

## Implementation strategy of transit-oriented development based on the bus rapid transit system in Indonesia

Prasadja Ricardianto<sup>a</sup>, Abdullah Ade Suryobuwono<sup>a</sup>, Esti Liana<sup>a</sup>, Endri Endri<sup>b\*</sup>

<sup>a</sup>*Institute of Transportation and Logistics Trisakti, Jakarta, Indonesia*

<sup>b</sup>*Universitas Mercu Buana, Jakarta, Indonesia*

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### ABSTRACT

The bus rapid transit (BRT) system has become a cheap public transportation option worldwide, including in Indonesia. The problem in the Jababeka area, Indonesia, was the unconnectedness and lack of transportation as a sustainable area with the whole residence, modal shift, and easy access for people. This research aimed to improve access to Bus Rapid Transit (BRT) based public transportation by implementing the Transit Oriented Development (TOD) Model in the Jababeka area, Bekasi Regency. In this research, modeling was made by using PTV Visum with the trip assignment method and continued with the projected movement from 2022 to 2042, resulting from the people movement survey in 2022 and the SWOT strategy. The sample of this research consists of 210 respondents domiciled in nine subdistricts of Bekasi Regency. The result of this research was that the Jababeka area, Bekasi, must be planned as a TOD-based area, facilitating people to fulfill their transportation needs so that derived demand can run efficiently. Therefore, the implemented strategy must improve transportation access by developing TOD areas with a BRT system. Jababeka area was developed using the typology of regional scale city TOD, with a potential sub-city and environmental TOD typology. TOD development using the BRT system must be able to shift the intercity movement to local movement because residential areas were provided as the substitute for intercity movement.

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## 1. Introduction

Population growth in Indonesian cities has been increasing over time. This, of course, can impact mobility problems in cities, such as traffic jams due to the extensive use of private vehicles and the emergence of pollution that can interfere with the surrounding community's health (Belzer & Autler, 2002). In addition, urban sprawl in several big cities in Indonesia has also led to the development of residential areas in peri-urban areas where some of the population has several activities in the City. This will add to mobility problems in cities, such as increasing congestion, primarily if cities need to provide public transportation facilities, impacting people's dependence on private vehicles for moving or mobility. Therefore, it is necessary to apply the concept of Transit Oriented Development (TOD) to reduce the use of private cars and optimize the use of public transportation, such as trans buses and trains to create an efficient city. In the development of an urban area, intermodal transit facilities and transit areas have become inseparable. The intermodal transit facility itself is a built area that consists of various transportation facilities with the hope that it can be used optimally by the general public. The area around the transit point is a potential site development area. This relates to the ease of access to transit facilities in the TOD area. TOD is essential for increasing transit effectiveness, supporting community goals, and facilitating accessibility.

The development of the TOD model in Indonesia, especially in the Jababeka area, Cikarang, Bekasi, is entering its second year and has collaborated with user partners who are relevant to this research Jababeka corporate group as Research Partners.

\* Corresponding author. Tel.: +628129204067

E-mail address: [endri@mercubuana.ac.id](mailto:endri@mercubuana.ac.id) (E. Endri)

The development of TOD in the Jababeka area is one of the efforts to attract people to use public transportation. The result of transportation nodes, especially in the Jababeka area, where railway stations and bus terminals are activity centers at regional and local scales, is based on integrating intermodal services and mixed-use development.

TOD development in Jababeka is very important to attract people to use public vehicles through a railway station as the center of activities at regional and environmental scale based on the integration of intermodal services and the development of mixed-use land. In general, some problems of TOD in the area around the capital city of Jakarta or Jabodetabek are; (1) The third most congested city among 403 cities in the world; (2) The limited use of public transportation; and (3) Based on AQI (Air Quality Index), Indonesia is ranked fourth worst in the world. The problems in Jababeka area, Cikarang, Bekasi Regency are generally that the Jababeka city has not been connected and integrated with the whole residences, typical urban spaces, ease of access-absorption scale, combination of various differences, as well as a more sustainable and healthier lifestyle. Jabodetabek Transportation Management Agency gives technical recommendations to ensure whether the development plan of TOD area of Jabodetabek has met the transportation aspects and gives guidance in the forms of regulations execution, controlling, and supervising. The Head of BPTJ informs that TOD development of Cikarang-Jababeka in Bekasi Regency includes five areas to be developed, such as Grandhika City in East Bekasi.

The development of transportation nodes, such as railway station and bus terminals as the centers of both regional and environmental activities, especially in Jababeka area is based on the integration of intermodal services and the development of mixed-use land. As informed by a TOD executive, some obstacles are still found. For example, the regulation has not been applied 100% in the development areas, the spatial is not for TOD area but it is demanded to fulfill the requirements of an appropriate TOD area. Some problems are identified; (1) The unconnected and unintegrated area of Jababeka with residences, (2) No typical space in Jababeka, (3) Obstacles of access to the location of station as a transit location, (4) It needs a combination of various differences, (5) It needs an urban area which is more sustainable with healthier lifestyle. The topic of this research, which is also mentioned in the Research Theme of 2020-2024 in the Ministry of Research and Technology, is Intelligent Transportation System with the research topic of Urban Transportation Management.

The research for developing the TOD Modelling in Indonesia especially in Jababeka area, Cikarang, Bekasi Regency has cooperated with the partner user relevant to this research, namely PT Wibawa Cipta Perkasa, one of the groups existing in Jababeka area, to be a Research Partner. Jababeka as an integrated Independent City is located 35 km away from the east of Jakarta and can be travelled for 45 minutes from the business center district of Jakarta. It has very good access and connectivity with 3 Exit Tolls to Jababeka City and there is a construction of Main Transportation Infrastructure along the East Corridor of Jakarta to Jababeka City. Jababeka City in Cikarang has a Masterplan as wide as 5,600 ha and Land Bank as wide as 1,245 ha. Jababeka as the biggest industrial area in Indonesia is occupied by more than 2,000 local and multinational companies. Jababeka City is a flagship for public companies in developing other cities in Indonesia. Foreign and domestic companies are willing to pay premium price for strategic and established locations with quality infrastructures.

## *2. Literature Review*

Transit Oriented Development (TOD) as a mixed- area, composed of high-density residential and commercial areas, highly needs a railway station and bus terminal such as Bus Rapid Transit (BRT) which can meet the need for mass and rapid transportation. TOD is a concept of developing areas within and around the transit node to have added values focusing on the integration of between networks of mass public transport, and between mass public transport network and non-motor transportation mode network, as well as reducing the use of motor vehicles accompanied by the development of a high-density mixed area with a medium to high intensity of space utilization.

TOD-oriented development is a pattern of urban planning development integrated with the transportation system to create an efficient city. The Transit Oriented Development (TOD) concept aims to provide an alternative and problem-solving for urban growth with an oriented development pattern. The Transit Oriented Development Area (TOD) concept integrates the transit network regionally and complements existing environmental development strategies around transit nodes. The Transit Oriented Development (TOD) area combines residential land use, trade, services, offices, open space, and public space to make it easier for people and users to travel by foot, bicycle, or other modes of public transportation (Calthorpe, 1993). TOD has the principles of Density, Mix, and Design, subsequently completed to become 5Ds, and adding Accessibility and Distance to Transit (Calthorpe, 1993). The quality of a friendly environment for a pedestrian is consistently identified as the core element of physical design needed for the success of TOD. Based on the World Bank's study, the method used to cope with the existing challenge of congestion is TOD, which is a multi-discipline planning and design strategy to promote sustainable urban development (Ollivier & Basat, 2020). According to ITDP (2017), TOD plans and designs high-quality spatial and regional layout models to prioritize public transportation, walking, and cycling. Another opinion says that TOD is an approach to transportation and land use planning as a facility for convenient walking, cycling, and TransitTransit, and can maximize the efficiency of public transportation services with the priority of development around the transit station and terminal (Liu et al., 2016; Chiu, 2022). Public transportation prioritizes more on quality development near the network of mass public Transit (ITDP, 2017). Urban transport is vital to urban development, the smoothness of people and cargo mobility, and the City's economic growth (Hassan et al., 2021). In South Korea, especially

Sejong City, TOD will play an essential role in solving urban problems by reducing urban traffic jams and is considered a better choice for the existing municipalities and is needed for planned cities growing in Asia and Africa (Kang, 2012). Research by Hasibuan et al. (2014), and Taki and Maatouk (2018a) in Indonesia, need to restructure urban land use growth effectively or use public transportation. TOD in Osaka, Kyoto, and Kobe cities in Japan has improved connectivity and accessibility and made the City more exciting to live, work, play, and run a business (Waygood, 2011). The result of research by Kitajima et al. (2015) in Bangkok city, Thailand, also explains that they have a concept for mixed-use, multi-mode, public space through TOD. Research in Bogota, Colombia, Vergel-Tovar, and Rodriguez (2022) indicates the need for the change of land use for BRT as an essential factor but needs to be more frequently addressed. In addition, Ricardianto et al. (2020) and Thomas et al. (2018) explain that mixed-use is consistently the critical success element of TOD and is expected to improve accessibility by providing a relatively high level of transportation connection around the transit station. In TOD, loyalty and potential modal shift from various transit systems need to pay attention to competitiveness and tariff affordability (Satiennam et al., 2016).

Several indicators of TOD, according to TOD Guide, (2010), are; (1) transit service, (2) high accessibility, (3) mixed-use, (4) Pedestrian and bicycle riders, (5) Density development, and (6) Reduction of parking tariff for private cars. In addition, TOD provides people with a different mix of land use, service, and facilities so that they can live, work, shop, and socialize quickly by walking, cycling, or making a transit journey from their house (TOD Guide, 2010). According to Litman and Steele (2017), other TOD indicators are regional accessibility, density, mixed land use, closeness to the center, parking and mobility management, and road design. Other indicators are connectivity, innovative thinking, efficient public transportation, active space, mixed land use, and a shift to a multimodal city (Transit Oriented Denver, 2014). Theoretically, a pedestrian lane aimed at developing a pedestrian-friendly environment is a part of road space provided for pedestrians (ITDP, 2017). However, in Rodriguez and Vergel (2013) opinion, space for pedestrians is frequently side by side with the road because the sidewalk takes up 10-20 percent of the road. A study was conducted in Denver related to understanding urban places that can be used for walking (Transit Oriented Denver, 2014). As a result, Denver has become a world-class city with a transit community providing a complete network from the urban places that can be traversed on foot.

A cycling lane that gives priority to the network of non-motor transportation is a part of road space used for cycling traffic; it includes bicycle lanes, the land intended for the everyday use of intermodal vehicles, and others (ITDP, 2017). For bicycle users, ITDP (2017) explains that Reforma Avenue in Meksiko city has a living pedestrian space that is well-designed and located near the public transportation network and gives priority to pedestrians and bikers. Along the BRT corridor, a bicycle parking rack facility is provided under the people crossing bridge in Hangzhou, China (ITDP, 2017). Crossing with a motor vehicle lane is made easy to see and eye-catching. Compact development, multi-use road facilities, and cycling are the main dimensions of TOD (Ricardianto et al., 2020; Thomas et al., 2018). However, based on the suitability analysis between transportation capacity and land use pattern in Teheran, Iran, the principles of TOD could be more successful in cycling (Kalantari et al., 2020; Aminah, 2007; Cats & Hartl, 2016). Based on the theory, public/transit transportation focuses on developing near a quality mass public transportation network (ITDP, 2017). However, the research by Padon and Iamtrakul (2019) in some cities, such as Hong Kong, New York, and Tokyo, indicate the importance of access to other public transportation systems. Furthermore, according to Jeffrey et al. (2019), it needs a development area for public transportation. Maximizing the walking distance as long as 500 meters for local bus service connected to the transit network indicates TOD. The modal shift moves from private vehicle mobility by making parking arrangements and road use policy (ITDP, 2017). Limited and valuable urban space can be switched from being used as roads and unnecessary parking lots for motor vehicles to being reallocated for more productive social and economic purposes. TOD implementation aims to realize sustainable transportation (Ramadhan & Pigawati, 2019). Transit-Oriented Development (TOD) has become one of the media to make public transportation functions more effective to switch travel from private mode. Especially in Denmark, according to Knowles (2012), TOD Ørestad has secured the modal shift from car to public transport. Ørestad has attracted investment and additional work to Copenhagen and widened its capture area. So, it succeeds in increasing the international competitiveness of Copenhagen.

BRT system for resolving traffic jams in urban areas is a choice of mode and sustainable traffic. It is known worldwide as a cost-saving alternative besides investing in urban railways (Soomro et al., 2022). In general, BRT service, according to Acton et al. (2022), and ITDP (2017), is very effective and has become a reliable transportation for urban people with high capacity, speed, and service quality as well as affordable price. ITDP explains that in monitoring TOD in China, the BRT corridor pushes further development in the crowded urban area on Zhongshan street, Guangzhou, Tiongkok (ITDP, 2017). Generally, BRT can effectively and efficiently promote green transportation in developing countries with the implementation of several policy instruments like planning, regulation, economy, information, and technology (Hoonsiri et al., 2021). The result of the research will commonly help policymakers and become a foundation for scientific studies of the travel demand model for the BRT system (Nadeem et al., 2021; Soomro et al., 2022). The local authority policy in managing the transportation network is also to ensure reliable and sustainable transportation (Hassan et al., 2021; Wahyuni et al., 2022). The research aims to analyze the impact study of the BRT implementation strategy in developing TOD in the Jababeka area, Bekasi, Indonesia. The research conducted a sample modeling of the Jababeka area to become a safe, comfortable, and healthy urban area in Indonesia so that people will switch their modes of transportation to public transportation, namely trains and especially BRT. Research is expected to contribute to the problem of traffic jams and

chaos in urban areas. However, it tends to ignore the sense of justice for users of transportation facilities and other development stakeholders who contribute to public transportation activities. By the result of this research, it is hypothetically expected that the development of TOD areas around a new or existing transit station can be served by a regular and efficient transit system, by taking Jababeka area, Cikarang, Bekasi as the model. TOD is also expected to enhance the accessibility by providing a relatively high connection of transportation, the use of high density land, as well as the mixed use of land for cycling and pedestrians. The ultimate target of this research is that it is expected to have a social-cultural engineering through the development of the TOD model in order to improve the development of sustainable transportation so that people will switch their transportation modes to public transportation, namely train and bus.

## 2. Method

In this research, modeling is made by using PTV Visum with Trip Assignment, a transportation modeling program to analyze the existing traffic condition, forecasting that supports GIS data. PTV Visum is used for macroscopic simulation. This research uses primary data from a survey conducted through 23 statements to 210 respondents. The phasing process of Visum is through Nodes & Links using PTV Visum, continued by projecting the movement from 2022 until 2042 based on the result of the people movement survey in 2022. SWOT analysis is also used to determine the strategy of TOD implementation. Visum Model is an optimization method implemented for multimodal public transportation networks (Rossolov et al., 2021). Some research using PTV Visum, primarily related to the BRT system, has been done before. A study by Fadyushin (2021) generally proposes Visum modeling on the vehicle capacity, which values the modal shift to the high-capacity bus. Research in Cutiba, Mexico, conducted by Lopez Vasquez (2022), using the Visum model will reduce more than 15% of the total travel time and the average waiting time for transferring to public transportation within the public transportation study area. From the research of Bocarejo et al. (2016) and Triviño and García (2021) conducted in Bogota, Colombia using the Visum model, significant changes during travel can be known for all scenarios change the accessibility in a significant way. Especially in Indonesia, bus lane using the Visum model has also been implemented (Suryadwanti & Ha, 2021).

## 3. Results

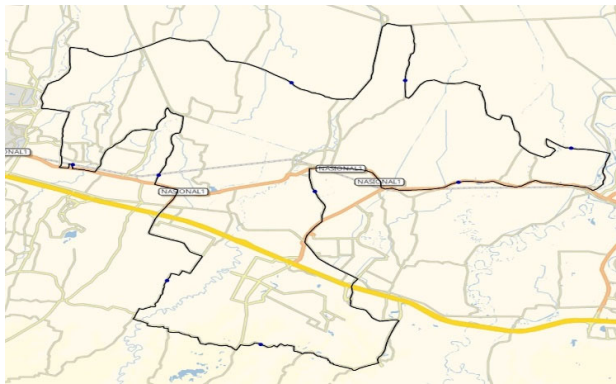
The research has passed through the phase of the modeling process by using the Visum model obtained from the survey on the existing 210 respondents. Based on the survey result spread, the most original domicile is from Bojongmangu, Bekasi Regency, as many as 14.3%. Based on the respondents' trip destination, the most destination is Bogor Regency, with as many as 51.4%. The transportation mode used during the Covid-19 pandemic is a motorcycle. The distance from the origin to the destination is mostly 32, 15 km to 29 km; as much as 32.9% of the travel time from the origin to the destination is mostly 30 to 59 minutes, as much as 37.1%. Based on the survey, the obstacle frequently faced while transportation in the Jababeka area is congestion (88%). Such a condition mainly concerns using public transportation (35.2%) without making TransitTransit. The survey indicates the top four locations for TransitTransit are on the road, railway station, bus terminal, and bus halt. From the survey, the easy transit process to changing routes or switching transportation modes is the most reason (45.7%). So, as many as 35.7% of public transportation passengers feel satisfied with the service. The favorite public transportation mode in Jababeka is a motorcycle (48.3%), followed by a train, online taxi, and city bus.

Bus Rapid Transit in Jababeka is known as Trans Jababeka. Trans Jababeka serves several routes; (1) Hollywood Junction – Bandung (by Primajasa), (2) Hollywood Junction – Blok M (Jakarta) (by PPD), (3) Hollywood Junction – Soekarno Hatta (by DAMRI), (4) Riverview Apartment – Wonosobo (by Sinar Jaya), (5) Hollywood Junction – Wonosobo (by Sinar Jaya) and (6) Hollywood Junction – Bogor (by Sinar Jaya). Trans Jababeka Terminal is located on Rodeo Street next to Hollywood Junction Jababeka. In addition, an inter-area feeder bus is passing through Jababeka, namely K99B. K99B bus (Jababeka area) has 11 halts from its departure on Tarum Barat Street, Central Cikarang, Bekasi Regency, and finishes on Jababeka Raya Street, North Cikarang, Bekasi Regency. K99B bus starts to operate at 5:00 and stops at 22:00.

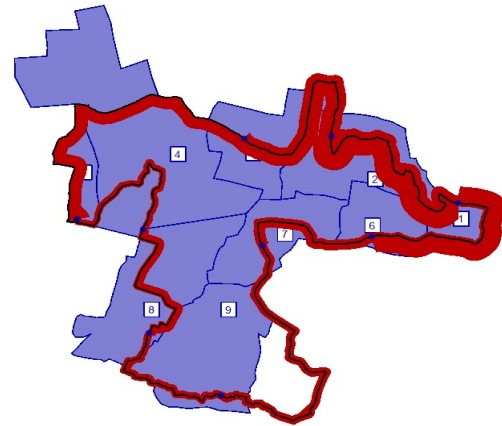
The characteristics of TOD are based on the eight-dimension factors (8Ds). According to (ITDP, 2017), the dimensions used for the urban area of Jababeka as a TOD development model are; (1) Density, (2) Mix, and (3) Design. (ITDP, 2017) in its report, explains several dimensions and urban principles, namely; (1) Walk, (2) Cycle, (3) Connect, (4) Public transport (Transit), (5) Mix, (6) Densify, (7) Compact, and (8) Shift. This study of TOD supporting facility and infrastructure development will prioritize walking, cycling, Transit, and modal shift facilities.

Bus Rapid Transit in Jababeka is known as Trans Jababeka. Trans Jababeka serves several routes; (1) Hollywood Junction – Bandung, operated by Primajasa, (2) Hollywood Junction – Blok M Jakarta, operated by PPD, (3) Hollywood Junction – Soekarno Hatta, operated by DAMRI, (4) Riverview Apartment – Wonosobo operated by Sinar Jaya, (5) Hollywood Junction – Wonosobo operated by Sinar Jaya; and (6) Hollywood Junction – Bogor operated by Sinar Jaya. Trans Jababeka Terminal is located on Rodeo Street next to Hollywood Junction Jababeka. In addition, an inter-area feeder bus passes through Jababeka, namely K99B, operated by KOASI. K99B bus of the Jababeka area has 11 halts from its departure on Tarum Barat Street, Central Cikarang, Bekasi Regency, and finishes on Jababeka Raya Street, North Cikarang, Bekasi Regency. Subsequently, the previous survey results are processed using PTV Visum software, a transportation modeling

program for analyzing the existing traffic condition. This forecasting supports Geographic Information System (GIS) data. In addition, PTV Visum is used for macroscopic simulation. Based on the mapping, Jababeka Industrial Area is surrounded by nine subdistricts in Bekasi Regency. Those subdistricts are Karang Bahagia, Kedungwaringin, West Cikarang, South Cikarang, Sukatani, Cibitung, and South Tambun (Fig. 1). Therefore, Jababeka Industrial Area, which is located between East Cikarang Subdistrict and North Cikarang Subdistrict, becomes the central mobility area of Bekasi Regency people and can be seen from the Link that connects those subdistricts (Fig. 2).

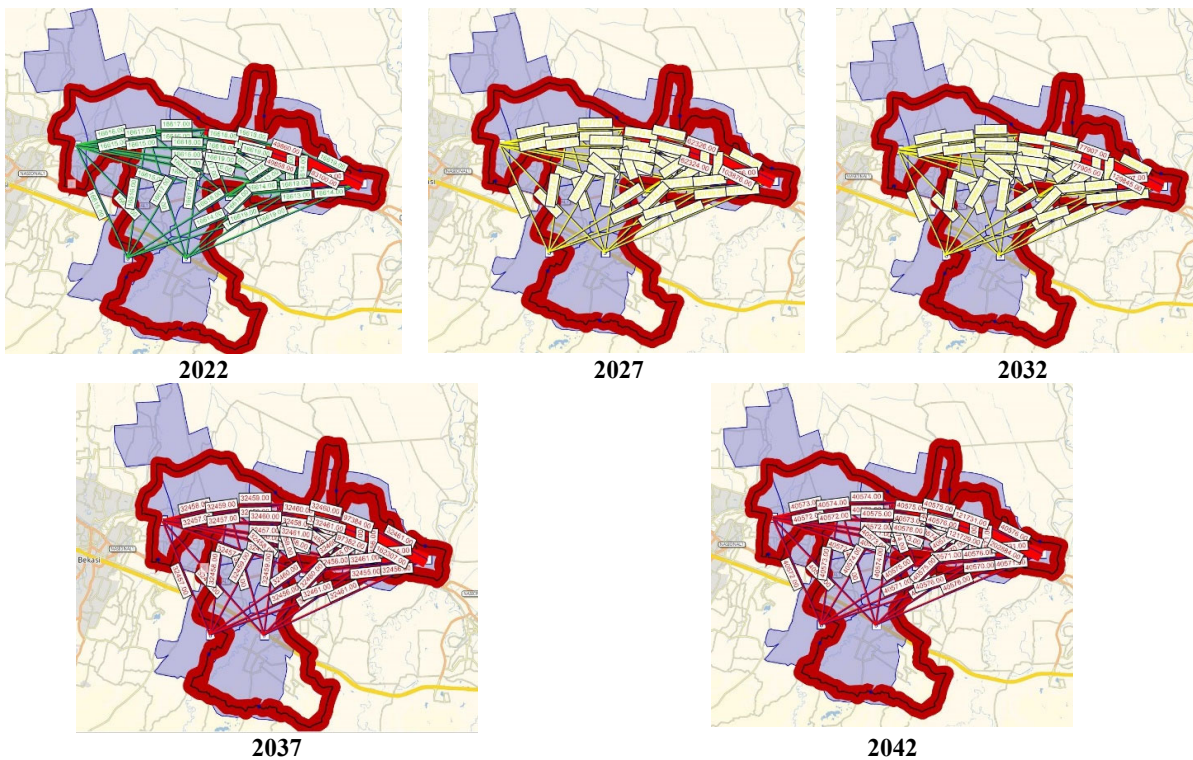


**Fig. 1.** Nodes & Links by Using PTV Visum



**Fig. 2.** Central Mobility Area of Bekasi Regency People

In 2022 is projected with the most origin-destination of North Cikarang – South Cikarang – Karang Bahagia, with as many as 1,662,043 trips. Figure 3 is the result of the people movement survey in 2022, showing that the movement is still rare. The projected movement in 2027-2042 is assumed to increase by 5% from the previous year. The projected movement in 2027-2032 with the most origin-destination of North Cikarang – East Cikarang – South Cikarang – West Cikarang - Sukatani - Karang Bahagia - Cibitung – South Tambun - Kedung Waringin with the total trips in 2027 and 2032 respectively as many as 2,077,554 and 2,596,942 showing lots of movement starts to exist. The movement projection in 2037 - 2042, with the most origin-destination of North Cikarang – East Cikarang – South Cikarang – West Cikarang - Sukatani - Karang Bahagia - Cibitung – South Tambun - Kedung Waringin with the total trips in 2037 and 2042 respectively as many as 3,246,178 and 4,057,722 showing there have been many movements.



**Fig. 3.** Results of Survey on People Movement in 2022-2042

Based on the result of running using PTV Visum with the method of Trip Assignment, it can be concluded that the people's mobility activities are mainly in South Cikarang toward North Cikarang. The result of the PrT Volume of Vehicles per hour indicates this. The overall results of the PrT Assignment show that the number of people having activities around the Jababeka area increases yearly. If the condition of regional growth does not keep pace with the condition of people growth, then what will happen is that traffic density increases every year, which can cause high congestion and people accumulation in that area. Such a condition indicates the need for sustainable transportation management with the potential implementation of Transit Oriented Development (TOD) in the next 5-10 years.

In developing the Jababeka area, it is oriented toward Transit Oriented Development (TOD). Therefore, the expectation is that there will be improvements in intensity, physical and environmental quality, the creation of a more efficient area, and the availability of public and social facilities. However, Jababeka industrial area, housing, hospitals, schools, and Universities dominate this area. Therefore, positive and negative values will be combined to find the potency and problems of TOD in Jababeka, the strategy to cope with the problems, and the efforts to optimize the potency of Transit Oriented Development (TOD) area in Jababeka (Table 1).

**Table 1**  
SWOT Analysis

Internal		
<b>External</b>	<b>Strength</b>	<b>Weakness</b>
	<ul style="list-style-type: none"> <li>▪ A toll road and an arterial road, a secondary artery pass the area.</li> <li>▪ Housing, trade, and industrial service areas dominate the area.</li> </ul>	
	<b>S-O Strategy</b> <ul style="list-style-type: none"> <li>▪ Led the development based on a Transit Oriented Development(TOD) area;</li> <li>▪ Increase the space density of the TOD area;</li> <li>▪ Provide supporting facilities as a transit place in the industrial area of Jababeka by developing TOD.</li> </ul>	<b>W-O Strategy</b> <ul style="list-style-type: none"> <li>▪ Build new roads inside the area and integrate them with the existing routes of public transportation;</li> <li>▪ Build a Transit Oriented Development (TOD) area along the railway from Lemah Abang up to inside Jababeka industrial area;</li> <li>▪ Build facilities and facilitate the development of a mix-use based area.</li> </ul>
<b>Threat</b>	<b>S-T Strategy</b>	<b>W-T Strategy</b>
There has still no trend of construction in the area	Give incentives for property development in the area.	Invite collaboration with the developer to build a Transit Oriented Development(TOD)-based area.

Jababeka is designed as an area with a Transit Oriented Development (TOD), functioning to facilitate people to fulfill their need for transportation so that Derived Demand can run efficiently. The fulfillment of the demand for Derived Demand is related to the current transportation development. Jababeka has owned quite a complete and adequate infrastructure. In such a condition, people's mobility will be more effortless because all things have been localized in Jababeka. This finally insists that TOD development be implemented to support the City's advancement and complement existing infrastructures. The policy to develop a center of integrated transportation is about urban spatial will be implemented through a strategy of improving access to public transportation, namely by conducting public transportation-based development through; (1) Developing a TOD area prioritized for public transportation in the typology of City (regional scale), and (2) Recommending a development plan for an area that has TOD potency in the typology of Sub-City and Environment.

#### 4. Discussion

Based on the Running result using PTV Visum with the method of Trip Assignment, it can be concluded that the people mobile activities are mostly from South Cikarang Selatan toward North Cikarang. This is shown by the result of PrT Volume Vehicle per hour. If we see the whole result of PrT Assigment, it can be analyzed that the number of people having activities around Jababeka area increases every year. If the growth of this area does not offset the growth of population, then traffic density will increase every year which in turn can cause a high level of congestion and Community Accumulation in that area.

This research results align with the study in Bangkok city, Thailand (Iamtrakul et al., 2020; Kitajima et al., 2015), explaining that Transit-Oriented Development (TOD) also prioritizes the environment for pedestrians. In addition, this research supports the research (Iamtrakul et al., 2022) that walking must be a choice to connect various traveling activities around the station area. In Lisbon, Portugal, TOD exists in a diverse area with high density, within walking distance from public transportation, and with a high-capacity station (Galelo et al., 2014). The research prioritizing pedestrians is in line with the study of ITDP (2017) that a particular road for a pedestrian in Rio de Janeiro Brasil provides an exciting atmosphere that stimulates walking activities. Pedestrian lane plays an essential role in creating an environment-friendly culture and is one of the main dimensions of TOD. It will be able to create a cultural community and provides green open space (Jeffrey et al., 2019; Hailuddin et a., 2022). In the TOD area, the pedestrian lane is vital for creating people who like walking (Li et al., 2019) as one of the main dimensions of TOD. The pedestrian lane's physical and non-physical factors can influence people's behavior. This research also aligns with the study of Jiang et al. (2012) related to pedestrians as BRT passengers.

The decision maker of transit investment provides several critical access routes for pedestrians to the station. This study about pedestrian lanes is in line with the observation of Inderadi et al. (2022) in the study of walk station area in Jakarta based on the four principles of ITDP, namely walk, connect, Transit, shift, and recommends the availability of pedestrian lane and facilities for the pedestrian with a particular need.

This research also supports the research of Jeffrey et al. (2019), and Laham and Noland (2017), that bicycle lane plays an essential role in creating an environment-friendly people culture. Cycling combines the comfort of the door-to-door trip, the flexibility of routes and schedules like walking, and the reach and speed of public transportation service. TOD is a compact multi-function development that facilitates walking and cycling as one of the main dimensions of TOD (Ricardianto et al., 2020). However, based on the suitability analysis between the transportation capacity and the pattern of land use in Teheran, Iran, the principles of TOD fail in cycling (Kalantari et al., 2020).

Access and closeness to mass public transportation service, defined as Bus Rapid Transit (BRT) or railway-based transportation, are prerequisites for getting recognition from TOD Standard. The result of this research is in line with the research of Padon and Iamtrakul (2019), which shows access to other public transportation systems in several cities like Hong Kong, New York, and Tokyo. In South Korea, especially Sejong City, according to Kang (2012), TOD will play an essential role in solving city problems by reducing traffic jams in the City. It will be considered a better choice for the existing cities and is needed by planned cities newly growing in Asia and Africa. The result of research in Java, especially in the Jabodetabek area, including Jakarta, Bogor, Depok, and Tangerang, states it needs to effectively restructure urban land use growth or regain a part of public transportation mode. At the same time, it also needs to improve the quality of the urban environment (Taki & Maatouk, 2018b). The public transportation management in Jakarta, based on transit nodes, like poorly integrated railway services, causes a spatial clutter, especially around the railway station area.

This research on TOD supports the study of Knowles (2012), becoming a means for public transportation to function more effectively in shifting travel from private modes. Especially in Denmark, according to Knowles (2012), TOD Ørestad has secured the modal shift from car to public transportation. Ørestad has attracted additional investment and jobs to Copenhagen and widened its capturing area so that it succeeded in increasing the international competitiveness of Copenhagen. ITDP gives an example in Nantes, France, where a crowded area, high-quality public space, calm road traffic, Bus Rapid Transit, and bike sharing are planned orderly (ITDP, 2017). This research supports the study of Oktari et al. (2022), Prayogi and Lissimia (2021), and Satiennam et al. (2016), stating that modal shift by the users of passenger cars and motorcycles to Bus Rapid Transit (BRT) is very potential for the developing countries in Asia. This research aligns with Primatama's (2018) study on BRT policy in Jakarta from private transportation mode to Transjakarta public transportation related to the change of traveling behavior and modal shift. This modal shift-based research aligns with the study of Prayogi and Aqli (2020). However, a modal shift to Transjakarta corridor 1 in Jakarta has not significantly triggered a modal shift. This research is also in line with the study of Li et al. (2021) in the USA, where its result shows that Bus Rapid Transit allows higher traveling speeds for middle and far-distance commuters, which can significantly increase the share of transportation modes. This research is also in line with the findings of Yang et al. (2020), which indicates that the change of public lane to bus lane will significantly reduce the delay of the bus waiting time. In general, this research supports the research of ITDP (2017) that the place of public transportation connecting and integrating urban areas needs to be farther for pedestrians. TOD becomes a means of making public transportation function more effectively in shifting travel from private modes. Access and closeness to mass public transportation service, defined as Bus Rapid Transit (BRT) or railway-based transportation, are prerequisites for getting recognition from TOD Standard. ITDP gives an example in Nantes, France, with a crowded area with high-quality public space and calm road traffic; Bus Rapid Transit and bike sharing are planned orderly (ITDP, 2017). Generally, BRT can effectively and efficiently promote green transportation in developing countries by implementing several policy instruments such as planning, regulation, economy, information, and technology. So, this research is in line with their study. The result of this research is in line with the study of Knowles (2012), Padon and Iamtrakul (2019) that shows the access to other public transportation systems in several cities such as Copenhagen, Hong Kong, New York, Tokyo, and Seoul as the cities representing one of the public transportation systems known as a comprehensive network and the easiest to be accessed in the world.

The result of this research related to BRT is in line with the study of Rodríguez and Mojica (2009), where the implementation of BRT started in Bogota, Colombia, and Curitiba, Brazil. Furthermore, BRT has been used in Seoul, South Korea (Cervero & Kang, 2011; Cervero & Dai, 2014). This research is also in line with several research results (Guzman et al., 2021). In addition, to the result of research concerning passenger movement, in general, the study of BRT in Asia (Satiennam et al., 2016; Ricardianto et al., 2022; Ricardianto et al., 2023) also influences the choice of mode, where travel time very significantly influences the users of a passenger car in choosing BRT. This research also supports some studies that the BRT system in Jakarta, known as Transjakarta, will become the backbone of the public transport system and can act as the connector to other systems, namely urban railway and MRT systems as well as planned monorail (Basheer et al., 2020). Transjakarta is designed to provide Jakarta citizens with fast public transportation systems to help reduce traffic during rush hours. Although this research aligns with other research, the TOD project in Jakarta has not fulfilled the principle of TOD as a planning approach in responding to urban sprawls and integrated development (Prayogi & Lissimia, 2021). Public

transportation management in Jakarta, based on transit nodes, like poorly integrated railway services, causes a spatial clutter, especially around the railway station area.

## 5. Conclusion

Jababeka is designed as the area that will have a Transit Oriented Development (TOD) that functions to facilitate people to meet their need for transportation so that their Derived Demand can go efficiently. Meeting the derived demand is very sustainable with the development of the existing transportation. Jababeka has owned complete and adequate infrastructures with which condition people mobility will be easy since everything has been localized in Jababeka. Jababeka area is included in the Development of Integrated Area or Special Zone TOD planned in the Land Use Plan 2010 having 13 points of area with the typology of Sub Urban. Through the four principles of TOD using Jababeka city as the TOD development model, namely diversity and destination, density, distance and design, and demand management, we can implement the concept of TOD, TOD development model, and the strategy for implementing TOD development to become a safe, secure, and healthy city area in Indonesia. The principles of TOD now must pay attention to the health aspects because since Covid 19 Pandemic, the movement of people and goods must pay attention to the health aspects such as hand washing, wearing mask, keeping distance, avoiding crowds and reducing mobility.

This research aims to investigate the effect of the BRT implementation strategy on TOD development in the Jababeka area, Bekasi, Indonesia. The study results indicate that the Jababeka area in Bekasi must be planned as a TOD area that makes it easier for the community to meet their transportation needs so that derivative demands can run efficiently. Jababeka already has a relatively complete and adequate infrastructure. Under such conditions, people's mobility will be more effortless because everything is localized in Jababeka. TOD development must be able to divert movement between cities using the BRT system and use taxis, motorcycle taxis, walking, and cycling to move from residential areas to bus terminals. Thus, an implementation strategy is needed to increase transportation access by developing the TOD area with the BRT system. They were developing the Jababeka area with a regional-scale city TOD typology and a sub-city and neighborhood TOD potential typology. TOD must be implemented to support the progress of the City with all the completeness of the existing infrastructure. Furthermore, TOD development with the BRT system must be able to divert inter-city movements into local movements because residential areas are provided as a substitute for inter-city movements. Thus, the study results recommend conducting a more detailed and comprehensive feasibility study.

## References

- Acton, B., Le, H. T., & Miller, H. J. (2022). Impacts of bus rapid transit (BRT) on residential property values: A comparative analysis of 11 US BRT systems. *Journal of Transport Geography*, *100*, 103324.
- Aminah, S. (2007). Public Transportation and Accessibility Urban Communities. *Masyarakat Journal of Society, Culture and Politics*, *20*, 31–45.
- Basheer, M. A., Boelens, L., & Bijl, R. V. D. (2020). Bus rapid transit system: A study of sustainable land-use transformation, urban density, and economic impacts. *Sustainability*, *12*(8), 3376.
- Belzer, D., & Autler, G. (2002). Transit-oriented development: moving from rhetoric to reality. In *Washington, DC: Brookings Institution Center on Urban and Metropolitan Policy*.
- Bocarejo, J. P., Escobar, D., Hernandez, D. O., & Galarza, D. (2016). Accessibility analysis of the integrated transit system of Bogotá. *International Journal of Sustainable Transportation*, *10*(4), 308–320.
- Calthorpe, P. (1993). *The Next American Metropolis*. Princeton Architectural Press, Inc.
- Cats, O., & Hartl, M. (2016). Modeling public transport on-board congestion: comparing schedule-based and agent-based assignment approaches and their implications. *Journal of Advanced Transportation*, *50*(6), 1209–1224.
- Cervero, R., & Dai, D. (2014). BRT TOD: Leveraging Transit-oriented development with bus rapid transit investments. *Transport Policy*, *36*, 127–138.
- Cervero, R., & Kang, C. D. (2011). Bus rapid transit impacts land uses and values in Seoul, Korea. *Transport Policy*, *18*(1), 102–116.
- Chiu, B. Y. (2022). Does the bus's rapid Transit reduce motorcycle use? Evidence from the Jakarta metropolitan area, Indonesia. *Case Studies on Transport Policy*, *10*(3), 1767–1774.
- Fadyushin, A. (2021). Changes in the Structure of Urban Mobility with the Development of Public Transport. *Urban and Maritime Transport* *27*, 204, 283.
- Galelo, A., Ribeiro, A., & Martinez, L. M. (2014). Measuring and Evaluating the Impacts of TOD Measures—Searching for Evidence of TOD Characteristics in Azambuja Train Line. *Procedia-Social and Behavioral Sciences*, *111*, 899–908. <https://doi.org/10.1016/j.sbspro.2014.01.124>
- Guzman, L. A., Arellana, J., & Camargo, J. P. (2021). A hybrid discrete choice model for understanding the effect of public policy on fare evasion discouragement in Bogotá's Bus Rapid Transit. *Transportation Research Part A: Policy and Practice*, *151*, 140–153.
- Hailuddin, H., Suryatni, M., Yuliadi, I., Canon, S., Syafrudin, S., & Endri, E. (2022). Beach Area Development Strategy as the Prime Tourism Area in Indonesia. *Journal of Environmental Management and Tourism*, *13*(2), 414–426. DOI:10.14505/jem.v13.2(58).11



- Hasibuan, H. S., Moersidik, S., Koestoer, R., & Soemardi, T. P. (2014). Using GIS to integrate the analysis of land use, transportation, and the environment for managing urban growth based on Transit-oriented development in Jabodetabek, Indonesia. *IOP Conference Series: Earth and Environmental Science*, (Vol. 18, No. 1, 012177).
- Hasibuan, H. S., Soemardi, T. P., Koestoer, R., & Moersidik, S. (2014). The Role of Transit-Oriented Development in Constructing Urban Environment Sustainability, the Case of Jabodetabek, Indonesia. *Procedia Environmental Sciences*, 20, 622–631. <https://doi.org/10.1016/j.proenv.2014.03.075>
- Hassan, S. A., Hamzani, I. N. S., Sabli, A. R., & Sukor, N. S. A. (2021). Bus rapid transit system introduction in Johor Bahru: A simulation-based assessment. *Sustainability*, 13(8), 4437. <https://doi.org/10.3390/su13084437>
- Hoonsiri, C., Chiarakorn, S., & Kiattikomol, V. (2021). Using combined rapid Transit and buses in a dedicated bus lane enhances urban transportation sustainability. *Sustainability*, 13(6), 3052.
- Iamtrakul, P., Padon, A., & Klaylee, J. (2022). The Study on Association between Urban Factors and Walkability of Transit Oriented Development (TOD). *GMSARN International Journal*, 16, 388–398.
- Iamtrakul, P., Raungratanaamporn, I. S., Klaylee, J., & Chayphong, S. (2020). The Walkability Of Transit Oriented Development (TOD): A Case Study Of Bangkok Metropolitan, Thailand. *Lowland Technology International*, 22(4), 181–192.
- Inderadi, A., Priyomarsono, N. W., & Siwi, S. H. (2022). Analysis of the Accessibility of Pedestrian Paths in Thamrin City Area Based on the Transit-Oriented Development (TOD) Concept. *3rd Tarumanagara International Conference on the Applications of Social Sciences and Humanities (TICASH 2021)*, (pp. 247-254).
- ITDP. (2017). *TOD Standard*. New York: Despacio.
- Jeffrey, D., Boulangé, C., Giles-Corti, B., Washington, S., & Gunn, L. (2019). Using walkability measures to identify train stations with the potential to become Transit-oriented developments located in walkable neighborhoods. *Journal of Transport Geography*, 76, 221-231.
- Jiang, Y., Zegras, P. C., & Mehndiratta, S. (2012). Walk the line: station context, corridor type, and bus rapid transit walk access in Jinan, China. *Journal of Transport Geography*, 20(1), 1–14.
- Kalantari, M., Ahadnejhad Roshti, M., Meshkini, A., & Noroozi, M. J. (2020). Structural-functional explanation of the Physical development on Transit-oriented development in metropolitan cities (Case study: Tehran metropolitan). *Regional Planning*, 10(38), 125–142.
- Kang, J. (2012). *A Study on the Future Sustainability of Sejong, South Korea's Multifunctional Administrative City, Focusing on Implementing Transit-Oriented Development*. Uppsala University.
- Kitajima, R., Kidokoro, T., & Seta, F. (2015). Study on Actual Conditions of Transit-Oriented Development from the Viewpoints of Components in Bangkok. *Journal of the City Planning Institute of Japan*, 50(3). <https://doi.org/10.11361/journalcpjij.50.568>
- Knowles, R. D. (2012). Transit Oriented Development in Copenhagen, Denmark: from the Finger Plan to Ørestad. *Journal of Transport Geography*, 22, 251–261. <https://doi.org/10.1016/j.jtrangeo.2012.01.009>
- Laham, M. L., & Noland, R. B. (2017). Nonwork trips associated with transit-oriented development. *Transportation Research Record*, 2606(1), 46–53.
- Li, Q., Huerta, A. K. R., Mao, A. C., & Qiao, F. (2021). Using Random Undersampling Boosting Classifier to Estimate Mode Shift Response to Bus Local Network Expansion and Bus Rapid Transit Services. *International Journal of Civil Engineering*, 19(10), 1127-1141.
- Li, Z., Han, Z., Xin, J., Luo, X., Su, S., & Weng, M. (2019). Transit-oriented development among metro station areas in Shanghai, China: Variations, typology, optimization, and implications for land use planning. *Land Use Policy*, 82, 269–282.
- Liu, C., Erdogan, S., Ma, T., & Ducca, F. W. (2016). How to increase rail ridership in Maryland: direct ridership models for policy guidance. *Journal of Urban Planning and Development*, 142(4), 04016017.
- Litman, T., & Steele, R. (2017). *Land use impacts transport*. Canada: Victoria Transport Policy Institute.
- Lopez Vasquez, J. M. (2022). *Integrating dial-a-ride and ridesharing services in Curitiba's Public Transport Network (RIT)*. KTH, School of Architecture and the Built Environment (ABE), Civil and Architectural Engineering, Transport planning.
- Nadeem, M., Azam, M., Asim, M., Al-Rashid, M. A., Puan, O. C., & Campisi, T. (2021). Does Bus Rapid Transit System (BRTS) meet the citizens' mobility needs? Evaluating performance for the case of Multan, Pakistan. *Sustainability*, 13(13), 7314.
- Oktari, K., Haryadi, B., & Riyanto, B. (2022). The potential transfer of motorcycle mode to BRT Trans Semarang for students to campus in Semarang city. *IOP Conference Series: Earth and Environmental Science*, (Vol. 955, No. 1, 012026).
- Ollivier, G. P., & Basat, G. (2020). *Transit-Oriented Development for Sustainable Cities (No. 148840, pp. 1-2)*. <https://documents1.worldbank.org/curated/en/136041590645680032/pdf/Transit-Oriented-Development-for-Sustainable-Cities.pdf>
- Padon, A., & Iamtrakul, P. (2019). Land use and transport integration to promote pedestrian accessibility in the proximity of mass transit stations. *Urban Rail Transit: In Proceeding of the 6th Thailand Rail Academic Symposium of Thailand Conference, Thailand, p. 21–22 November*, pp. 185–206.
- Prayogi, L., & Aqli, W. (2020). Transit passengers-oriented built environment: An evaluation of mode shift and street network and design. *IOP Conference Series: Earth and Environmental Science*, (Vol. 532, No. 1, 012006).

- Prayogi, L., & Hanton, D. (2021). Bus rapid transit system as a potent agent for transit-oriented development: A study of Transjakarta passengers' mode shift. *IOP Conference Series: Earth and Environmental Science*, (Vol. 780, No. 1, 012081).
- Prayogi, L., & Lissimia, F. (2021). The Evaluation of Mode Shift Preference within Bus Rapid Transit-Oriented Development Context. *International Journal of Built Environment and Scientific Research*, 5(1), 17-22.
- Primatama, M. (2018). Tipping points on transport and behavior: Examining Bus Rapid Transit system in Jakarta, Indonesia. *International Conference of Communication Science Research (ICCSR 2018)*, (pp. 51-55).
- Ramadhan, R. A., & Pigawati, B. (2019). Transit Oriented Development (TOD) on the Commuter Train Network. *IOP Conference Series: Earth and Environmental Science (Vol. 313, No. 1, p. 012030)*.
- Ricardianto, P., Yanto, T., Wardhono, D., Fachrial, P., Sari, M., Suryobuwono, A., Perwitasari, E., Gunawan, A., Indriyati, I & Endri, E. (2023). The impact of service quality, ticket price policy and passenger trust on airport train passenger loyalty. *Uncertain Supply Chain Management*, 11(1), 307-318. DOI: 10.5267/j.uscm.2022.9.012
- Ricardianto, P., Putra, A.P., Majid, S.A., Fachrial, P., Samosir, J., Adi, E.M., Wardana, A., Rafi, S., Ozali, I., & Endri, E. (2022). Evaluation of the Two Runway Queuing System: Evidence from Soekarno-Hatta International Airport in Indonesia. *WSEAS Transactions on Systems and Control*, 17, 142-152. DOI: 10.37394/23203.2022.17.16
- Ricardianto, P., Marlita, M., Widiyanto, P., & Krisnawati, S. (2020). The Role of Transit Oriented Development in the Urban Area Development with Railway-Based Transportation. *Elixir Transport Management*, 143(2020), 54455–54462.
- Rodrigue, J.-P., Comtois, C., & Slack, B. (2019). Transport, energy and environment. In *The Geography of Transport Systems*. <https://doi.org/10.4324/9781315618159-8>
- Rodríguez, D. A., & Mojica, C. H. (2009). Capitalization of BRT network expansions effects into prices of non-expansion areas. *Transportation Research Part A: Policy and Practice*, 43(5), 560-571.
- Rodriguez, D., & Vergel, E. (2013). Bus rapid transit and urban development in Latin America. *Land Lines 2013*, pp. 25, 14–20.
- Rossolov, A., Naumov, V., Popova, N., Vakulenko, E., & Levchenko, O. (2021). Estimation of transport accessibility in case of rational transport hub location. *Transport*, 36(1), 1-12.
- Satiennam, T., Jaensirisak, S., Satiennam, W., & Dettamrong, S. (2016). Potential for modal shift by passenger car and motorcycle users towards Bus Rapid Transit (BRT) in an Asian developing city. *IATSS Research*, 39(2), 121-129.
- Soomro, R., Memon, I. A., Pathan, A. F. H., Mahar, W. A., Sahito, N., & Lashari, Z. A. (2022). Factors That Influence Travelers' Willingness to Adopt Bus Rapid Transit (Green Line) Service in Karachi. *Sustainability*, 14(16), 10184.
- Still, T. (2002). Transit-oriented development: Reshaping America's metropolitan landscape. *On Common Ground*, 44-47.
- Suryadwanti, N., & Ha, L. S. (2021). Performance Evaluation of Bus Network in Yogyakarta, Indonesia Using Macroscopic Simulation Model (VISUM). *IOP Conference Series: Earth and Environmental Science*, (Vol. 832, No. 1, 012031).
- Taki, H. M., & Maatouk, M. M. H. (2018a). Promoting Transit Oriented development typology in the transportation planning. *Communications in Science and Technology*, 3(2), 64-70. <https://doi.org/10.21924/cst.3.2.2018.103>
- Taki, H. M., & Maatouk, M. M. H. (2018b). Spatial Statistical Analysis for Potential Transit Oriented Development (TOD) in Jakarta Metropolitan Region. *Journal of Geoscience, Engineering, Environment, and Technology*, 3(1), 47-56. <https://doi.org/10.24273/jgeet.2018.3.01.1091>
- Thomas, R., Pojani, D., Lenferink, S., Bertolini, L., Stead, D., & van der Krabben, E. (2018). Is transit-oriented development (TOD) an internationally transferable policy concept? *Regional Studies*, 52(9), 1201-1213.
- TOD Guide. (2010). Transit oriented development: guide for practitioners in Queensland. In *Transit Oriented development guide* (pp. 1–47). Department of Infrastructure and Planning.
- Transit Oriented Denver. (2014). *Transit Oriented Development Strategic Plan 2014*.
- Triviño, J. M., & García, W. C. (2021). General guidelines for the design of BRT routes in the Public Transport Integrated System of Bogotá. *Transportation Research Procedia*, 58, 622-629.
- Vergel-Tovar, C. E., & Rodriguez, D. A. (2022). Bus rapid transit impacts on land uses and development over time in Bogotá and Quito. *Journal of Transport and Land Use*, 15(1), 425-462.
- Wahyuni, T., Ricardianto, P., Harits, A., Thamrin, M., Liana, E., Anggara, D., Abidin, Z., Setyowati, T., Sugiyanto, S & Endri, E. (2022). The implementation of minimum service standards on ship operational performance: Empirical evidence from Indonesia. *Uncertain Supply Chain Management*, 10(4), 1297-1304. DOI: 10.5267/j.uscm.2022.7.010
- Waygood, E. O. D. (2011). What is the role of mothers in transit-oriented development? The case of Osaka–Kyoto–Kobe, Japan. *Transportation Research Board Conference Proceedings (Vol. 2, No. 46)*.
- Yang, G., Wang, D., & Mao, X. (2020). Modelling the Modal Shift Effects of Converting a General Traffic Lane into a Dedicated Bus Lane. *Promet-Traffic & Transportation*, 32(5), 625-637.

