Development of Transit Oriented Development (TOD) Areas in Improving Public Transport Services and Traffic Engineering in DKI Jakarta Province

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Abstract. Transit Oriented Development, hereinafter referred to as TOD, is a concept of regional development based and centered on a mass public transit station, which accommodates new growth into a mixed area with an area of 350 m to 700 m from the center of the area that is integrated with the area around it through the use of ground surface space, elevated space and underground. In the existing conditions in the field and the lack of availability of public transport services to the public there are still lacks of lack of attention from transportation providers, one of which is the interconnection and integration of public transport, where the facilities and infrastructure for moving public transportation are inadequate at the beginning and end of a trip (first mile and last mile). smooth traffic is needed to meet the target of public transport services. Planning and re-evaluating traffic networks and implementing transportation policies that can support the use of public transportation. The need for integration of public transportation in order to reduce travel time, as well as to improve the standard of living of the people, then based on these considerations, the Development of DKI Jakarta TOD needs to be done as an effort to realize healthy transportation.

1. Introduction

1.1. Transportation
Transportation is an effort to move or move people or goods from the original location to the destination location for certain purposes by using certain tools. The demand for transportation arises as a result of human socio-economic activities. Humans need goods such as food items and social activities in meeting the needs of life. In this case, transportation plays a role in supporting and facilitating humans in achieving their social and economic life, so that transportation cannot stand alone but must be a whole and comprehensive unit called the transportation system [1].
The overall (macro) transportation system consists of several micro transportation systems. Some parts of the micro transportation system include: Activity Systems, Network Systems, Movement Systems, Institutional Systems [2].

1.2. Transit Oriented Development
Transit Oriented Development is an area that has mixed land uses around transit locations and trade centers. The use of land is in the form of housing, trade, markets, open space, and public facilities. In general, TOD is a mix-used community that encourages people to settle and move around the transit area to reduce people's dependency on using private vehicles and switch to using public transportation [3]. In his book entitled The Next American Metropolis (1993), Calthorpe explained that: "A Transit Oriented Development is a mix-used community within an average 2000 foot walking distance of a transit stop and a core
commercial area. TODs mix residential, commercial, office, open space, and public uses in a walkable environment, making it convenient for residents and employees to travel by transit, bicycle, foot, or car."

TOD as an area concept with high development efficiency, where the efficiency is seen from the presence of mixed land uses, accessibility in reaching transit locations and pedestrian friendliness. The parameters in the development of the TOD concept are mix-used land use, regional density, regional accessibility, and the availability of pedestrian facilities to support pedestrian friendliness [4].

Summarized from several existing sources including one of the TOD concept plans that will be implemented in DKI Jakarta, especially around the following MRT corridors, are eight principles, namely:
1. Mixed functions (development of mixed functions within walking distance of each station, namely commercial functions, offices, humidity, housing, and public facilities);
2. High density (maximum transit and activeness around the transit station) in accordance with the carrying capacity of the region;
3. Enhancing the quality of connectivity (simple, direct and intuitive connections that support the mobility of users to, from, and between stations that are free of transport vehicles and have a clear system of marking towards stations in the development zone);
4. Improved quality of life (attractive, safe and comfortable space experience that supports the needs of daily passengers, pedestrians, workers, residents and visitors through roads, plazas, open spaces that can provide positive support for the identity and character of the connected transit area);
5. Social justice (enabling new communities that can survive and succeed for a long time with shelter for all socio-economic circles, maintaining existing social networks and communities in the development area, and providing social infrastructure to support stronger community relations and identities);
6. Reducing the Environment to the Environment with an environmentally friendly design, reducing the carbon footprint as an optimization of walking and circulation, controlling air and energy, managing natural ecosystems and cities, and managing waste for new resources);
7. Infrastructure resilience (city conservation that can withstand major disasters and have an impact on climate change); and
8. Economic renewal (local economic development that can attract investment and new job opportunities).

**Characteristics of Transit Oriented Development**
Transit Oriented Development (TOD) is a concept that focuses on land use patterns that places a strong emphasis on a mixture of types of activities, mobility, connectivity, density and high intensity and pedestrian friendliness. In this case, the TOD scale is an area that has a radius of ¼ - ½ miles (400-800 meters) or the ease of walking for 5-10 minutes from premium transit. TOD is in an area with a compact development with high density and mix-used oriented to urban forms that are pedestrian-friendly when traveling from other activity center transit locations (Florida TOD Guidebook, 2012).

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There are two types of Transit Oriented Development area development, namely: Urban TOD, is an area development that is located in the main network of public transportation which is close to a mixture of land use activities such as offices, housing, trade, and other activities in increasing access to community achievements efficiently. Neighborhood TOD, is the development of an area connected with local transportation or feeders that can support the needs of the community and minimize the use of private vehicles so as to support non-motorized movements such as walking or cycling [6]

| Concept | Source | Indicator used | Variable |
|---------|--------|----------------|----------|
| Transit Oriented Development | Cervero (2004) | Density (land use density) | Building Density |
| | Watson (2003) | | Basic Building Coefficients |
| | Florida TOD Guidebook (2012) | | Building Floor coefficient |
| | Ververo (2004) | Diversity (mixed land use) | Use of Housing Lanah |
| | Watson (2003) | | Use of Office Lanah |
| | Renne (2009) | | Use of Trade and Service Areas |
| | Florida TOD Guidebook (2012) | | Use of Public Facilities Lanah |
| | Cervero (2004) | Design (pedestrian friendly) | Availability of Pedestrian Paths |
| | Renne (2009) | | Pedestrian Path Dimensions |
| | Florida TOD Guidebook (2012) | | Pedestrian Path Connectivity |
| | ITDP (2014) | | Availability of Road Crossing Facilities |
| | | | Bicycle Path Availability |
Table 2. Building Density Benchmarks and Pedestrian Networks Based on the Minister of Public Works Regulation

| Regulation                | Variable       | Terms       | Provisions                      |
|--------------------------|----------------|-------------|---------------------------------|
| Minister of Public Works | Building Density | Very High Density | > 1000 buildings / hectare      |
| Regulation No.20 of 2011 |                | High density | 100 - 1000 buildings / hectare  |
|                          |                | Medium Density | 40 - 100 buildings / hectare    |
|                          |                | Low density   | 10 - 40 buildings / hectare     |
|                          |                | Very Low Density | <10 buildings / hectare        |
|                          | Pedestrian width | -            | Minimum of 2 meters            |
|                          | Pedestrian Paths Special Needs (disabled) | - | Miniman width of 1.5 meters equipped with guide lines and guidance devices along the pedestrian network |
|                          | Pedestrian distance | The distance of pedestrians to reach a stop or transit location | Maximum distance of 400 meters or maximum travel time of 10 minutes |
|                          | Crossing lane | - | There are Zebra crossings, Pelikan crossings or bridges to facilitate pedestrian crossing in different lane changes |
|                          | Cycling area | - | Miniman width of 1.5 meters |
|                          | Green line availability | - | Located between pedestrian and vehicle lanes |

Source: Minister of Public Works Regulation No.20 of 2011 and No.3 of 2014

2. Method
2.1. Preparation
Preparation activities include things that are supported in the beginning of the research, preparation of the implementation methodology, preparation and stabilization of the work plan.

2.2. Data collection
In collecting data there are 2 (two) categories, namely Primary Data and Secondary Data, the data to be obtained are:
Primary Data, that is data obtained from direct collection in the field, including: Photos of data locations and information on road sections, Data deemed necessary in making road network modeling (eg geometric surveys, side obstacle surveys, etc.), Past data road network crossing, Transjakarta Busway operational data, MRT, Traffic data in and around selected TOD locations, Survey of potential development of transit-oriented areas, Needs of public transport and traffic engineering needs, including: Sarpras conditions and situations in and
around the transportation node, Inventory of public transport both road and rail based, Traffic performance during the existing conditions and after the traffic engineering; Fulfillment of public transportation services according to cross services; and Management of traffic engineering and policies that can be applied by the government.

Secondary data, i.e. data obtained from literature studies, including secondary data in the form of information and policy regulations from various relevant agencies both private and government agencies, the results of previous research on transportation and related traffic, map data, includes maps of road networks, maps of spatial and territorial plans, and other maps required.

2.3. Analysis

After obtaining the data, then the data is processed and analyzed. Analysis of the results of the secondary survey was carried out to obtain an initial overview of the study and as a basis for preparing plans and developing terms of reference for the purposes of improving the report. Analyzing the primary survey results so that a detailed picture of the location on the field is obtained along with the problem. Compile survey data, both in the form of soft and soft materials in which the compilation results become data for Transit Oriented Development (TOD) development.

Perform modeling simulations using a softening system of the transportation network system capable of conducting transportation analysis including traffic, which is related to the capacity and speed of the vehicle flow in accordance with the background and location of the study and analyzing the results of the modeling along with conclusions and recommendations on a series of alternative solutions that might be carried out as the consequences of the results of the modeling above.

The analysis was carried out in achieving the three research objectives namely identifying the criteria of the TOD concept that are in accordance with the study area, analyzing the suitability of the characteristics of the transit area with the TOD area criteria and determining the priority of the transit area development criteria with the TOD concept.

2.4. TOD Design Concepts

The compilation of the design and description of the plan from the results of the study, as a result or product of the calculation carried out, and the handling solution in the form of construction and other infrastructure improvements needed in the implementation of the TOD.
3. Conclusions and suggestions

Make conclusions from the whole set of analyzes as a material for thought and compile recommendations and priority scenarios so as to produce maximum TOD concept results.

The results of the analysis of determining the node as an intermodal connectivity point in DKI Province consists of 9 node points, namely (1) the dukuh atas area (2) the pegangsaaan area (3) the pulomas area (4) kampong rambutan terminal (5) grogol terminal (6) senen terminal (7) manggarai terminal (8) rawa buaya terminal (9) lebak bulus terminal. The use of mixed land and pedestrian-friendly design are as follows

1. Need to regulate the proportion of the use of trade and service land
2. Need to adjust the proportion of Office Land Use
3. Increase Increasing the availability of pedestrian paths on all roads in the transit area.
4. Encourage the diversity of land use functions and maintain land use areas for public facilities in the transit area.
5. Pedestrian Connectivity by Developing connecting or translucent roads, applying grid pattern road networks and building road crossing facilities (JPO) to avoid pedestrian crossing with vehicles.
6. It is necessary to regulate and determine the Building Floor Coefficient (KLB) in accordance with the planned TOD development.
7. Increase the average value of KLB in blocks 1, 4 and 7 which are limited by KKOP.
8. Add or prepare a pedestrian path in accordance with the standard dimensions issued by the Ministry of Public Works.
9. Organize and increase the value of Building Density, especially in the transit area or node.
10. Provide facilities and infrastructure that support cyclist activity in the form of integrated bicycle lanes.

4. References
[1] Miro, 1997.
[2] Tamin 2000,
[3] Peter Calthorpe, 1993, The Next American Metropolis 1993
[4] Dittmar and Ohland 2004
[5] Florida TOD Guidebook, 2012
[6] Peter Calthorpe, 1993