DETERMINATION OF ORIENTED TRANSIT DEVELOPMENT AT LIGHT RAIL TRANSIT STATIONS BY THE PROCESS HIERARCHY ANALYSIS

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Abstract- Palembang is the capital of South Sumatra and is one of the big cities in Indonesia which is a trade center, so urbanization has an impact on traffic jams. To overcome this congestion, the local government built an integrated Light Rail Transit (LRT) Station and implemented the Transit Oriented Development (TOD) concept is the 16 Ilir market area [19]. The method used in determining stations is Process Hierarchy Analysis (AHP) which is defined as the representation of a complex problem in a multi-level structure where the first level is the goal, followed by the level of factors, criteria, sub-criteria, and so on until the last alternative level. There are four research locations such as (1) Bumi Sriwijaya area, (2) Cinde Market area, (3) 16 Ilir Market area, and (4) Jakabaring Stadium area where the 16 Ilir market area has the highest presentation obtained after AHP data processing [19] has very high potential to become a Transit Oriented Development (TOD) area. The determination of the TOD area in Palembang city is the Pasar 16 Ilir area. The Pasar 16 Ilir area has the highest scale of the three other areas that will be designated as TOD areas in Palembang city. Pasar 16 Ilir is likely to become a Transit Oriented Development (TOD) area which will be reorganized using the three main criteria, namely density, diversity and design. This aims to create the area as Transit Oriented Development (TOD).

Keywords: Indonesia, LRT Stations, Transportation, Congestion, Neighborhood Facet.

1. INTRODUCTION

Palembang which is the capital city of South Palembang, it has a population density of up to 2 million people in 2020. The migration of residents from the regions to the city of Palembang for work, business and school has become a new problem, such as traffic jams and slum settlements [28]. Public transportation will be needed, as an impact of the level of urban activity as a solution to overcoming congestion which causes traffic conditions and requires an integrated pattern of urban development planning between one aspect and another. Now Palembang city has several means of transportation such as Bus Rapid Transit (BRT) and Light Rail Transit (LRT) [7, 5].

A strategy for developing dense areas with mixed land uses consisting of housing, offices, shopping, education, health and other social facilities with a focus on transit stations (bus or trains) (25, 26). The benefits of TOD are reducing the use of private cars, increasing pedestrians and transit users, reviving downtown areas, increasing density and intensity, saving and developing for parking, as well as increasing property values and sharing activities around transit locations, to improve environmental quality and community. On a regional scale, it is hoped that this concept can solve congestion problems in urban areas [14, 15]. In the discussion of urban mass transportation systems, the concept of the relationship between transit activities and development becomes an interesting discussion in the science of urban planning and design, including the Transit Oriented Development (TOD) or transit-oriented development which has been realized in many cities in Indonesia. TOD has been widely recognized as a concept that answers the needs of transit areas [11].

2. STUDY AREA

These research locations as (1) Bumi Sriwijaya area, (2) Cinde Market area, (3) 16 Ilir Market area, and (4) Jakabaring Stadium area. The research locations are in Figure 1.
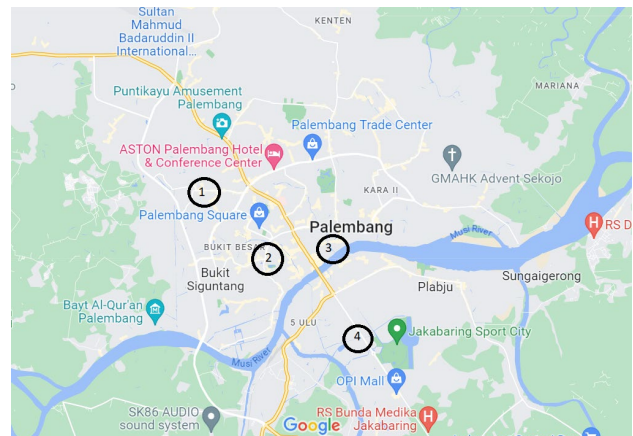

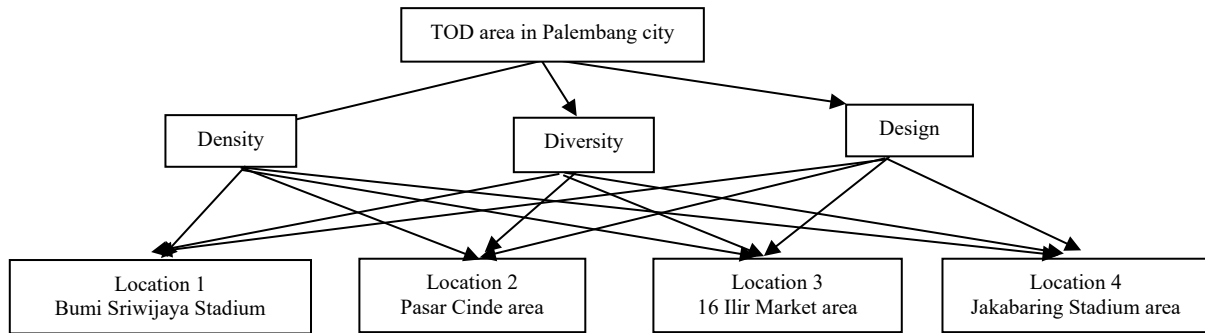Figure 1. Map of Palembang city, Indonesia

Figure 2. Hierarchical structure determination of Transit Oriented Development (TOD) [19]

Description: Kota Palembang, Palembang city:
(1) Kawasan Bumi Sriwijaya: Bumi Sriwijaya area
(2) Kawasan Pasar Cinde: Cinde Market area
(3) Kawasan Pasar 16 Ilir: 16 Ilir Market area
(4) Kawasan Stadion Jakabaring: Jakabaring Stadium area

3. METHODS

3.1. Research Design

The areas are taken as TOD zoning areas.

3.2. Research Variable

The variables of research are independent variables and dependent variables as Table 1.

Table 1. Operational variable, source; processed from various sources, 2021 [11, 13]

Variable	Dimension	Type
Mixed land use (Diversity)	• Residential land use • Use of office land • Commercial land use • Land use for public facilities	Primary and Secondary
Density	• Koefisien Building Base Coefficient • Building Floor Coefficient • Population • High density of residential buildings	Primary and Secondary
Supporting facilities (Design)	• Availability of pedestrian paths • Adequate pedestrian width • Comfortable walking distance. • Pedestrians connected to roads and local activity centers in the area. • Availability of parking facilities • Easy access to public transportation	Primary and Secondary

3.3. Data Analysis Technique

3.3.1. Analyzing the Conformity of Area Characteristics with TOD-Based Area Criteria

To find out which areas are potential TOD that are not suitable and are appropriate in the Palembang city area based on TOD criteria, this Descriptive Statistical analysis technique was chosen to answer target 3 (three) in this study. The process of determining the suitability of the transit area is carried out by tabulating the ideal TOD criteria and existing characteristics that have been obtained in the previous process. From the criteria and characteristics of the transit areas that have been tabulated, then one by one the variables on the existing characteristics are compared with the parameters of the ideal criteria from the TOD concept [4, 11].

After obtaining data on the congruence of the characteristics of the area with the TOD criteria, the next step is to implement an all evaluation of each variable into indicator evaluation [19].

3.3.2. Formulated Directions for Improved Development of Transit Areas Based on TOD Concept

The three (3) objectives in this study, the results of the analysis of the third objective (3) will be used as input for this objective to formulate directions for increasing the application of the TOD concept in Palembang city by using a descriptive analysis tool. Palembang city, Indonesia based on environmental aspects using the TOD concept approach with research results that have been obtained based on regional suitability and development priorities that should be applied to Palembang city [7, 5].

3.3.3. Determine the Intensity Priority of Each Criteria

Density Criteria, Diversity, and Design of intensity priority are shown in Table 2.

Table 2. The Intensity priority of each criterion

Criteria	Bumi Sriwijaya area	Cinde Market area	16 Ilir Market area	Jakaba ring Stadium area
Density				
Bumi Sriwijaya area	1	2	0.33	3
Cinde Market area	0.5	1	0.33	2
16 Ilir Market area	3	3	1	5
Jakabaring Stadium area	0.33	0.5	0.2	1
Sum	4.83	6.5	1.87	11
Diversity				
Bumi Sriwijaya area	1	2	0.5	8
Cinde Market area	0.5	1	0.33	3
16 Ilir Market area	2	3	1	5
Jakabaring Stadium area	0.12	0.33	0.2	1
Sum	3.62	6.33	2.03	17
Design				
Bumi Sriwijaya area	1	2	0.33	3
Cinde Market area	0.5	1	0.33	4
16 Ilir Market area	3	3	1	5
Jakabaring Stadium area	0.33	0.25	0.2	1
Sum	4.83	6.5	1.87	11

The results of calculations using the AHP method result of multiplying each alternative weight column with the corresponding criteria weight column are shown in Table 3.

Table 3. The AHP method result

Combined Weight	Bumi Sriwi-Jaya area	Cinde Market area	16 Ilir Market area	Jakaba-ring Stadium area	Criteria Weight
Density	0.24	0.15	0.52	0.09	0.63
Diversity	0.33	0.16	0.45	0.06	0.26
Design	0.23	0.19	0.50	0.07	0.11
Ranking	0.26	0.16	0.49	0.08	1
Result	2	3	1	4	

3.3.4. Advantages of Each Location

Table 4 shows the area around the Pasar 16 Ilir LRT Station includes the Musi River area, Pasar 16 Ilir, tourism, shops, offices and a few residential areas. In this area, the areas that dominate the generation are the Pasar 16 Ilir area and the tourist area.

Table 4. The advantage of each location

Result	Location	Case
1	16 Ilir Market area	1. Diverse mixed areas: High 2. Residential area: Low 3. Integrated transportation: BRT, LRT, Small Public Transport, River Transportation
2	Bumi Sriwijaya area	1. Diverse mixed areas: Low 2. Residential area: Moderate 3. Integrated transportation: BRT, LRT,
3	Cinde Market area	1. Diverse mixed areas: Moderate 2. Residential area: Moderate 3. Integrated transportation: BRT, LRT, Small Public Transport
4	Jakabaring Stadium area	1. Diverse mixed areas: Low 2. Residential area: Moderate 3. Integrated transportation: BRT, LRT, Small Public Transport

In this area, there are places for revival, including 16 Ilir Market, Kuto Besak Fort Tourism, Ampera Bridge, Palembang Grand Mosque, Palembang city Government Office Complex. In this area there are several integrated transportation facilities, including the Bus Rapid Transit (BRT) stop which is integrated with the Light Rail Transit (LRT) station, apart from that, there is also a boat dock which is a priority for river transportation around the Musi River. Currently it is still integrated with public transportation which operates only on certain routes. Therefore, currently Location - 3 has very high potential to become a Transit Oriented Development (TOD) area based on previous research that has been carried out. Based on the author's interview with the Palembang city Bappeda, the concept of developing the TOD area itself was already planned in the Pasar 16 Ilir area. Bumi Sriwijaya area can be said to be a mixed area which has a high diversity area because there are several generation area points. The area around the Bumi Sriwijaya LRT Station contains office areas, sports areas, modern shopping areas (malls), office areas and residential areas.

3.3.5. Disadvantages of Each Location

Table 5 shows Jakabaring Stadium area is an area that has a low mixed area. The area around Jakabaring Station contains sports facilities, offices, tourism and residential areas. In this area, the areas that dominate the generation are the Sports Facilities and Tourism Areas.

Table 5. The disadvantages of each location

Result	Location	Case
1	16 Ilir Market area	• The area is dense it consists of Musi River area, 16 Ilir Market, tourism, shops, offices and a few residential areas difficult to station development
2	Bumi Sriwijaya area	• In this area, the dominant trip generation area is the Modern Shopping (Mall) and Office area cause low diversity • Less integrated transportation
3	Cinde Market area	• Diverse mixed areas: Moderate therefore Transit Oriented Development area requires high diversity • Less integrated transportation
4	Jakabaring Stadium area	• Diverse mixed areas: Low, Transit Oriented Development area requires high diversity

In this area there are several integrated transportation facilities, including Bus Rapid Transit (BRT) stops which are integrated with Light Rail Transit (LRT) stations. Cinde Market area the dominant generation areas are shopping and residential areas. In this area there are generating areas including Cinde Market, Hotels, Walang Temple Cultural Heritage Area, International Plaza Mall, Palembang Indah Mall, and Residential Residential areas. In this area there is also a Bus Rapid Transit (BRT) stop which is integrated with the Light Rail Transit (LRT) station, apart from that it is also integrated with public transportation which operates only on certain routes.

4. RESULTS AND DISCUSSIONS

4.1. Result
1. The multiple linear regression equation model it can be seen that the constant value is 6.72, the density variable is 0.25, diversity variable is 0.23, the design variable is 0.25, the density variable is 0.38, the walkable variable is 1.00, the parking variable is 0.90, the pedestrian variable is 1.27, the transit variable is 0.78.
2. The normality Kolmogorov-Smirnov test that the value is more than 0.05.
3. The decision is based on a significant value which must be greater or equal to 0.05 so that heteroscedasticity do not occur [19].
4. With this AHP method, a decision can be made the area has the potential to a Transit Oriented Development (TOD) area in Palembang city is Pasar 16 Ilir.
5. Multiple linear regression analysis was carried out to test which variables influenced the determination of the Transit Oriented Development (TOD) area in Palembang city. The use of the AHP analysis method is used to see which factors most influence the determination of the Transit Oriented Development (TOD) area in Palembang city. So, regression tests and AHP really determine the success of data taken in the field and based on Google Form surveys.

4.2. Discussions
1) The autocorrelation test that that there is no autocorrelation if the dU value $< DW <$ 4-dU, the DW value is in the data processing results in the Durbin Watson column, now while the dU value is obtained from the DW table, there is a separate file there, we can take the value

according to the number of variables $X(k)$ and the number of samples (n), with $k=8$ and $n=113$ the value of dU is 1.8468, then calculate the value of $4-dU = 4-1.8468 = 2.1532$, then compare the value of dU, DW, and $4-dU$ it turns out that the value is $1.8468 < 1.952 < 2.1532$, which means that there is no autocorrelation because $dU < DW < 4-dU$ is fulfilled.

2) From the regression test, variable X is said to have a positive and significant effect if these three conditions are met,

a. The unstandardized coefficients value of variable X is positive (no negative sign),

b. The calculated T value is greater than T table,

c. The significant value is less than 0.05.

3) The table value is obtained from a separate table such as the dU table. The T value in the table of results of research data processing is called T arithmetic, the reference or limit is the T table value. The way to find the numbers in the T table is the formula $n-k-1$, $n=$ number of samples, $k=$ only the number of X variables, so the T table value is 1.983.

4) The 66.0 % is influenced by other variables outside the research variables.

5) The value of F count is 6.64. This means that H_a is accepted.

6) The result of AHP test that is 16 Ilir Market area.

7) Focuses on the three main criteria, are density, diversity and design.

8) Transit Oriented Development (TOD) locations based on Google form data results are density, shared land use (diversity), supporting facilities (design), high area density (high density), pedestrian friendly (walkable), parking (parking), pedestrian (Pedestrian), and moving (transit).

9) A location that has the potential to a Transit Oriented Development (TOD) area is the Pasar 16 Ilir area (location 3). This area has the highest potential compared to other areas after processing AHP data on the three main criteria.

5. CONCLUSIONS

Based on the results of research, it can be concluded that: [19]

1. Impacts on environmental aspects are density, diversity, design, high density, walkable, parking, pedestrian, and transit.

2. Three criteria are needed that density, diversity, and design.

3. Since looking at the advantages and disadvantages of these 4 locations, then a location that the potential to a Transit Oriented Development (TOD) area is the Pasar 16 Ilir area.

4. Location 3 that 16 Ilir Market area is the potential Transit Oriented Development (TOD) area in Palembang city

5. The result of AHP test is 16 Ilir Market area.

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