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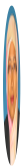

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IMPLEMENTATION OF TRANSIT ORIENTED DEVELOPMENT (TOD) IN THE JAKARTA SUB-URBAN AREA

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ABSTRACT

The high mobility of sub-urban communities has become the focus of the government to create an effective transportation system by creating a Transit-Oriented Development concept at several stations in sub-urban or supporting cities of DKI Jakarta. **Aims:** The purpose of this research is to find out whether the Bekasi and Plawad stations which are located in the suburbs are effective for making transit oriented development. **Methodology and results:** The type of research to be carried out is quantitative and qualitative research, in which the variables in this study will cover the area, the distance between points, the number of trips from each region to the types of transportation modes used by the community. Then, these variables will be analyzed spatially using maps created in the ArcGIS application and compared to be given a score (scoring) in accordance with the provisions of the indicators of the variables that have been determined in this study. **Conclusion, significance and impact study:** Plawad and Bekasi Stations are considered not feasible to be used as TOD due to inadequate facilities, the train itself is not yet the main transportation and needs to be increased to meet the commuter mobility needs of the people of Bekasi City.

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1. INTRODUCTION

Transit-oriented development or TOD for short is one of the most popular interventions to lower the mobility footprint, making it an important component of smart growth and new urbanism. TOD, which is based on dense and transit-oriented growth patterns around train, light rail, or metro stations, aims to promote modal shifts and reduce car dependency while increasing the livability of the environment, which is a multidimensional and rather vague concept that includes health, a safe and comfortable environment, the quality and aesthetics of public space, and the expansion of social and economic opportunities (Padeiro, 2019). Development of public transportation systems and policies that benefit the environment is one way to reduce the use of private vehicles. In addition, people's comfort and health are the main concerns. Green transportation is an important part of any community development, and transit-oriented development (TOD) has grown in popularity in recent years. Transit-oriented development seeks to create practical, versatile, pedestrian-friendly cities that include travel, accommodation, schools, parks, and other social and monetary improvements, thereby benefiting many elements of society (Ali, 2021). With this TOD, it is hoped that it can reduce the problem of urban sprawl that often occurs in suburban areas and can make public transportation modes such as trains and buses the main choice of people when traveling.

Peter Calthorpe defines it as a multi-purpose community located at an average distance of 2,000 feet on foot from transit stations and major commercial districts. TOD combines residential, retail, public and office uses and open spaces in walkable neighborhoods, making it convenient and comfortable for residents and employees to travel by transit, bicycle, foot, or car. Thus the basic principle of TOD is to provide multi-use development that is close to transit and serves it well (Calthorpe in Alrobaee, 2021). TOD works to develop cities for the better, by contributing to land use to reduce congestion and pollution, as well as supporting urban agglomeration economies by creating new employment and housing opportunities that can be accessed through public transport, while providing many choices from other modes of transportation, reducing the need to use private cars, and achieving integration between transportation and land use, this is what helps cities become attractive places to work and live (Al-Jabeeri, 2019). TOD is defined as urban development with relatively high intensity with a healthy mix of land use and urban environment that is walkable, cycling or using public transportation instead of branded cars, so the concept of TOD is an approach to sustainable development that relies on integration between

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land use and transportation (Singh, 2015).

Rodrigue in his writings argues that the effectiveness of a TOD area can be judged by the amount of density of activities around the TOD area and how much the TOD area can accommodate the mobility of people who carry out their daily activities (Rodrigue, 2020). Hale argues that the term TOD should be reserved for developments with a sustainable level of travel behavior. He stated that many so-called TODs had failed to deliver transit-oriented outcomes, saying that 'true' TODs should be able to stimulate transit-oriented behavior among residents. It should provide a livable environment where transit and facilities are within walking distance and thereby minimize the need for automotive use. Research has revealed that the development of the built environment, especially TOD, influences travel behavior (Hale, 2015).

Berawi *et al* (2020), in his research provided several variables that have been taken from books and also previous literature, namely the existence of housing where the large and dense population in a TOD area can lead to high movement and the presence of TOD can be said to be right on target for community mobilization. Offices as well as commercial areas, these places are the targets of movement of urban communities for their daily lives, namely economic activities or simply work, work that is done daily if it can be accommodated properly with TOD in this area will add to economic movement. Papa and Bertolini (2015), think that the most important thing in TOD is the relationship between the goal (to work) and the homes of these workers where TOD is better in areas with residents who need transportation for work activities or in areas that have a lot of economic activity as the goal of these workers.

The TOD concept as implemented in Beijing City which we can see in Lyu et al's research, the focus of TOD is to connect the downtown area where this place has many economic activities such as work or trade, and also the suburban area which is a place for employees or economic actors who work in the city center (Lyu, 2020). Rail access does little to reduce car ownership or use of an area, while other factors such as housing type and ownership, local and sub-regional density, bus services, and in particular the availability of off- and on-street parking play an even more important role in the context of discussions on TOD (Padeiro, 2019).

The Indonesia Transportation Master Plan covering the cities of Jakarta, Bogor, Depok, Tangerang, Bekasi 2018-2029 stipulates several indicators used in station selection as TOD. The movement of an area must reach 60% using public transportation of the total available transportation, the average travel time from a transportation to its destination is 1 hour 30

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minutes, walking access to transportation is a maximum of 500 meters, each area must have its own city transportation to support inter-city transportation activities, each station must have a park and ride system, and in one trip a maximum of three transportation vehicles.

Bekasi Station and Poris Plawad Station in Tangerang City in the Jakarta, Bogor, Depok, Tangerang, Bekasi Transportation Master Plan for 2018-2029 are planned to be developed into TOD stations that serve the people of Bekasi and Tangerang City for traveling to and from Jakarta. The existence of a relationship between the two regions between Bekasi and Tangerang with Jakarta or other areas will form a linkage in the area with a complementary relationship between the two or more regions, transferability, and opportunities for mutual intervention (Pinanigas, 2021). This opportunity is owned by Bekasi Station and Poris Plawad Station which are capable of becoming hubs/centers in moving people from Bekasi and Tangerang City to be developed into intermodal TOD stations. The potential for Bekasi station to serve long-distance trains, KRL trains that can reach all of Greater Jakarta, as well as airport trains, makes Bekasi station a dense transit point which is connected to Bekasi City area public transportation, shuttle buses, and online motorcycle taxis (Pangestu, 2021). Meanwhile, the potential of the Poris Plawad Station area was chosen as the biggest transit node in Tangerang City. This area has a type A terminal (Poris Plawad Terminal) which accommodates Bus Rapid Transit services, city and online transportation as well as a passenger station (Batu Ceper Station) which is the only station in Tangerang City that is visited by the Airport Train and Commuter line (Ardini, 2022).

From several sources and previous studies that have been included in the previous explanation, this research takes several related variables and indicators. Tangerang City and Bekasi City are buffer cities for Jakarta, so the number of people moving from these cities to Jakarta is used and also the choice of mode they use along with the percentage. because there are so few stations in these two cities, it is certain that all people will use these stations if they want to use the train or KRL mode of transportation. An analysis was carried out on the existence of other modes in the city to support people's needs to travel from their homes to this station, as well as an analysis of the existence of integration of modes of transportation in implementing the park and ride function for train passengers.

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2. RESEARCH METHODOLOGY

This research is a quantitative research where research uses various spatial variables such as the area and also the distance between one point to another. The attribute variables used in this study are the number of trips from each region and the type of mode used in the movement. From a spatial perspective, the author will examine integrated modes of transportation at stations in the Bekasi City and Tangerang City areas.

The data needed in this study is the number of people's movements from the outskirts of Jakarta, which in this study are the City of Bekasi and the City of Tangerang. Other transportation data is the mode of transportation used with the percentage with stations as TOD points, namely Bekasi and Plawad stations.

Data collection was carried out using secondary data from government and private sources with less than 5 (five) years. These data were collected by directly contacting the agency, then collecting literature study data, as well as measuring spatial data with the help of GIS.

The analytical method used in this study is a spatial analysis method using GIS techniques. Existing variables are visualized with maps created in the ArcGIS application and comparative analysis to provide values according to applicable regulations. The final results are discussed qualitatively and identified with real conditions which can be used as a specific assessment of existing indicators.

3. RESULTS AND DISCUSSION

3.1 Movement of Bekasi Station

The movement of suburban or hinterland communities, namely Bekasi City towards the urban center of Jakarta, can be seen in the commuter data on Table 1, it shows that the people of Bekasi City are active in Jakarta with a total of 277,234 people who carry out commuter activities for work, college, or other daily activities. The second most activity was heading to Bekasi Regency with a total of 58,921 people.

The people who go to Bekasi City itself are relatively small compared to the people of Bekasi City who go out of Bekasi City every day. The highest number of trips is Bekasi Regency with 94,227 and the second is DKI Jakarta with 37,190.

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Table 1 People from Bekasi City go to and do activities in other cities

Commuter Activities	Activity Destination City	Amount
Activities outside Bekasi City	DKI Jakarta	277.234
	Bogor City	3.031
	Bogor Regency	8.651
	Depok	12.129
	Tangerang Regency	-
	Tangerang Selatan City	722
	Tangerang City	7.933
	Bekasi Regency	58.921
	Other city	4.522
Total		373.125

Table 2 Community Movement From other cities to and do activities in Bekasi City (Source: Commuter Survey 2019, BPS)

Commuter Activities	Activity Destination City	Amount
Activities outside Bekasi City	DKI Jakarta	37.190
	Bogor City	27.087
	Bogor Regency	785
	Depok	6.481
	Tangerang Regency	-
	Tangerang Selatan City	-
	Tangerang City	427
	Bekasi Regency	94.227
	Other city	-
Total		166.197

The majority of trips home from work are still mostly using private vehicles, namely motorbikes with 218,744 people and vehicle trips generally still using trains with 35,043 people.

The data explains that the train is still the main choice of main mode of transportation for the people of Bekasi City to carry out their daily activities, especially going to work. Even though the use of private vehicles such as motorbikes is still the main choice because of the convenience for high mobility, for public transportation, trains are still the most preferred choice compared to ordinary buses and BRT. Therefore, the findings from this study are that the choice of Bekasi Station to be one of the TOD expansion projects is very appropriate because for now the level of train use is already high in Bekasi City, with the TOD expansion project and several facility updates

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it can increase people's interest in switching to using vehicles or public transportation, especially trains.

Table 3 The mode of transportation people use to go to work

Type of Main Mode of Transportation Used	Amount
Walk	722
Bicycle	-
Motorcycle	223.636
Motorcycle Ojek Online	8.080
Car	48.849
Online Rental Cars	-
Invitation Vehicle	15.229
Public transport	18.716
Public bus	13.825
Train (KRL)	36.583
Trans-Jakarta Buses	7.485
Other	-
Total	373.125

Table 4 The mode of transportation used by the community to return from work

Type of Main Mode of Transportation Used	Amount
Walk	1.444
Bicycle	-
Motorcycle	218.744
Motorcycle Ojek Online	11.674
Car	46.488
Online Rental Cars	1.547
Invitation Vehicle	15.962
Public transport	19.916
Public bus	13.173
Train (KRL)	35.043
Trans-Jakarta Buses	9.134
Other	-
Total	373.125

2.1 Characteristics of Bekasi Station and Bekasi City

The availability of parking locations at Bekasi station in the north is usually used for parking motorized vehicles, around the station at the north and south exits there are stopping facilities

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for public and online transportation which are also supported by road infrastructure around the station which can be traversed by public and private vehicles. As for 2-wheeled and 4-wheeled vehicles, there are many car parks (Park and Ride) provided by the station and there is also an individual day care that is used by local people who have a large parking lot or land to rent it out as a Park and Ride parking lot for KRL users. Completeness of other supporting facilities is also available around Bekasi Station which can be seen on Figure 1.

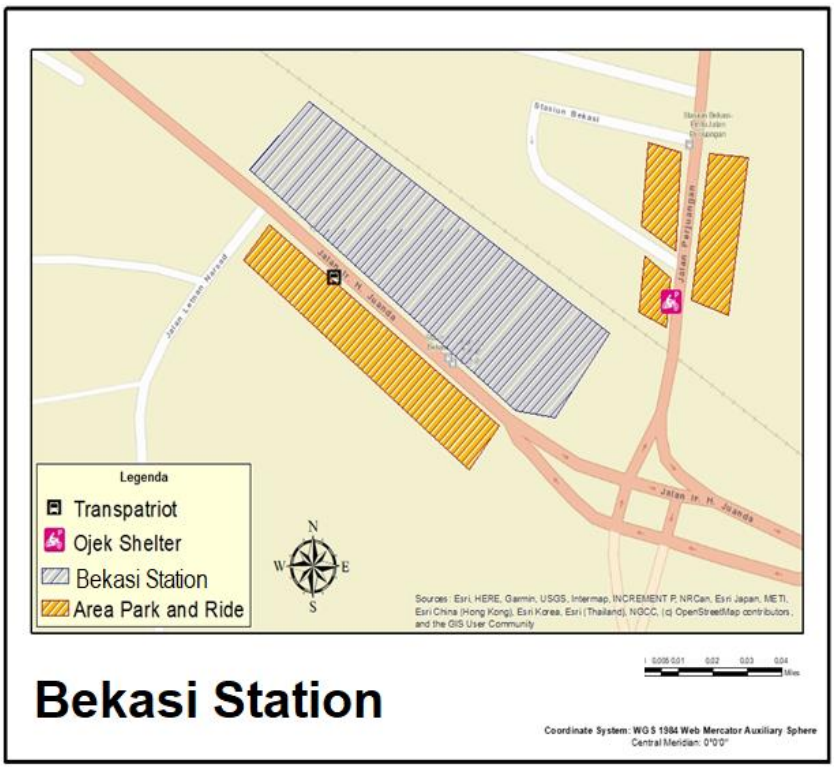

Figure 1 Map of spatial characteristics of Bekasi station

Bekasi Station already has adequate facilities for commuting needs such as the availability of public transportation such as public transportation and Transpatriot Buses, then there are several online motorcycle taxi shelters that can be used so that online motorcycle taxis do not stop carelessly and create traffic jams in the station area. There are many park and ride areas that motorbike users can use to leave their vehicles. Its strategic location, having access from the primary road has made this station the majority of the people of Bekasi City to choose as a mode of public transportation for commuting activities, namely work.

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2.2 Movements of Tangerang Station

Number of Community Movements

From the City of Tangerang itself, it is the same as the City of Bekasi in that the most destinations for people who commute from this city are DKI Jakarta with 172,410 people and the second most is to the City of South Tangerang with 28,693 people.

Table 5 Number of community movements from Tangerang City to and activities in other cities

Commuter Activities	Activity Destination City	Amount
Activities outside the City of Tangerang	DKI Jakarta	172.410
	Bogor City	-
	Bogor Regency	-
	Depok	619
	Tangerang Regency	25.742
	Tangerang Selatan City	28.693
	Tangerang City	427
	Bekasi Regency	3.113
	Other cities	3.113
Total		234.137

Meanwhile for the people who came to Tangerang City the most were from Tangerang Regency with 113,269 people and the second was DKI Jakarta with 54,644 people.

Table 6 Number of movements from other cities to and activities in the city of Tangerang

Commuter Activities	Activity Destination City	Amount
Activities in the City of Tangerang	DKI Jakarta	54.644
	Bogor City	1.055
	Bogor Regency	11.303
	Depok	4.583
	Tangerang Regency	113.269
	Tangerang Selatan City	19.032
	Tangerang City	7.933
	Bekasi Regency	-
	Other cities	-
Total		211.819

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The choice of going to work alone is the same as Bekasi City using private vehicles, namely motorbikes with 175,907 people and for public vehicles, namely KRL or trains with 12,021 people, but the difference is with other public transportation with 11,202 people.

Table 7 The mode of transportation used by the community

Type of Main Mode of Transportation Used	Amount
Walk	-
Bicycle	-
Motorcycle	175.907
Motorcycle Ojek Online	8.333
Car	11.787
Online Rental Cars	-
Invitation Vehicle	4.827
Public transport	11.202
Public bus	2.809
Train (KRL)	12.021
Trans-Jakarta Buses	7.251
Other	-
Total	234.137

Table 8 The mode of transportation that people use to go home from work

Type of Main Mode of Transportation Used	Amount
Walk	-
Bicycle	-
Motorcycle	173.166
Motorcycle Ojek Online	9.166
Car	10.121
Online Rental Cars	-
Invitation Vehicle	4.827
Public transport	13.324
Public bus	4.116
Train (KRL)	12.854
Trans-Jakarta Buses	6.563
Other	-
Total	234.137

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To go home from work, the majority still use private vehicles, namely motorbikes with 173,166 people and for general vehicles themselves there is a shift in the majority of the use of other modes of transportation using other public vehicles with 13,324 people and KRL occupying second place with 12,854 people.

From the tables above it can be seen that the movement from the City of Tangerang in the context of this research is that there is little disagreement between trains or KRL and other public vehicles, for one reason or another it can be seen that there is an assumption or possibility that using other public transportation is felt to be easier or cheaper and also efficient than using KRL so that people switch from KRL especially when they come home from work. This needs to be a concern if the government plans to expand the TOD area at Poris Plawad Station where the KRL itself has not become the main choice for the people of Tangerang City for the choice of mode in carrying out their daily commute activities.

2.3 Spatial Characteristics of the Station and the City of Bekasi

Tangerang Station does not have a vehicle storage location or adequate parking space where the exit and entry doors from the station itself are only available to the west of the station, besides that, supporting facilities around the station for changing modes are still lacking where the station location is surrounded by commercial sectors such as shophouses causing the need for other transportation facilities to be able to take passengers to their destination is reduced. An overview of the facilities at Poris Plawad Tangerang Station can be seen on Figure 2.

With this, further development is needed, especially in terms of an attractive design and also increased access by Poris Plawad Station because for now the station itself has not been able to attract the public's interest in using KRL as a commuter mode option because the station's conditions are unattractive and still difficult in terms of access and the large area of the station cannot accommodate various facilities to accommodate large numbers of KRL users, some facilities such as park and ride are only available for motorcycles or 2-wheeled vehicles and the availability of other public transportation to and from the station only has city transportation and does not even have an online motorcycle taxi shelter.

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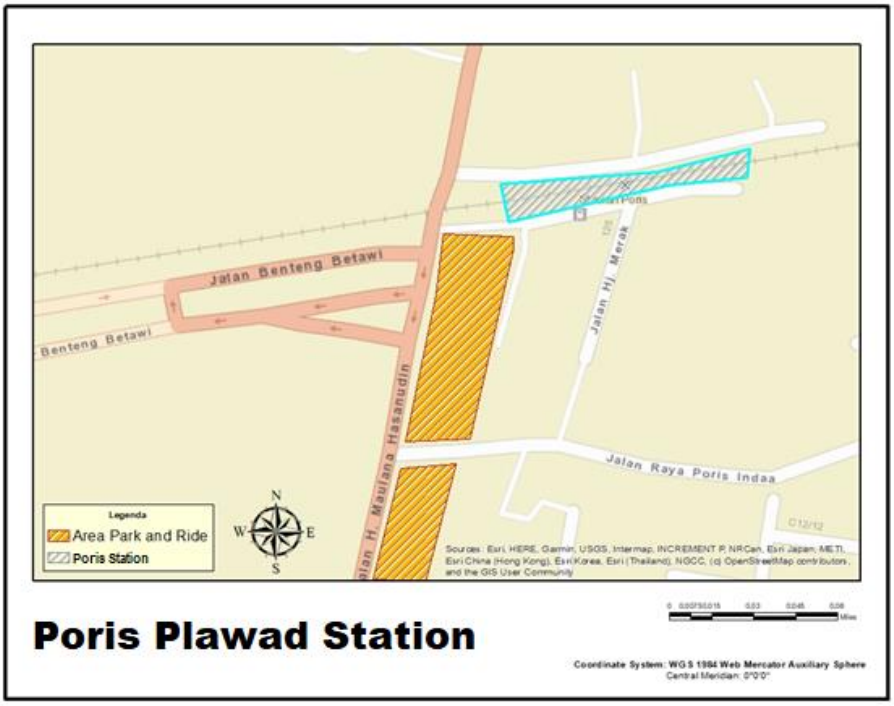

Figure 2 Spatial characteristics map of Poris Plawad station

4. CONCLUSION

Plawad and Bekasi Stations are considered not suitable to be used as TOD due to inadequate facilities and the train itself is not the main transportation used by the people of Tangerang to carry out their daily activities or to commute to work from and to their homes. Bekasi Station with new facilities that have been built but needs to be increased in meeting the commuter mobility needs of the people of Bekasi City.

5. CONFLICT OF INTEREST

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