of attitude will not affect their mobility, travelling time, and level of accessibility. Also, based on the literature, the study found that the previous studies did mention the characteristic of Transit-Oriented Development (TOD). However, only a few studies focus on the specific criteria for land use, especially

in designing the rail-based transit-oriented development. Subsequently, this research summarises two (2) main findings from the literature regarding the interrelationship between land use and transit-oriented development and the principal characteristic of land use that is compulsory in each TOD.

4.1 Interrelation between Land Use and Transit-Oriented Development (TOD)

Transit-Oriented Development focuses on land use planning that is integrated or located with public transportation hub or station, either a rail-based system or the rapid bus system. Through the definitions, the importance of proper land use planning cannot be denied due to the impact it will cause on certain areas targeted for transit purposes and act as one of the sustainable urban land use planning approaches (Ruan, 2021). The dissemination of land use influences the concentration of development in or around a transit station (Mishra & Mishra, 2021). Otherwise, land use planning is one of the land administration and management functions to obtain sustainable development (Shrestha, Nepali, & Dahal, 2021). Similarly, Liang et al. (2020) also stress integrating land use with TOD to achieve sustainability. Merging the rail-transit system with surrounding land use can solve transportation and urban development issues in a comprehensive way (Huang et al., 2021). Back and forth, TOD and land are usually integrated to encourage public and non-motorised transportation modes and alleviate the pollution caused by car dependency (Abdi, 2021). According to Berawi et al. (2019), the suitable proportions for land planning in TOD areas are designated as 46% for residential purposes, 18% for offices, 23-26% for commercials such as hotels and retail, and 12-13% for other land use type because the proportion will allow more properties to be developed in one area. The essential parts of the development, such as compactness and mixed-used activities, will influence the allocation or distribution of land use within the transit-oriented development radius. TOD will organise settlements around transit nodes as centres of urban life (Ibraeva et al., 2020) since it involves intense, mixed development around transit nodes (Yang & Pojani, 2017) and allows a mix of residential and commercial (Kamal, 2019). According to this study, rail-based transport systems and land use should be integrated into TOD planning to enhance the suitability of the rail transit, efficient land use, and the effectiveness of traffic operations (Ding et al., 2017; et al., 2018). Sahu (2014) indicates the relevance of land uses for TOD, in which land use can be changed to fit the TOD concept, and integration between two of these will affect each other since both are linked together coherently. PLAN Malaysia (2016) justifies an approach to land use solution by emphasising accessibility enhancement, compacting the urban form, and allowing mixed-used development within 400 to 800 meters from the transit station. These matters were all associated with forming plans for the area and planning documents for the local authorities. Figure 2 below shows the network mapping of the interrelation between land use planning and TOD.

4.2 Main Criteria for Land Use and Transit Oriented Development

The first criterion is TOD's type of land use or land use diversities. Through several works of literature, the study found that the various kind of activities in an area is the main attribute to be offered while allocating the land for transit development purpose (Jamal, 2011, Singh et al., 2014, Rahmat et al., 2016, Motieyan & Mogeswari, 2018, Sohu, 2018, Liang et al., 2020, Liu et al., 2020, and Huang et al., 2021). Sahu (2018) recommends increasing the diversity of land use for daily needs such as supermarkets, laundry, retail shops, restaurants, and other services. Furthermore, it was suggested that making a certain mix percentage is necessary for development around the radius area. Motieyan & Mogeswari (2018) also stated measuring the land use mixture or percentage of each land use type is essential. Taki & Maatouk (2018) pointed out that the integration to make diverse land use types must include the transit station, transport support facilities, residential, and facilities services such as schools, hospitals, recreation, and other community facilities. A study by Liang et al. (2020) claimed that land use must be integrated to achieve land use efficiency and social equity (example: land use activities and provision of housing types). Huang et al. (2021) indicated that TOD planning will be a success by integrating rail transit stations, and commercial, residential, and public land use. Liang et al. (2020) clarify that providing different types of activities will increase access to urban facilities. Based on the evaluation established by Taki & Maatouk (2018), it can be concluded the most suitable land for TOD must include more than 80% of buildings coverage, 2-9% of the land use is a park. Meanwhile the ratio for planned housing is between 1.2-2.3, the residential area is between 1.9-4.6, and the ratio for industrial (>4.7), commercial (>0.3), and residential is (>6.9).

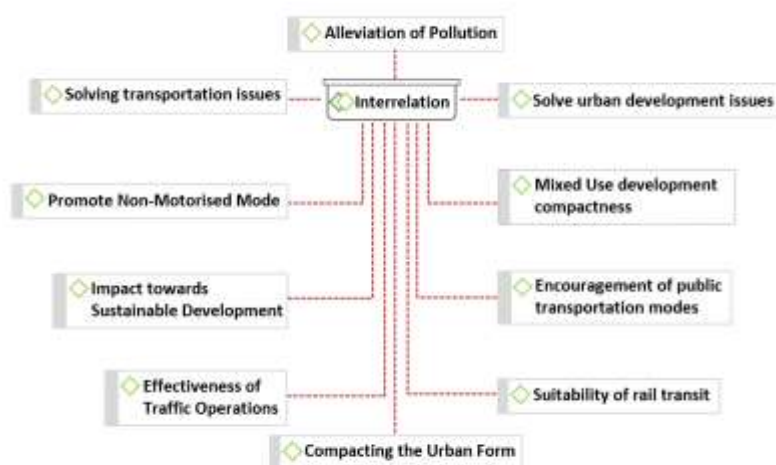


Fig. 2: Mapping of Interrelation between Land Use Planning and TOD

The second criterion is compactness or density. The study also found that the second aspect to be prioritised in designing the land is the level of compactness or density in the area (Jamal, 2011, Singh et al., 2014, Rahmat et al., 2016, Motieyan & Mogeswari, 2018, Sohu, 2018, Liang et al., 2020, Liu et al., 2020, and Huang et al., 2021). Jamal (2011) mentioned that the type of residential around the transit station must be considered whether it will be a high-density area; thus, multi-storey residential types or high-rise units are the main concern. Furthermore, the researchers added that the development must fulfil the minimum density required. Singh et al. (2014) and Motieyan & Mogeswari (2018) highlighted that density must be incorporated into all land use types, including commercial, employment, administrative or residential buildings. Sahu (2018) clarifies that the planning must minimise land use change and make land uses more compact to achieve human development scale. Meanwhile, Liu, Zhang & Xu (2021) elaborated that the density can be measured by quantifying the concentration or intensity of activities per area unit (measured by the number of people and jobs per acre, dwelling units per acre, or building floor-area ratio). Taki & Maatouk (2018) calculated that the suitable population density is more than 28,000 people. In addition, the equation made from the study conducted by Zulkifli (2017) categorises low density as (0-400 unit/hectare), medium density (401-700 unit/hectare), and high density (701-and above).

The third is the accessibility, connectivity, walkability level, or proximity. The parameter to be emphasised is regarding on the distance between one land use type to another land use type (example: the accessibility from the residential area to the commercial area) (Jamal, 2011, Singh et al., 2014, Rahmat et al., 2016, Motieyan & Mogeswari, 2018, Sohu, 2018, Liang et al., 2020, Liu et al., 2020, and Huang et al., 2021). Sahu (2018), in his study, highlighted a recommendation to increase residential and commercial near the stations. Huang et al. (2021) stated that accessibility within the land cells is the most vital part to be measured. In addition, the study also stressed the best way or land use plan based on the quantity, location, and density of each land use type cell in the station area. Liu et al. (2020) use measurement in creating the area by emphasising street network, transit station and route, distance to the transit with the time required, and destination accessibility supported by facilities and environment offered in that area. Liang et al. (2020) mentioned the importance of establishing a well TOD radius zone to increase walkability. Also, Motieyan & Mogeswari (2018) elucidated that the design of the street will determine the connectivity between land areas. Additionally, Rahmat et al. emphasised the distribution of surrounding land use within the radius of each TOD zone to ensure the provision is within the radius and enhance access to all facilities. These studies concluded that the distance from the basic community facilities must be not more than 250 meters from the station. Table 1 shows the land use criteria required for TOD that were agreed upon by many scholars from the analysis of the much related 27 articles.

Table 1. *Land Use Criteria that Required for Transit-Oriented Development*

Author Keyword/ Subject	Total Number of Publications	Percentage (%)	Rank
Types of land use	10	37.04	1
Land use diversities			
Compactness	9	33.33	2
Density			
Accessibility	8	29.63	3
Connectivity			
Walkability			
Proximity			
	N= 27	100	

The data collected from the reviews showed that early studies focused more on TODs in general by exploring the distinctive of each TOD typology. Nonetheless, it was found that TOD was defined using specific aspects involved, thus establishing the TOD characteristic accordingly. Moreover, the findings indicated similarities between the design principles for TOD with the characteristic established by various agencies or researchers. Several recent studies also showed that the topic was extended to incorporate transit into land use planning. This study can then categorise all the characteristics into detailed land use elements to be considered in TOD planning through previous studies. However, the findings also contradict several characteristics distributed in different terminologies due to the repetitiveness of the basic requirement for land use planning for TOD.

Meanwhile, through various reviews, it was also found that TOD will succeed if the land use distribution or allocation can be effectively integrated, hence allowing more benefits for the area. It is strongly suggested that giving priorities to comply with the main criteria in creating TOD will encourage effective land use around the transit nodes especially allowing a mixture of the land use types. TOD is one of the approaches to creating a more sustainable urban environment; therefore, planning for TOD by complying with all the matters to achieve diverse, high intensities and the walkable area is essential for better living conditions.

5.0 Conclusion and Recommendation

This paper summarises the interrelation between land use planning with Transit-Oriented Development (TOD) and three (3) primary characteristics of land use planning for a TOD area. The results demonstrated that priority must be given to offering the types of land use activities in the area, including the mixture between each land use type supported by various facilities allowing the end-users or residents to easily obtain the urban services. Secondly, having all the activities centred in an area will encourage the next priority toward creating a compact and high-density area. Lastly, it is crucial to ensure all the land uses can be easily accessible and incorporate elements that encourage walkable neighbourhoods or cities where transit is the centre of the development of that area. Therefore, the study recommends that any new TOD development consider the three (3) essential criteria for land use planning to integrate with TOD development, as these elements were primarily discovered as the most significant aspects of land use planning for TOD. It is suggested that since land use

planning is often conducted at a local level, the approach to practice must be changed and that local authorities should coordinate with the state government or federal government to look at the planning aspect within a regional level and not just at a local level. This will ensure that the transit corridor will integrate with the land uses, thus achieving the efficacy of TOD functionality.

6.0 Limitation of Study

This study involved exploratory research from the secondary data gathered through a systematic approach by scrutinising related literature from many scholars. It did not include any case study for investigation but mainly aimed at examining the relationship of TOD with land use planning. The main purpose was to acquire the concept and features of TOD and review the criteria of land use for the efficacy of TOD. Because many scholars agreed that TOD should be integrated with land use planning, this study revealed the main criteria for land use planning for TOD, which inevitably will promote the performance of TOD.

7.0 Potential Future Work and Direction

The researchers believe that there are opportunities for further research within the TOD realm which were not covered in this study. There is a possibility for future research to measure the effectiveness of TOD or transit corridors by using case studies that embrace the criteria of land use planning for TOD, as discovered in this study. Or perhaps a study that applies the use of technology like the Geographical Information System (GIS) to determine transit corridors together with land use planning to ensure the success and advantages of TOD design and development. Otherwise, the future study may include the design of TOD for functionality and practicality. And finally, this study also suggests that future research may explore the urban design aspect since the scope of urban design studies is more detailed in creating walkable neighbourhoods toward integrating successful land use and transit planning.

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Paper Contribution to Related Field of Study

This study contributes to establishing TOD criteria related to land use planning, which can potentially be applied in planning rail-based transit development. Moreover, this paper compares the previous studies with the new potential TOD rail-based stations based on the various conceptual ideas of many scholars. The outcome of this study infused those beliefs and suggested the ideal criteria for linking land use planning with TOD development.

References

- Abdi, M. H. (2021). Towards Transit-Oriented Development in Iran Understanding Policy, Planning and Urban Design Prerequisites (Doctoral dissertation, Arquitectura).
- Abdullah & Mazlan (2016)). Characteristics of and Quality of Life in a Transit-Oriented Development (TOD) of Bandar Sri Permaisuri, Kuala Lumpur. *Procedia - Social and Behavioral Sciences*, 234, 498–505. <https://doi.org/10.1016/j.sbspro.2016.10.268>.
- Ariffin, R. N. R., & Zahari, R. K. (2018). To Walk or Not to Walk. *Asian Journal of Behavioural Studies*, 3(11), 191-199.
- Arksey, H., & O'Malley, L. (2005). Scoping studies: towards a methodological framework. *International journal of social research methodology*, 8(1), 19-32.
- Berawi, M. A., Ibrahim, B. E., & Miraj, P. (2019). Developing a conceptual design of transit-oriented development to improve urban land use planning. *Journal of Design and Built Environment*, 19(1), 40-48.
- Calthorpe, P. (1993). *The next American metropolis: Ecology, community, and the American dream*. Princeton architectural press.
- Cao, K., (2018). Spatial Optimization for Sustainable Land Use Planning. *Comprehensive Geographic Information Systems*, 244-252.
- Curtis, C., Renne, J. L., & Bertolini, L. (Eds.). (2009). *Transit oriented development: making it happen*. Ashgate Publishing, Ltd.
- Ding, C., Liu, C., Zhang, Y., Yang, J., & Wang, Y. (2017). Investigating the impacts of built environment on vehicle miles traveled and energy consumption: Differences between commuting and non-commuting trips. *Cities*, 68, 25-36.
- Duncan, M., Torres, Y. V., Gladwin, K., Horner, M., & Wood, B. (2021). Transit-oriented development for older adults. *Journal of Transport and Land Use*, 14(1), 255-276.
- E, Papa. (2017). Implementing Transit Oriented development - TOD in Greater London. *Annual International Conference of the Royal Geographical Society*. London: Westminster Research.

- Ewing, R., Tian, G., Goates, J. P., Zhang, M., Greenwald, M. J., Joyce, A., & Greene, W. (2015). Varying influences of the built environment on household travel in 15 diverse regions of the United States. *Urban Studies*, 52(13), 2330-2348.
- Grant, M. J., & Booth, A. (2009). A typology of reviews: an analysis of 14 review types and associated methodologies. *Health information & libraries journal*, 26(2), 91-108.
- Hasibuan, H. S., Moersidik, S., Koestoer, R., & Soemardi, T. P. (2014, February). Using GIS to integrate the analysis of land use, transportation, and the environment for managing urban growth based on transit-oriented development in the metropolitan of Jabodetabek, Indonesia. In *IOP Conference Series: Earth and Environmental Science* (Vol. 18, No. 1, p. 012177). IOP Publishing.
- Hrelja, R., Olsson, L., Pettersson, F., & Rye, T. (2020). Transit Oriented Development (TOD): A Literature Review.
- Huang, X., Liang, Q., Feng, Z., & Chai, S. (2021). A TOD Planning Model Integrating Transport and Land Use in Urban Rail Transit Station Areas. *IEEE Access*, 9, 1103-1115.
- Ibraeva, A., Correia, G. H. de A., Silva, C., & Antunes, A. P. (2020). Transit-oriented development: A review of research achievements and challenges. *Transportation Research Part A: Policy and Practice*, 132(October 2019), 110–130. <https://doi.org/10.1016>
- Jamal, M. R. S. B. A., & Alam, S. (2011). UDM 750: Urban Economics and Finance Transit Oriented Development (TOD) Towards Enhancing Economics of Urban Centers in Klang Valley.
- Kamal.A, W. C. (2019). *Integrating Transportation and Land Use Development Approaches in the Commercial Corridor of Baroshke Neighbourhood*. Iraq: University of Duhok.
- Lambert, L. (2014, October 15). *Smart Growth / Smart Energy Toolkit Transit-Oriented Development* *Transit-Oriented Development TOD Smart Growth / Smart Energy Toolkit Making it Happen*. Retrieved from Slideplayer: <https://slideplayer.com/slide/6113492/>
- Liang, Y., Du, M., Wang, X., & Xu, X. (2020). Planning for urban life: A new approach of sustainable land use plan based on transit-oriented development. *Evaluation and program planning*, 80, 101811.
- Linton, C. & Bray (2019). *The Place to Be: How Transit Oriented Development Can Support Good Growth in City Region*. United Kingdom: Urban Transport Group. Retrieved from <https://www.urbantransportgroup.org>.
- Liu, L., Zhang, M., & Xu, T. (2020). A conceptual framework and implementation tool for land use planning for corridor transit-oriented development. *Cities*, 107, 102939.
- Maguire, M., & Delahunt, B. (2017). Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *All Ireland Journal of Higher Education*, 9(3).
- Marzukhi, M. A., Omar, D., & Leh, O. L. H. (2018). Re-appraising Regulatory Framework of Planning and Land Law System towards Sustainable Development in Malaysia. *Asian Journal of Behavioural Studies (AjBeS)*, 3(9), 153-160.
- Ma, X., Chen, X., Li, X., Ding, C., & Wang, Y. (2018). Sustainable station-level planning: An integrated transport and land use design model for transit-oriented development. *Journal of Cleaner Production*, 170, 1052-1063.
- Mishra, A. K., & Mishra, S. (2021). Smart Growth and Transit Oriented Development: Financing and Execution Challenges in India. In *Smart Cities*. IntechOpen.
- Motieyan, H., & Mesgari, M. S. (2018). Development of a TOD index through spatial analyses and HFIS in Tehran, Iran. *Journal of Urban Planning and Development*, 144(4), 04018038.
- Nasrudin, N., Noor, H. M., & Abdullah, Y. A. (2018). Public awareness towards sustainable transportation in Shah Alam, Malaysia. *Asian Journal of Behavioural Studies*, 3(11), 137-146.
- Niu, S., Hu, A., Shen, Z., Siu, S., Lau, 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), 19–30.
- Ostojić, I., & Glažar, T. (2014). Criteria for evaluation and guidelines for land use planning in terms of sustainable urban development. *IGRA USTVARJALNOSTI (IU)/CREATIVITY GAME (CG)—Theory and Practice of Spatial Planning*, 2, 24-32.
- PLAN Malaysia (2016). *National Physical Plan 3*. Retrieved from <https://www.townplan.gov.my/download/RFN3.pdf>
- PLAN Malaysia (2018). *Garis Panduan Pembangunan Berorientasikan Transit*. Retrieved from <https://www.planmalaysia.gov.my/index.php/garis-panduan-perancangan/2134-24-gpp028-pembangunan-berorientasikan-transit-tod-2018/file>
- Rahmat, A., Endot, I. R., Ahmad, Z., Ishak, Z., & Ibrahim, C. K. I. (2016). Development of Transit Oriented Development (TOD) model for Malaysia. *Journal of Built Environment, Technology and Engineering*, 36-47.
- Ruan, Z., Feng, X., Wu, F., Ding, C., & Hua, W. (2021). Land Use and Transport Integration Modeling with Immune Genetic Optimization for Urban Transit-Oriented Development. *Journal of Urban Planning and Development*, 147(1), 04020063.
- Sahu, A. (2018). A methodology to modify land uses in a transit-oriented development scenario. *Journal of Environmental Management*, 213, 467–477. <https://doi.org/10.1016/j.jenvman.2017.12.004>
- Saidan Khaderi, S, Bakeri, N.N. & Abd Shukor, A.S. (2021) The Transit-Oriented Development (TOD) Improvement Towards a Sustainable Development, *International Journal of Sustainable Construction Engineering and Technology*, Vol. 12, No. 3 (2021), pp. 333-341.
- Selangor Department of Town and Country Planning (2010). *Garis Panduan dan Piawaian Perancangan Negeri Selangor (Edisi kedua)*. Selangor: Selangor Town and Country Planning Department.

- Singh, Y. J., Fard, P., Zuidgeest, M., Brussel, M., & van Maarseveen, M. (2014). Measuring transit-oriented development: a spatial multi criteria assessment approach for the City Region Arnhem and Nijmegen. *Journal of Transport Geography*, 35, 130-143.
- Shah, M. I. B., Abdullah, J., & Rashid, K. (2020). Transit Oriented Development and Ridership at Kelana Jaya Line LRT Stations. *Environment-Behaviour Proceedings Journal*, 5(14), 293-300.
- Sham, R., Hussein, M. Z. S. M., & Ismail, H. N. (2018). Crime and Safety among Women Travellers in Kuala Lumpur City. *Asian Journal of Behavioural Studies*, 3(11), 37-43.
- Shrestha, R., Nepali, P. B., & Dahal, T. P. (2021). Towards Sustainable Land Management: State-of-the-Art in Land Use Policies of Nepal. In *Examining International Land Use Policies, Changes, and Conflicts* (pp. 351-369). IGI Global.
- Taki, H. M., & Maatouk, M. M. H. (2018, June). Spatial planning for potential green TOD using suitability analysis at the metropolitan region scale. In *IOP Conference Series: Earth and Environmental Science* (Vol. 160, No. 1, p. 012020). IOP Publishing.
- Ullah, K. M., & Mansourian, A. (2016). Evaluation of Land Suitability for Urban Land-Use Planning: Case Study Dhaka City. *Transactions in GIS*, 20(1), 20-37.
- Vale, D. S. (2015). Transit-oriented development, integration of land use and transport, and pedestrian accessibility: Combining node-place model with pedestrian shed ratio to evaluate and classify station areas in Lisbon. *Journal of transport geography*, 45, 70-80.
- Vale, D. S., Viana, C. M., & Pereira, M. (2018). The extended node-place model at the local scale: Evaluating the integration of land use and transport for Lisbon's subway network. *Journal of Transport Geography*, 69, 282-293.
- Westphaln, K. K., Regoeczi, W., Masotya, M., Vazquez-Westphaln, B., Lounsbury, K., McDavid, L., ... & Ronis, S. D. (2021). From Arksey and O'Malley and Beyond: Customizations to enhance a team-based, mixed approach to scoping review methodology. *MethodsX*, 8, 101375.
- Yang, K., & Pojani, D. (2017). A decade of transit-oriented development policies in Brisbane, Australia: Development and land-use impacts. *Urban Policy and research*, 35(3), 347-362.
- Yupho, S., Jomsueb, T., & Pujinda, P. (2017). Unique Land Use Pattern and Travel Behavior on Waterborne Transport. *Environment-Behaviour Proceedings Journal*, 2(5), 403-413.
- Zulkifli, S. N. A. M., Hamsa, A. A. K., Noor, N. M., & Ibrahim, M. (2017). Evaluation of land use density, diversity and ridership of Rail Based Public Transportation System. *Transportation Research Procedia*, 25, 5266-5281.