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Influence of food kiosk attraction on the road's level of service

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Abstract. The main purpose of the research is to analyze the influence of food kiosk attraction on the road's level service and to find a solution to decrease congestion at Mayjen Sungkono Road in Surabaya City. The development of commercial sector has profoundly contributed to the land use change into business and residential areas. There is an increase in the number of vehicles passing through Mayjen Sungkono Road per year based on the data from Department of Transportation in Surabaya. In 2014, the number of light vehicles (LV) passing through Mayjen Sungkono Road was as many as 131,620 units, heavy vehicles (HV) reached 248 units, while motorcycles (MC) recorded at 187,371 units. The research uses the road's level of service analysis, multiple linear regression analysis, and do-something analysis. The results show that the influential variables comprise of the number of visitors (X_{32}), parking area (X_{30}), and building area (X_{29}). The food kiosk attraction model is $Y_{\text{food kiosk}} = 51.827 + 0.723(X_{32}) + 5.859(X_{30}) + 0.072(X_{29})$, and the result of attraction movement derived from food kiosk is 7,670.71 pcu/day. Widening the road can raise the average ofthe road's level of service (LOS) at Mayjen Sungkono of formerly F value increased to D.
Keywords: commercial area, food kiosk attraction, multiple linear regression, the road's level of service

1. Introduction

There is a tendency that the development of a city coincides with the aggravating transportation problems so that these issues overshadow the urban growth. One of the problems that often occur in big cities the traffic density or congestion, caused by the inadequacy of infrastructures compared with the greater transportation need. Changes in the activity schemes will affect the network structure through alterations in service levels on the movement system [1]. Being the economic center and capital of East Java Province, Surabaya City gives the biggest contribution to the formation of GRDP of East Java [2]. It is the largest city in East Java with an area of 32,637.08 Ha. In 2016, the population in Surabaya City is 2,977,520 people, and its growth is annually increased by 1.7%. The economic structure of Surabaya City is supported by the tertiary sectors such as trade, hotel and restaurant, transportation and communication, and other services sectors which directly contribute to Gross Domestic Product (PDRB) with an average value of 62.28% per year [3]. Dominated by private vehicles with a percentage of 93.8%, the average number of vehicles in the City of Surabaya in 2010 amounted to 122,087 units.It increased by 4.2% in 2011 to 132,802 units [4].

The growth rate of private transport modes in Surabaya tends to increase annually by 8.3% in line with the population growth, while the increment of public transportation there is only 0.9% per year. As a comparison, the percentages of private vehicles and public transports are 73.41% and 26.58%, respectively [5]. The satellite development unit is directed to carry out the main functions as a residential

area, trade and services, as well as special areas. Based on current trends, commerce and services dominate the Mayjen Sungkono Road which is the main access in this region [6]. Along with the progression of infrastructures development in the City of Surabaya, the generation, attraction, and movement patterns are shifting toward the east-west. Mayjen Sungkono Road, an addition that connects West Surabaya with Surabaya City Center, is one of the main streets in this corridor that experiences congestion at rush hour [7]. Technically, the function of Mayjen Sungkono Road as one of the areas in the secondary activity structure is serving the internal part of Surabaya as trade and service area [8].

Mayjen Sungkono Road is one of the streets in South Surabaya where there are many office center, high-rise buildings, and many spread trade sectors [9]. An increase in the number of vehicles passing through Mayjen Sungkono Road each year is based on the data from Surabaya's Department of Transportation. In 2014, the number of light vehicles (LV) passing on Mayjen Sungkono Road was as many as 131,630 units, while for heavy vehicles (HV) and motorcycles (MC) were 248 units and 187,371 units, respectively. The rapid development of trade and services sectors has affected the conversion of land use into commercial and settlement areas. This condition becomes a transportation problem that must be resolved because of the effect on the movement that occurred. Therefore, this study was conducted to determine the influence of the foodkioskattraction on theroad'slevel ofservice at Mayjen Sungkono Road in Surabaya City.The presence of this research is expected to boost the movement of vehicles to be more effective and efficient to break the congestion so that the traffic of the city is not inhibited. Thus, it canprovide valuable input for the development of adequate infrastructures at Mayjen Sungkono Road.

2. Research Method

Mayjen Sungkono Road connects West Surabaya and Surabaya Center. This road has administrative boundaries adjacent to Sawahan Sub-district, Dukuh Pakis Sub-district, and Wonokromo District (Figure 1). Mayjen Sungkono Road has a length of ± 2.58 km and six lanes of 3.5 meters width each, also equipped with a median strip. It includes secondary arterial road with two-ways and street status belongs to Surabaya City.

2.1. Data collection

The types of data required for this research are primary data (taken from the field observation) and secondary data (taken from the related institutions, literature, and electronic media). The data collection methods are divided into two as well, i.e., primary survey and secondary survey. The primary surveys cover the land use characteristics (building area, parking area, number of visitors, number of employees), road characteristics, food kiosk attraction characteristics (origin of movement objectives, travel times, and modes used), traffic volume, plate matching, interviews, and documentation techniques. The traffic volume calculation had been beingconducted for one week to determine the peak hour on weekdays and the weekend.The peak days of the movement on Mayjen Sungkono Road are Tuesday for weekdays and Sunday for the weekend. Secondary surveys are obtained from books, dissertations, journals, and other supporting literature.

2.2. Sampling

The sampling was carried out using Isaac and Michael tables [10], where the proportion for attraction is 139 samples. Generation and attraction for other land uses such as housing, education, health, and office do not use the sampling method since there are only a few of them along Mayjen Sungkono Road, occupied by the entire population.

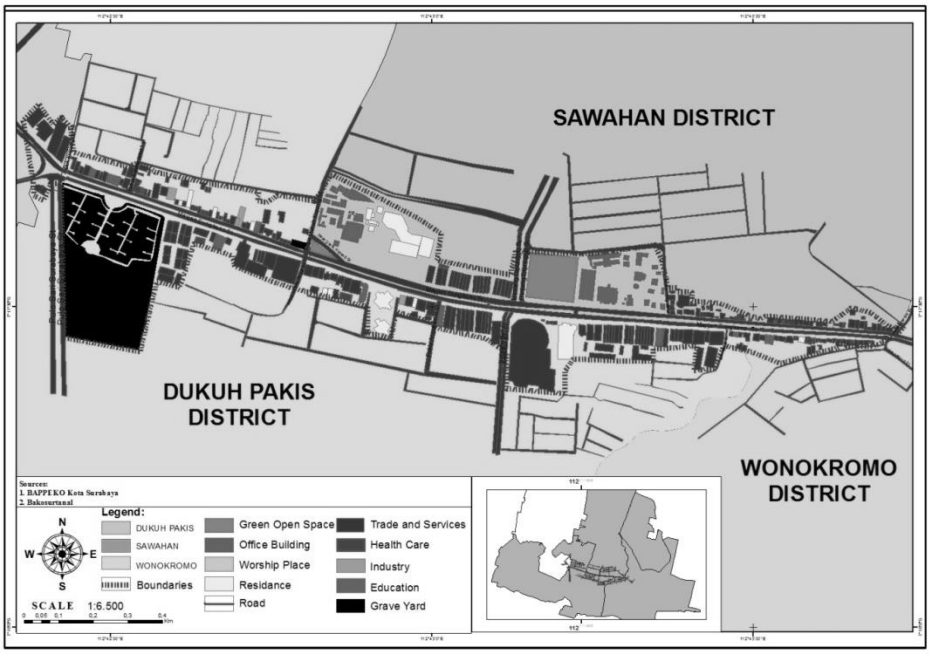

Figure 1. Research location.

2.3. Multiple linear regression analysis

The calculation of the attraction of food kiosk movement uses a multiple linear regression analysis, an analytical technique that links one dependent variable to two or more independent variables that are considered or may affect the observed dependent variable changes [11]. The independent and bounded variables used in this research are:

$$Y = A + B_1X_1 + B_2X_2 + \cdots + B_nX_n \quad (1)$$

$Y_{Food\ kiosk}$= Total movement, X_{29}= Building area, X_{30}= Parking area, X_{31}= Number of Employees, X_{32}= Number of Visitors, A= Constants, B_{29} ... B_{32}= Regression coefficient.

2.4. Model of land use interaction and road network

Before calculating the total interaction between land use and road network, it is necessary to know the relation between the model of the attraction of movement in a region with land use variables, between the road network capacity model in one area and the land use variables, as well as the relation between the model of the generation/attraction with road network capacity model designated by the formula [12]:

1. Total volume of vehicle influence from generation/attraction of land use ($V_{internal}$):
   ΣY_I = $Y_1 + Y_2 + Y_3 + Y_4 + \ldots\ldots Y_n$ (volume of vehicle movement per day)
   ΣV_I = $e_1Y_1 + e_2Y_2 + e_3Y_3 + e_4Y_4 + \ldots\ldots e_nY_n$ (volume of vehicle/hour movement in main road corridor)
   E_1 = V_I / Y_1 = Ratio of volume of vehicle movement out / incoming from land use during certain hours compared to total volume of vehicle movement/day.

2. Total volume of external vehicle movement ($V_{external}$)
   ΣV_{eks} = External vehicle volume / clock on the main road
   ΣV_{eks} = $V_{eks-1} + V_{eks-2} + \ldots\ldots + V_{eks-n} + V_{eks-5} + V_{eks-6}$

Based on the above frameworks to compute the internal and external volumes, the formula derived for finding out the interaction model of land use in this study, especially regarding food kiosks on the road network [12] is:

$$V_{total} = \Sigma V_{external} \quad (2)$$

V_{total} = Total volume of vehicle/hour in a corridor, $\Sigma V_{internal}$ = Total volume of vehicle / hour movement from the generation/attraction of land use, $\Sigma V_{external}$ = The amount of movement of an existing external vehicle/clock on a corridor of the vehicle/hour movement volume of environmental streets or alleys plus the continuous volume of vehicle/clock movement on a corridor.

2.5. The Road's level of service analysis

The degree of saturation (DS) or the road's level of service (LOS) is the ratio of volume (flow) of traffic to the capacity. The degree of saturation is used as the main factor in determining the service level of the road. The degree of saturation can be calculated by the following formula.

$$DS = \frac{Qpcu}{C} \quad (3)$$

Q_{pcu} = Total flow (pcu/h), C = Capacity (pcu/h)

After calculating the degree of saturation, the determination of LOS value was conducted using the boundaries of service level indicator [13]. Scope limitation is useful in classifying the road's level of service according to the stability characteristics of vehicles passing on Mayjen Sungkono.

3. Results and Discussion

3.1. Road Characteristics

Geometrics of Mayjen Sungkono Road can be seen from the ownership of the number of lanes that is 6/2 D or six lanes divided by the condition of cement concrete pavement and the splitting system separating the two directions. The width of the lane at Mayjen Sungkono is 10.5 meters. This road also includes high side barriers due to the use of commercial and service lands along the street (Figure 2).

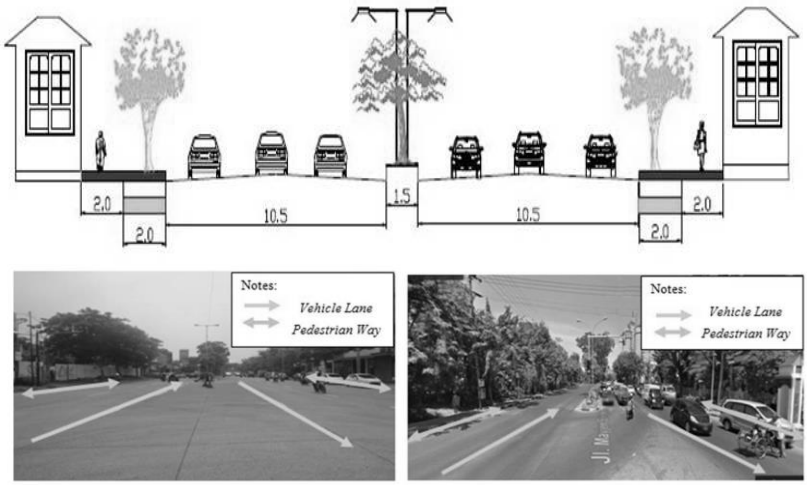

Figure 2. Cross-section of Mayjen Sungkono road.

Mayjen Sungkono is the connecting road between West Surabaya and Surabaya City Center. Its concrete pavement is in good condition, although there are several damages at some points. Mayjen Sungkono is included in the secondary arterial road, categorized as class II. The management of this

road is under the auspices of Surabaya City Government. In addition, Jalan Mayjen Sungkono is equipped with zebra cross, pelican crossing, and traffic signs.

3.2. Land use characteristics

The existing commercials on Mayjen Sungkono Road are dominated by houses and food stalls, clothing and sports stores, electronics and computer stores, as well as dealers and workshops, whereas for services dominated by Banks and ATMs, also design and photography. As much as 85% of the existing lands on Mayjen Sungkono Road is trade and services, so the in-and-out movement of vehicles from land use is also a factor causing congestion. The continuous movement on Mayjen Sungkono Road is very high because this road has the main function as a liaison between West Surabaya with Central Surabaya, as well as a connecting road to Surabaya-Gempol Toll.

3.3. The Road's level of service

The value of LOS on Mayjen Sungkono Road is obtained from knowing the volume of the vehicles and calculating the capacity of the road. The average LOS on Mayjen Sungkono Road with a value of 9,108 capacity on the working days (weekdays) as well as on holidays is F. The LOS value F meanspoor road service conditions, sluggish roads, and congestion occurs. During peak hours, the volume of vehicles on Mayjen Sungkono Road increases because in the morning (08.00–09.00), the average riders start their travel activities, resulting in the built up of vehicles. On the other hand, during the day (12:00–13:00) is the hours of office break for workers and school hours for students, so the flow of vehicles increases again. Similar to the morning and afternoon, the condition of Mayjen Sungkono Road in the evening (5:00 p.m. to 18:00 pm) also increased because most riders or road users end travel activities of either purpose of work, school, shopping, or other activities.

3.4. Influence of Food Kiosk Attraction

3.4.1. Implementation of Generation/Attraction Model of Mayjen Sungkono Road

Food kiosks are located on Mayjen Sungkono as many as 25 units with an average of visitors as many as 73 people, the mean parking area of 10 m^2, and the average building area of 270 m^2. Based on the above, daily movements are obtained as follows:

$$Y_{\text{Food Kiosk}} = 51.827 + 0.723(X_{32}) + 5.859(X_{30}) + 0.072(X_{29})$$
$$Y_{\text{Food Kiosk}} = 51.827 + 0.723(73) + 5.859(10) + 0.072(270)$$
$$Y_{\text{Food Kiosk}} = 183 \text{ pcu/day}$$

Based on the results of these calculations, the amount of attraction that comes from Food Kiosk, can be obtained from this equation:

$$Y_{\text{Food Kiosk}} = Y_{\text{Food Kiosk}} \text{X Total of Population}$$
$$Y_{\text{Food Kiosk}} = 183 \text{ X } 42$$
$$Y_{\text{Food Kiosk}} = 7686 \text{pcu/day}$$

3.4.2. Influence of food kiosk on the road's level of service

The peak contribution of the highest movement volume affected by food kiosk is at 17.00–18.00 with a value of 6.97% due to the movements of many riders at that hour on Mayjen Sungkono Road, mostly the workers who come home from offices. The contribution of the lowest movement is at 21.00–22.00 with a percentage of 2.73% since there is neither commercial, education, nor office activities at that time anymore.

4. Conclusion

The contribution of food kioskland use to traffic conditions can be seen from the generation and attractionvalue of the resulting movement compared to the value of the road's level of service. The road's level of service at Mayjen Sungkono is on average F value. Based on the research results, it can

be seen that the highest volume of movement influenced by the food kiosk activities is at 8–9 am, 12.00–13.00, and 5–6 pm The highest contribution value of tug is at 5–6 pm and equals to 6.97%, whereas the contribution value of the lowest attraction there is at 9–10 pm and equals to 2.73%. The high contribution is influenced by the operation of land use, commercial, office, health, and education. A recommended effort to handle the congestion is to broaden the road of initially 10.5 m width to 12 m (extending the road body of 0.5 m per lane). Widening the road can raise the average ofthe road's level of service (LOS) at Mayjen Sungkono of formerly F value increased to D.

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