



# The Transit-Oriented Development (TOD) Improvement Towards a Sustainable Development

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**Abstract:** Transit-Oriented Development (TOD) is gaining popularity as a tool to achieve sustainable development. It consists of a mixed-use development, which can cater to urban sprawl, road traffic congestion and an increase in carbon gas emission. There are efforts and incentives by the Malaysian policies related to TOD constructed under the Eleventh Malaysian Plan (RMK-11) to encourage public transportation, walking, and cycling as an alternative to the main modes. However, the efforts seem in vain as the public are not concerned regarding this issue. This study examined TOD's implementation towards sustainable community with the following objectives: to determine the criteria and concept of TOD, investigate the issues and challenges in implementing TOD towards sustainable development, and recommend TOD improvement towards a sustainable development. The scope of this study is to identify the TOD implementation around Subang Jaya station towards sustainable development. A mixed-method of qualitative and quantitative research is used in a semi-structured interview, questionnaire distribution, observation, and document analysis. The quantitative data collected was analyzed using Statistical Package for Social Science (SPSS) 22, while the qualitative data was analyzed using content analysis. The results show that the implementation of TOD still immature and in the developing phase. The top three criteria were identified; reduce private vehicle and road traffic congestion, reduce pollution and carbon emission, and connectivity to other spaces or area. Three significant issues and challenges identified; a limited number of park-and-ride facilities, housing price around transit station and quality service of the public transportation served by related agencies. A workable recommendation for TOD improvement towards a sustainable community developed after industry practitioners tested it. These suggestions and guidance can help industry players in making sound decisions when undertaking TOD projects.

**Keywords:** Transit-Oriented Development (TOD) implementation, sustainable development, improvement

## 1. Introduction

Sustainable development seeks to create an urban environment that maximizes economic growth and social equity while minimizing the natural environment (Renne, 2003). Transit-Oriented Development (TOD) has become a popular tool to achieve sustainable development. It involves the mixed-use of residential and commercial development, which add vibrancy to city spaces, reduce pollution and energy consumption, and increase public transport use. According to Yap & Goh (2017), TOD promotes the public transit system's usage to reduce the volume of private motor vehicles on Malaysian roads. Indirectly, it can improve the economy and quality of life (Rahmat et al., 2016) and at the same time, a solution to the increase in road congestion, increase in greenhouse emission and other environmental impacts. However, there are effort and incentives by the Malaysia policies related to TOD constructed under Eleventh Malaysian Plan RMK-11 to encourage the use of public transportation, walking, and cycling as an alternative to the main modes.

However, the efforts seem in vain as the public are not concerned regarding this issue (Rahmat et al., 2016). The dependency of the people on private vehicles stills a significant concern. The people need to take part with the government; the public needs to cooperate with the government. City authorities will adopt TOD as part of the city's competitiveness master plan to add vibrancy to city spaces, reduce environmental effect and energy consumption by increasing public transport or walking, and revitalize brownfield areas within the city (Economic Planning Unit, 2016).

TOD is supposed to bring about new compact development in urban areas to address the worsening urban sprawl situation in cities throughout the world (Abdullah & Mazlan, 2016). This research's main objectives are to identify the criteria and concept of TOD while investigating the issue and challenges in implementing this concept and recommend the suggestion for improvement. This research aims to give recommendation for improvement of TOD towards sustainable development.

## 2. Literature Review

Increase in population especially in the central of the nation led to increasing in demand for dwelling, job seeking and motorized vehicles on the road which also brings effect in the increase of congestion, greenhouse gas emission and other environmental, social and economic impacts (Sohoni, Thomas, & Rao, 2017). The demand for residential development and its surrounding in the city centre increases as the population increase. This medium led to pressure to an actual event, creating urban sprawl and creating a more suburban area (Zainuddin Rahman, 2013). To cater to the problems and demand, transit-oriented development (TOD) seems to answer the issues mentioned above.

### 2.1 Transit-Oriented Development (TOD) and Sustainable Development

Three pillars of sustainable development in Figure 1; social, environmental, and economical by which people, habitats, and economic systems are inter-related. TOD is said to be a favorite tool to achieve sustainable development as it can tackle three elements of sustainable itself. Peter Calthorpe first defines TOD in the late 1980s as a mixed-use community within an average one-fourth mile walking distance of a transit stop and core commercial (Renne, 2003). As mentioned in chapter 8 of Eleventh Plan (2016-2020) Handbook, TOD refers to the mixed-use of residential and commercial development, which promotes an urban development designed to be pedestrian-friendly, and full access of public transport (Economic Planning Unit, 2016). TOD is an urban planning concept that has been implementing widely to many cities around the world, especially Europe, North America, and Southeast Asia during the last few decades (Alwehab & Al Ani, 2015).

TOD generally constructed around public transportation such as heavy rail transit, light rail transit, bus transit etc. Thus, it is a process of reconnecting transportation and land use (Sohoni, Thomas and Rao, 2017). TOD is a concept of managing urban growth, which has mixed land use characteristics, compact, walking distance, and development focus around the public transit area (Hasibuan et al., 2014). To encourage people to walk, each destination's location must not exceed people's willingness to travel by foot as it may sound tiresome people. So, the concept of TOD itself is a mixed-use community within an average of 2,000-foot walking distance (10 minutes of comfortable walking distance for the majority of people), typically within a radius of 600-800m (Sohoni, Thomas and Rao, 2017) of a transit stop and core commercial area. Thus, it is convenient for residents to travel by transit, bicycle, or foot since it comprises a residential, office building and public uses in one development (Saffuan, 2011). Therefore, there will be several housing types such as townhouses, apartment and high-rise building will be developed near transit stations (Yap and Goh, 2017).

Yap and Goh (2017) in their finding in the comfortable walking distance for Malaysian communities have divided their targeted group into three categories: Baby Boomers (1946-1965), Generation X (1966-1976) and Generation Y (1977-1994). Generally, all respondents from these three categories are willing to walk five to ten minutes to every 1.2 minutes of walking is equivalent to approximately 100 meters in the distance. Research shows that most people who live near transit station have a higher rate of transit use than residents who didn't live near to transit station (Ling et al., 2016). The rule of thumb is that TOD built within one-quarter mile, or five to seven-minute walk to every destination that provide critical connections to the regional transit system (MIDF Research, 2017).

Therefore, the TOD development serves as the centre of the transit station, was within walking distances in radius in between 400m to 800m (Citizens for Improve Transit, 2015). Despite the distance and destination accessibility, Ogra and Ndebele (2013) state some other elements or principles widely cast in TOD: density, diversity, design, and demand management. Ogra and Ndebele (2013) also added that to make TOD successful; the highest priority should be given to creating the pedestrian walkway and train stations should be one of the town centre's prominent features, besides the factors of density and diversity of land uses. However, with Malaysia's condition, hot and humid, it is arguable whether people are willing to walk around five to ten minutes of walk. That is why it is recommended to construct a covered walkway to reduce the fatigue.

Thus, TOD's benefits can reduce the problem of urban sprawl, reduce dependency on private vehicles, reduce environmental issues, provide housing and mobility choices, and reduce traffic congestion. According to Abdullah and Mazlan (2016), TOD's main elements are diversity, density, and design. The difference is in mixed-use development, frequency in the way of more residence and jobs during the procedure in the form of functional street connectivity for the pedestrian. The concept of TOD is a mixed-use community with an average of 2,000-foot walking distance (10 minutes of comfortable walking distance for most people), typically within a radius of 600-800m (Sohoni et al., 2017). The principles of TOD are listed as below:

- Walk - Develop neighborhoods that promote walking.
- Cycle - Priorities non-motorized transport networks
- Connect - Create dense networks of streets and paths
- Transit - Locate development near high-quality public transport.
- Mix - Plan for mixed-use
- Densify - Optimize density and transit capacity.
- Compact - Create regions with short commutes
- Shift - Increase mobility by regulating parking and road use

(Source: USDOT, 2012)

In addition to TOD's concept and definition, this paper also investigates the issue and challenges in implementing this concept around Subang Jaya station. This medium because of a few problems and challenges faced in achieving the fullidea.

## 2.2 Issues and Challenges in TOD

Despite the numerous benefits of TOD, it cannot avoid any issue and problems arise. There are often barriers that need to overcome for TOD principles to include in planning processes successfully. A few of issues and challenges have identified such as require a higher amount of cost, requires regular maintenance, causes environmental and health problems, increase in the price of the land around Klang Valley and inconvenience of park-and-ride facilities. Generally, the development of a city's transportation system will influence the environmental aspects of its residents. There are two significant ecological problems relevant to the growth of the rail transit system.

### Indoor Air Quality

These are the indoor air quality of the vehicles, and the noise levels in the surrounding areas. These issues directly affect the environmental sustainability of the TODs for community residents. According to (Brandon et al., 2013), the indoor air quality (IAQ) of public transportation are established in Hong Kong. Based on these standards, the air quality in railway vehicles' passenger cabins may improve through the ventilation system using outside air. It is also reasonable touse the carbon dioxide (CO<sub>2</sub>) levels as the index improvement (Kwon, 2008). The IAQ of MTR in Hong Kong is a significant factor to estimate the achievements and limitations of public transportation, and its effect on riders. Adverse environmental impact on riders can cause health issues and discourage ridership.

The quality beyond the MRT station's limits has a large role in the environmental sustainability of each TOD. According to Borrego (2006), through air quality simulations, urban structures have a large effect on the city's air quality. Througha mixed fluid-dynamic and chemical diffusion model, each different type of town exposes to similar conditions. The towns that contained compact mixed-use buildings, airflow corridors, and centralized design were able to distribute pollutants more efficiently.

### Create Noise Disturbance

Public transportation is convenient for the residents; however, it also creates noise. Excess noise affects people's health and mood subtly and decreases the quality of life for residents. According to Lam (2009), his study results show that annoyance is largely caused by noise disturbance and perceived noisiness. When road traffic noise dominates, annoyanceis primarily determined by noise peaks of train events can induce a direct annoyance response. Noise is a criterion to assess the quality of living in TODs. By reducing the noise made by commuter rail, the mental states of residents will improve. Environmental sustainability encompasses each TOD's green area as well as quantitatively measurableparameters such as air quality and noise pollution. A meaningful study will evaluate all the sustainability indicators andcombine and compare the individual data sets (Brandon et al., 2013).

### Zoning and Land-Use Issues

There are several essential reasons why sustainable TOD is challenging to achieve. Transit and land-use decisions madeseparately-too often, and policy decisions favor transit locations that fail to optimize transit-oriented development opportunities, privileging short-term expediency over long-term value. Zoning and land-use restrictions can also prevent communities and developers from capturing the opportunities to create more compact, workable, and affordable organizations that take advantage of transit locations. This medium will be resulting in the built environment continues the favors of automobile dependence. Simultaneously, many areas near transit fail to produce the types of development needed to support equitable TOD.

Land-use decisions are made at the project level and neighborhood scale and fail to consider corridor or regional level issues. Land use policy and public and private investment decisions are often based on individual project and neighborhood considerations, yet creating sustainable TOD also requires planning and coordination at the transit corridor and region level. The result of this action is the critical connections between where people live, work, shop and play are often not factored into important decisions about where transit investments are made where housing and jobs are currently located, or where they should be created.

## Value of Land

Assembling land is expensive because transit line locations are often announced well before they are built, and speculation can occur years before construction. Land prices thus make the provision of affordable housing and other community amenities more challenging to provide. Besides, new transit corridors are most often auto-oriented places that require significant public and private investment to transition into more compact, walkable, and transit-cantered communities. The reality is that the benefits of TOD take time and coordination to develop. The experience in many places where the transit line has yet to be built is that property owners and developers create auto-oriented development of key parcels along these future transit corridors because the community has not yet experienced the transit's catalytic potential line.

This medium makes it much more challenging to create the more compact, walkable, mixed-use environments along these corridors that truly optimize the transit investment. This resulting to land speculation and short time horizons can reduce TOD to the high end of the market, at the expense of the border societal benefits that should be created at these sites (Wood and Brooks, 2009). Nevertheless, according to Brandon et al. (2009), major sustainability factors such as green area, walkability, mixed-use buildings, pollution, resident satisfaction, and station design.

## 2.3 Recommendation to Improve TOD

The study contributes to the various field of literature review presented, emphasizing sustainable urban development and the politics of transportation planning. It proposes the opportunity to explore and investigate current TOD implementation efforts in Malaysia. According to The World Bank Group (2018) and Garis Panduan Pelaksanaan TOD(2016), to build a sustainable community and make more positive effects on urban development, four main recommendations are provided.

- Established multi-mode public transportation systems
- Improve the operating efficiency of public transportations
- Increase the investment in the urban transportations industry
- Enhance the quality of passengers' behaviors

Many governments worldwide have adopted a series of measurement leading people to choose green travelling methods, such as raising parking fees, providing more discounts for public transportations, and applying a public bicycle sharing system. When the government makes more efforts to create a sustainable environment, individuals also need to conduct a suitable manner (Lyu et., al (2019). Therefore, the government should increase more investments in the transportation industry to achieve these goals.

## 3. Research Methodology

Subang Jaya has initially been a township of Petaling Jaya. However, due to the high population and rapid developments, it has earned its municipality, which governed by the Subang Jaya Municipal Council (MPSJ). Subang Jaya is well- connected to the cities of Kuala Lumpur, Shah Alam and the townships of Petaling making their public transport system highly developed with two (2) LRT lines, one (1) KTM commuter line, one (1) BRT line, bus and taxi services. With the highly developed public transportation, it is making Subang Jaya as one of the cities in implementing this TOD concept. Among many stations built in Subang Jaya, the Subang Jaya station hosted the LRT station and KTM Commuter station chosen as study area due to the rapid development and potential in developing the TOD concept. The station situated at the city centre of Subang Jaya behind Subang Parade and Aeon Big Subang. Ever since the station remodeled and upgraded to accommodate the LRT service, it is a famous train and bus hub. Collage students commonly used it for travel to and from colleges and universities like SEGi University College, Taylor's University, Monash University, Inti College, University of Wollongong, and Sunway University.



Fig. 1 - Nearby area of Subang Jaya station

This research adopted a mixed method of qualitative and quantitative research in a semi-structured interview, questionnaire distribution, observation, and document analysis. The research methodology chosen is undertaken to answer the research objectives. All the goals employed the same research instrument, which is the public's perception as an end-user and point of view from the local authority (MPSJ) whom in charge preparing the guideline of TOD. Targeted respondent is public who uses public transport from the Subang Jaya Station and the resident around the study area and interviews with the two resources person from the Town Planning Department of Subang Jaya Municipal Council (MPSJ). Fifty (50) sets of questionnaires distributed cover various aspects such as demographic background, the level of agreement for the criteria and concept of TOD and issues and challenges TOD around the study area. A total of 50 sets of the questionnaire returned, and the data gathered is analyzed by using Statistical Packages for Social Sciences (SPSS). The data analyzed will then be calculated and ranked according to the calculated mean to identify which the public most agrees criteria and issues. The data from the interview will then be analyzed and compare with the data from the questionnaire.

#### 4. Result and Discussion

In all, fifty (50) sets questionnaires were sent out by hand, and all the results obtained. The results are analyzed and divided by the research objectives as discussed below:

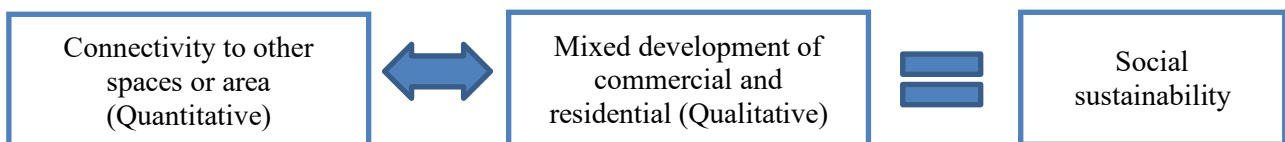
##### 4.1 Criteria and Concept of TOD

Based on the public's survey, the top three (3) criteria and thought that most respondents agree to implement TOD concept around Subang Jaya station. Table 1 shows the connection to other spaces, reduce pollution, and carbon emission and reduce the use of private vehicle and road traffic congestion.

**Table 1 - Criteria and concept of TOD**

	N	Min	Max	Mean	Classification
Accessibility to public transport	50	1.00	5.00	3.8200	Agree
Mixed of housing and commercial close to transit station	50	1.00	5.00	3.7400	Agree
Offer pedestrian-friendly space	50	2.00	5.00	3.8200	Agree
Walkable distance to transit station	50	1.00	5.00	3.7000	Agree
Reduce the use of private vehicle and road traffic congestion	50	2.00	5.00	3.9600	Agree
Reduce pollution and carbon emission	50	2.00	5.00	4.0000	Agree
Create more livable community	50	1.00	5.00	3.9600	Agree
Connectivity to other spaces or area	50	1.00	5.00	4.0600	Agree
Valid N	50				

From the interview with the local authority, they mentioned that connectivity to other spaces could result from mixed development, which consists of commercial and residential around the station in the radius of 400m. Thus, this concept can be related to social sustainability (Refer Fig. 2).



**Fig. 2 - Criteria of TOD in relation to social aspect**

The other two criteria, which are to reduce private vehicle use and reduce carbon emission, are correlated. This medium is because when individual vehicle uses decrease, it will contribute to the lowering of pollution and carbon emission. This medium might result from the implementation by MPSJ which any development in TOD area must comply with the guideline that mentioned any residential are limiting to one (1) parking/unit and one (1) parking / 1000 sq. Ft for commercial. This approach can reduce half of the number of private vehicles on the road and as a result, can help in reducing the carbon emission. Thus, these two concepts can tackle in term of environmental sustainability (Refer Fig. 3).

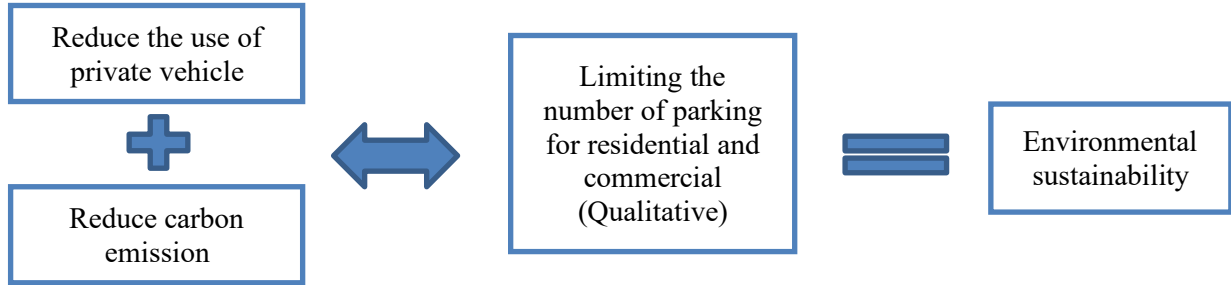


Fig. 3 - Criteria of TOD in relation to environment aspect

#### 4.2 Issues and Challenges in Implementing TOD

The bar chart shown in Figure 4, limited for park-and-ride facilities and higher in housing price around transit station is the major issue concerning for respondent. From the local authority interview, it is undeniable that minimal parking area is provided due to the approach to reduce private vehicles' use as they want the public to utilize feeder bus that equipped fully. Local authority provides feeder bus such as Rapid KL and Bus Smart Selangor to the station depending on the scheduled routes (Refer Fig. 5). This issue might relate to social sustainability, as it shows how people react to the physical environment.

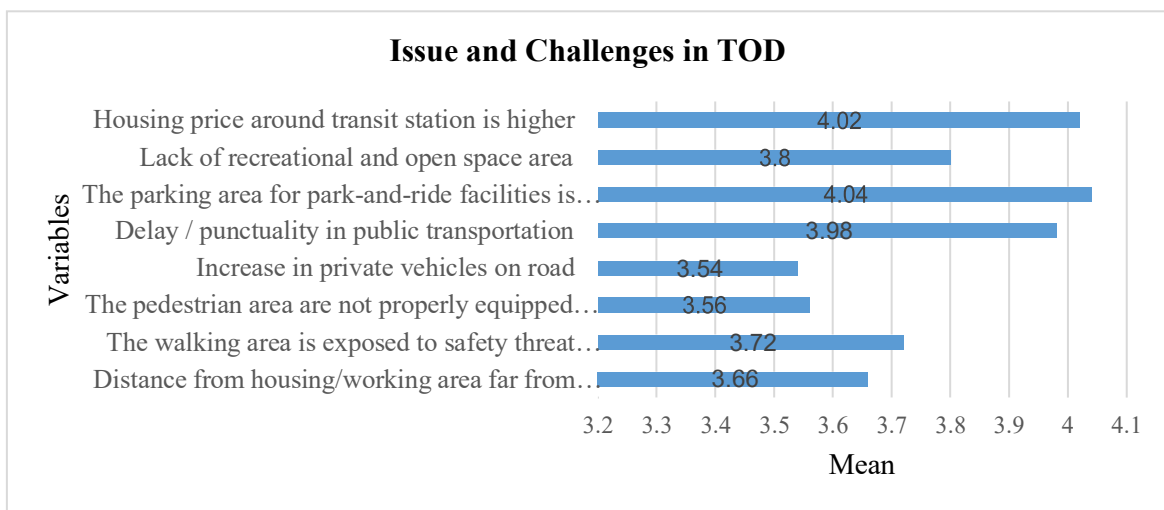


Fig. 4 - Issues and challenges in implementing TOD

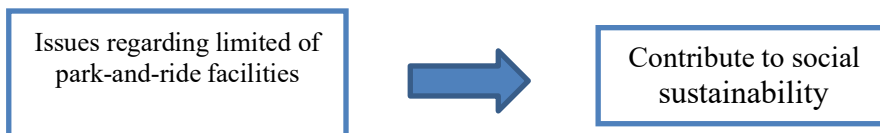
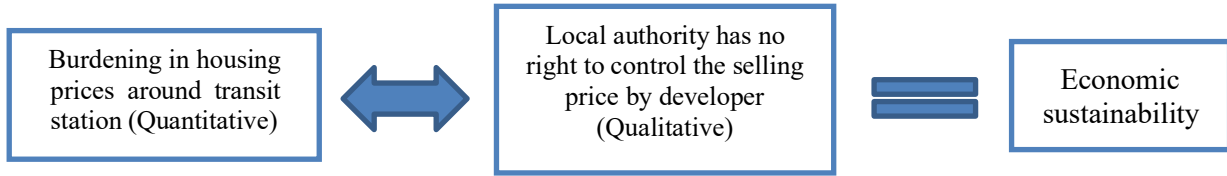


Fig. 5 - Relation of limited parking with social sustainable aspect

Regarding the issues of higher housing prices around a transit station, the local authority has no right to control the selling price for any residential property by the developer as shown in Fig. 6. It is undeniable that rail transit influence residential property value because of the amenities offered. Moreover, the developer has their target buyer, and they will not merely increase the price as it may affect their selling record. This medium will affect the economic sustainability as it about financial.



**Fig. 6 - Housing prices in relation with economic sustainability**

**4.3 Recommendation for Improvement of TOD**

Based on Table 2, the respondent's most recommendation is to improve the quality of public transportation, provide more park-and-ride facilities, and pedestrian walkways must be covered.

**Table 2 - Recommendation for improvement of TOD**

	N	Min	Max	Mean	Classification
The distance from one area to another can be reachable by walking or cycling.	50	1.00	5.00	3.9400	Agree
Pedestrian walkways must be covered and equipped with lighting especially at night.	50	3.00	5.00	4.5800	Agree
Encourage public to use public transport	50	3.00	5.00	4.4200	Agree
Improve the frequency of public transportation especially during peak hours.	50	3.00	5.00	4.6200	Agree
Provide more park-and-ride facilities	50	3.00	5.00	4.4800	Agree
Build more park and other recreational area.	50	2.00	5.00	4.2600	Agree
Provide more affordable housing price	50	3.00	5.00	4.4600	Agree

The local authority also agrees with the recommendation suggested that transportation agencies such as KTMB and Prasarana must improve their services as many complaints are received due to the incidents and misconduct by transport operator which cause frustration to the passenger. Another recommendation from the local authority is they need to have a clear and comprehensive guideline. Since the TOD concept development is still new and immature, they need to prepare clear and detailed guidance starting from plot setting until all the provided facilities. The local authority (MPSJ) needs to make a new guideline or checklist that suits the development around Subang Jaya. The direction will further enhance to work the current event to provide better facilities to the public.

In the public's view, most of the respondent agree to recommend for the improvement of the transit service quality, pedestrian walkways must be covered and provide more park and -ride facilities. Based on the interview conducted, there are two (2) recommendations made by the local authority to improve the TOD concept. The first recommendation by the public as the end-user is to improve the transit service quality. This medium is due to the lousy service such as delay/punctuality of public transport, which restrict the public from using public transportation. The improvement of the quality service might attract more public to trust and rely on public transport for daily use. Another recommendation is to provide covered pedestrian walkways and equipped with lighting, especially at night. The local authority might at least place a traffic light for pedestrian crossing. Another recommendation from the point of view local authority is they need to have a clear and comprehensive guideline.

Since the TOD concept development is still new and immature, they need to prepare a clear and comprehensive guideline starting from the plot setting until providing all the facilities by the developer. The policy from State in general, which contain nine principles that must refer to any development within the TOD area. So, the local authority (MPSJ) needs to prepare a new guideline or checklist that suits Subang Jaya's action. The government will be enhanced the policy to work the current development to provide better facilities to the public.

Furthermore, law enforcement by any related parties must strictly enforce so that people will eventually follow the rules. Another recommendation suggested by the local authority is that the developer needs to develop a successful TOD to prove that this concept indeed can reduce the use of the private vehicle. Suppose this concept can bring success and advantages. In that case, the government can further enhance any initiatives and effort to improve this concept so that many urban cities will implement this concept to reduce private vehicles and cater to all the urbanized issues.

## 5. Conclusion

This paper has evaluated and identified the implementation of TOD around Subang Jaya station. Overall, it can say that the application of TOD concept by Subang Jaya Municipal Council (MPSJ) is still in developing and planning phase due to the time constraint in preparing guideline and checklist to suit with development around Subang Jaya. Majority of the respondent agree that all the criteria and concept of TOD implemented in the study area. However, the public concerns limited park-and-ride facilities, burdening in housing price, and punctuality of public transportation—a few recommendations offered to improve the TOD concept towards a sustainable community. The first is to improve the quality of public so the public will attract to use public transport, which can increase the number of ridership. Another recommendation is to provide a covered walkway to the adjacent building. This medium would allow more people the convenience of going to the station, especially during rainy periods. The third proposal is by providing additional parking space. Hopefully, with these improvements, this concept would improve considerably and helping TOD achieves its main objectives.

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