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Trip Attraction Model of 4 in 1 Shopping Center Concept for Sustainable Development in Semarang City

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Abstract. One of sustainable development strategies is predict the future to anticipate the impact of the development. The rise of retail development has encouraged retail companies to innovate marketing concept. Allocation multi use commercial activity in one location is the 4 in 1 concept on Transmart. This retail development will affect the increase in the number of trips. One of the goals of planning is to minimize problems in the future. This can be done by modeling to predict the impact of development to implement sustainable development concept. The purpose of this study is to make a trip attraction model in shopping centers with a concept of 4 in 1. The method used in this study is trip rate and multiple linear regression model. The results of this study are trip rate and multiple regression linear model. The model of trip attraction arranged from the equation $y = 0.005 + 0.263x_1 + 0.186x_2 + 0.087x_3 - 0.061x_4$, where y is the total trip rate depending on the trip rate area (x1) 0.263, trip rate for dining area (x2) 0.186, the trip activity area play (x3) 0.087, the trip activity area watching rate (x4) - 0.061 with R-Square value (R²) 100%. This model can estimate the amount of travel attraction and anticipate traffic problems caused by the construction of similar shopping centers with different configuration areas of activity.

Keywords : trip attraction model, shopping centre, trip rate, multiple regression linear, sustainable development.

1. Introduction

The transportation system consists of an activity system, a network system, a movement system and an institutional system that influence each other [1]. Good transportation system indicated by integrated activity system and network system. This integration would produced an effective movement system like low number of trips. The activity system represented by land use such as residential, industrial and commercial. The high intensity of activities at a location will have an impact on increasing the number of trips. In general, trip is classified based on its main purpose [2]. Shopping centers are the second main destination after offices [3]. Shopping centers are part of the system of activities that attract individual trip. The activities of a landuse produced the movement system so that will impact on the existing transportation system. This is evidenced by there was a positive correlation of the shopping centers development with traffic congestion [4]. The trip attraction model is a method for predicting the number of trip attracts by a place [2]. Trip attraction model are important for transportation experts and urban planners in considering the impact of new developments such as offices, shopping centers and settlements [5].



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In Indonesia the shifting concept of shopping centers from single outlet became mixed use or multiple outlet. Transmart is a retail that has a mixed-use concept. Transmart has the concept of modern retail has developed into a shopping center with the concept of Shopping - Dining - Playing - Watching or commonly known as the 4 in 1 concept. The retail concept combines several functions of land use trade and services that will make visitors perform several segments of activity so that it is estimated can increase travel attraction. The higher intensity of activities will affect the more movement that occurs towards the building [6].

There are significant changes in the level of travel attraction if data is reclassified based on the type and size of development [7]. The types of trade and service land use are differentiated based on their size and both have different pull movements [3]. The location and size of shopping centers have a significant impact on the movement caused [8]. Other studies also explain that travel traction in trade and service areas is influenced by the area of rough floors and the number of trips based on peak hours on weekends [9]. Another study tried to do a linear regression test on the travel attraction of the rough floor area, it can be concluded that the area of rough floor as an independent variable is very dependent on the attraction of shopping malls [10]. The validity of the model is shown by the value of R^2 with a combination of variable area and availability of facilities in the mixed-use trade and service area [9]. The stronger the correlation represent by value 1 [7]. The t test and f test are used to compare the number of average trips to test for significant differences from different groups for analysis relating to data and classification of shopping centers [7]. This study complements the trip attraction model based on the trip rate combination of each activity area in modern retail using a multiple linear regression model that has been carried out with f test, t test, and heteroscedascity test. The model successfully predicts the trip attraction from the combination of trip rates in the modern concept of shopping centre in it. But the models were use in single use activity.

In Indonesia one of modern concept of shopping center is 4 in 1 concept that mixed 4 activities in 1 building. The activities sited in a group separated by floor area. This concept was a part of business strategy to attract consumer. The old models were use in single use activity so it is necessary to build model that can be used to predict the attraction of the multiuse activity shopping center to overcome traffic problem in future.

1.1 The Aim of Study

The purpose of this study is to make a trip attraction model in shopping centers with a concept of 4 in 1 in Semarang City

1.2 Data and Methods

The data used in this study is the number of visitors in one of 4 in 1 shopping center in sub urban Semarang City named Transmart. The data is collected at peak hours on weekend day. Total of gross floor area (GFA) is measured for each activity area.

Table 1. Number of Visitor and Gross Floor Area Based on Activity Area

Activity Areas	Number Of Visitor (person)	Gross Floor Area (m ²)
Shopping	337	9500
Dining	720	4750
Playing	342	4750
Watching	373	1250
Total	1146	20250

In this study the method used to arrange the model equation is the trip rate and multiple linear regression models. The trip attraction model is a mathematical model that built through the total of visitor trip rate data on the trip rate for each shopping, dining, playing and watching activity. Analysis

of the trip attraction model is arranged by combining trip rate calculations and multiple linear regression with the following explanation:

A. Trip Rate Peak Hour (Phase 1)

Trip rate obtained from the calculation of the number of movements from the visitors in each area activity or total area [11] :

$$\text{Trip Rate (person/m}^2\text{)} = \frac{\text{Number of Visitor}}{\text{Gross Floor Area (m}^2\text{)}}$$

Trip rate used to obtain the number of person/unit area of each activity area or total area that will be used as a variable in multiple linear regression.

B. Multiple Regression Linear (Phase 2)

Multiple linear regression consists of dependent variables and independent variables. Multiple linear regression variables are the total trip rate and trip rate for each activity area. The form of the combination of both can be formulated as follows :

$$T_i = a_i + a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4$$

T_i = total trip rate

X_1 = trip rate of shopping activity area

X_2 = trip rate of dining activity area

X_3 = trip rate of playing activity area

X_4 = trip rate of watching activity area

a_i = parameter, a numerical value produced by linear regression, using "minimum number of squares"

The results of multiple regression analysis will be tested again with several statistical tests as follows Correlation Coefficient (R^2) f test, t test and heteroscedasticity test.

The test was conducted to show the accuracy of the trip attraction model from the data of the number of visitors inputted by each unit area. In addition, multiple linear regression can also show the magnitude of the attractiveness of the certain activity area in Transmart, which is indicated by the magnitude of the coefficient of each independent variable.

2. Result and Discussion

2.1 Trip Rate Analysis (Phase 1)

The number of trip attracted by Transmart Setiabudi during peak hours is 0,057 person/m². This means that in one hour every 100 m² Transmart attracts 6 people to come. Previous study stated that the trip rate for shopping centers with characteristics similar to Transmart could attract 19 people per 100 m² at peak times [3]. The shopping center has an area of 10,000-50,000 m² consisting of 20-50 shops, playgrounds, and medium size food court. However, there is no movie theater in there. Unlike the case of Transmart which has a movie theater but produces a smaller attraction number of 6 people per 100 m² so it shown that Transmart attracted more trip with this activity. However, the other type of shopping center that has an area larger than Transmart with an area of more than 50,000 m² consisting of more than 50 shops, playgrounds, and large size food court attracts a trip rate of 6 people per 100 m² [3]. In another study, that the number of trips in the 6 shopping center locations in Dhaka ranged from 6 to 13 people per 100 m² during peak hours on weekends [11]. One of the shopping centers with the highest trip rate with 13 people per 100 m² has famous clothing brands as the characteristic

shopping centers. Whereas Mascot Plaza is a shopping center located close to settlements having the smallest trip rate that can attract 6 people 100 m².

Different from the previous study, Transmart is classified into medium size shopping center but the trip attraction result is not included in its classification of high trip attraction when compared to previous studies conducted in India. However, when compared with the standard, shopping centers in suburban locations have a trip rate of 3.81 people/100 m² during the peak hours of the afternoon [12] so that it can be concluded that Transmart can attract one and a half times people's trips greater than the standard set even if compared to best practice is included in the classification of low trip attraction. It shows that modern shopping centers with the 4 in 1 concept will attract lower trips than other shopping centers.

Tabel 2. Comparison of Trip Rate in Various Activity Area

Activity Area	Trip rate (person/100 m ²)	Trip Generation Manual (person/100 m ²)
Shopping	3,5	9,5
Dining	15,2	10-15
Playing	7,2	-
Watching	29,8	6,17

Based on the results of the trip rate analysis of each activity area, it can be concluded that in the shopping activity area has a trip attraction rate is not too large at only 4 persons/100 m², far below the standard Trip Generation Manual set at 9.48 person/100 m². The dining activity area attracts a trip rate that is in accordance with the standard Trip Generation Manual which is 15 persons/100 m². The playing activity area attracts a trip rate of 7 persons/100 m² and there has no comparison in Trip Generation Manual. The watching activity area attracts a trip rate of 30 persons/100m² smaller than Sandiego Land Use Municipal Code with a trip rate of a movie theater located in the city center of 80 person/100 m² but larger than the standard of Trip Generation Manual which is 6.17 person/100m². So, only the dining area is in accordance with the standard but, meanwhile the trip rate of shopping activity area is below the standard set. For the play activity area it does not have the standard because in the Trip Generation Manual shows that the trip rate for recreation is still separated in one function of recreational activities while the playing area in Transmart consists of a combination of game rides.

2.2 Trip Attraction Model Analysis (Phase 2)

According the trip rate of activity area as independent variable and total trip rate attracted by shopping center as dependent variable in peak hour time sequal session the model could be built as

$$T_i = 0,005 + 0,263x_1 + 0,186x_2 + 0,087x_3 - 0,061x_4$$

T_i = total trip rate

X_1 = trip rate of shopping activity area

X_2 = trip rate of dining activity area

X_3 = trip rate of playing activity area

X_4 = trip rate of watching activity area

The largest contribution to the total number of Transmart visitors is the trip rates in the shopping area which has coefficient of positive 0.263. It is necessary to consider, if the area of shopping activity expanded, it will be the biggest impact of the total trip rate compared to the other activities area.

When compared with previous study with same characteristic as Transmart, having a total trip total of 19 persons/100 m² [3] and included in the classification of high trip rates which has no movie

theater in it. In contrast to Transmart, a shopping center with a movie theater in there, has the trips rate is smaller than previous study, 6 persons/100m². This is interesting with the modeling which shows the movie theater has a negative contribution to the total trip rate level so that driving the level trip rate of watching activity area will reduce the value of the total trip rate level.

The coefficient value indicates the independent variable of the watching activity area has a negative sign which is -0.061. It means that the number of watching activity trip rate has opposite effect on the total trip rate because if total number of watching activity visitors increased does not always increase the number of visitors in watching activity area. During peak hours, visitors coming through entrance door and want to watching film do not always directly but they go to another activity area before the movie starts at a certain hour so the number of visitor movie increased does not appear at the peak hour of total visitor crowds.

The model of trip attraction in the shopping center which has the concept of shopping, shopping, playing, and watching representing 100% of the real conditions by the trip rate in each activity area that includes shopping activity areas, dining activity area, playing activity area, and watching activity area. This has been done with several statistical tests such as f test, t test, and heteroscedascity test. The three tests show the results of the model can predict real conditions. Therefore, the model can be used to calculate the estimated number of trips to Transmart based on the area configuration of the similar shopping centers.

3. Conclusion

The trip attraction model has successfully represents the real condition with the equation $y = 0.005 + 0.263x_1 + 0.186x_2 + 0.087x_3 - 0.061x_4$, where y is the trip rate for total visitors which is dependent on the shopping activity area (x₁), dining activity area(x₂), playing activity area (x₃), watching activity area (x₄).

The trip attraction model has been valid in statistical tests and can be used to estimate the number of visitor trip attracted using an area configuration of the similar shopping center.

Calculation of Trip Rate results in a trip attracted by Transmart Setiabudi during peak hours is 0.06 persons / m². The development of Transmart is considered quite effective, with various concepts of activity in which the trip rate produced is low but must be anticipated because it is higher than the standard. This model can be used to design a similar shopping center in Semarang so that it can be estimated the trip attraction and can anticipate traffic problems for better development that part of sustainable development concept.

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