On-Street and Off-Street Parking Analysis of Passenger Car in Malioboro, Yogyakarta

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Abstract— The increasing number of commercial activities in the Malioboro area, Yogyakarta will have an impact on the increasing traffic volume and parking space requirements. Therefore, this study aims to analyze the supply and demand of either on-street and off-street parking for passenger cars. To do so this study utilized quantitative method to evaluate the parking supply and demand. The analysis of parking supply considered the capacity for off-street parking at Malioboro Mall and on-street parking on Perwakilan Street, Yogyakarta. While parking demands are analyzed by considering Malioboro Mall floor area, number of visitors, and number of passenger cars parking at Malioboro Mall and Perwakilan street. The primary data was collected by conducting survey on-street and off-street parking of passenger cars, whereas secondary data was obtained from Transportation Office and Statistics Agency of Yogyakarta. The survey was conducted on the peak day (Saturday), at 10.00 AM to 20.00 PM by counting the passenger cars entering and exiting the parking areas. The result of analysis showed the maximum on-street parking accumulation (Ap) was 55 cars and off-street parking as many as 123 cars with parking volume (Vp) for on-street were 183 cars and off-street 421 cars. In addition, parking index (Ip) for on-street was 1.00 and off-street 1.171. Furthermore, the parking capacity (supply) consisted of on-street parking at Perwakilan Street was 55 cars and off-street parking at Malioboro Mall was 105 cars. The maximum on-street parking demand was 55 passenger cars, whereas off-street parking demand in Malioboro Mall were estimated by three conditions, where the first parking demand (Dmax1), the second (Dmax2) and the third one (Dmax3) were 160, 146, and 176 passenger cars respectively. Generally, it can be concluded that the parking demand exceeds the parking capacity (supply), so additional parking space for the passenger car is required.

Keywords— Commercial area, Parking demand, Passenger car, Yogyakarta.

I. INTRODUCTION

According to Law Number 22 of 2009 concerning Indonesian Road Traffic and Transportation, parking is defined as a condition of the vehicle stopping or not moving for a period and the vehicle is left by the driver. Further, parking can also be defined as a place to stop the vehicle for a while (Novier et. al., 2015). Meanwhile, parking facilities are a location determined as a non-temporary stop for vehicles to carry-out activities at a certain time (Irawan et.al., 2014). Based on Technical Guidelines for the Implementation of Parking Facilities (Department of Transportation the Republic of Indonesia, 1998), the parking place provision is divided into two types, namely on-street parking, and off-street parking. On-street parking is a parking facility on the effective width of the road either legally or illegally. On-street parking is considered more efficient for land use because it does not require access and entrance (Yuda et. al., 2016). On the other hand, off-street parking is defined as a parking space that is outside the road body and it does not reduce the effective width of the road. Due to off-street parking does not reduce the effective width of the road and has entrances and exits to the parking area so that it does not cause traffic problems on the road (Anjarwati, 2010). However, the main problem occurred in many big cities in Indonesia is the number of vehicles on street parking is more than off street parking (Mudjanarko et. al., 2013).

Yogyakarta is well known as the center of education and culture in Indonesia as well as the tourism destination (Ajeng and Gim, 2018; Mahmudah and Adhytia, 2015). The number of tourists in Yogyakarta in the period of 2012-2016 was increasing about 6.07% per annum with the total number of tourists in 2016 reached 4,407,538 (The Central Statistics Agency (BPS), 2017). The popular tourism destinations and mostly visited by tourists coming to Yogyakarta is Malioboro area (Roostika, 2012). The increasing number of tourists and the commercial activities occurred in the Malioboro area have an impact on the increasing traffic volume and the need for parking spaces, either for passenger cars or motorcycles. The previous study of Abubakar Ali motorcycle parking lot had found the parking demand was higher than supply (Mahmudah et. al., 2019).

Nowadays passenger car parking spaces on Perwakilan street and Malioboro Mall are part of the important parking spaces to support commercial activities in the Malioboro area. Therefore, the main objective of this study is to analyze the off-street parking demand in the Malioboro Mall area as well as on-street parking at Perwakilan street. The estimated demands are then compared with the available parking capacity (as the supply) to evaluate the parking performance of passenger cars generally.

II. METHODOLOGY

The study was conducted in the Malioboro area, Yogyakarta city as illustrated in Fig. 1. The parking locations were Perwakilan Street as an on-street parking area and Malioboro Mall on Malioboro street number 52 - 58 for off-street parking. The main consideration in the selection of parking locations was the parking areas have different types of parking and are near one to another.

The stage of study is summarized on flow chart in Fig. 2. The secondary data was obtained from Transportation Office as well as the Central Statistics Agency Yogyakarta, particularly to

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Fig 1. Car parking area on Perwakilan Street and Malioboro Mall

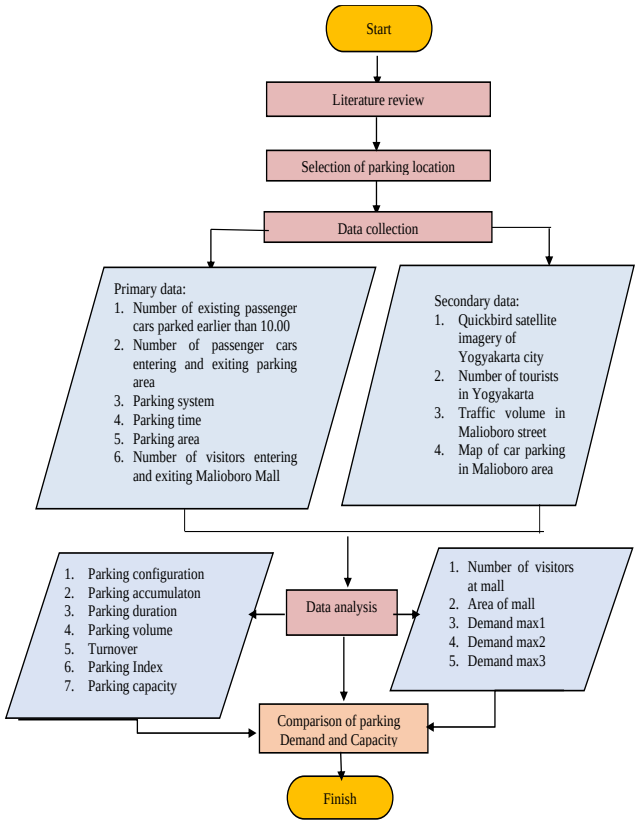


Fig 2. Stages of conducted study

have data of the number of passenger cars and the number of tourists visited Yogyakarta. This data was required to predict the traffic volume entering the Malioboro area. In addition, the quick bird satellite imagery of Malioboro area, which was obtained from Provincial Planning Board (Bappeda) of Yogyakarta, was mainly used for plotting the location and estimation area of the parking spaces precisely. Primary data collection from field survey was essential to have a better

TABLE 1.

Determination of parking space unit (Department of Transportation the Republic of Indonesia, 1998)

Type of Vehicle	Parking Space Unit (m^2)
Passenger car type I	2.3 × 5.0
Passenger car type II	2.5 × 5.0
Passenger car type III	3.0 × 5.0

TABLE 2.

Parking demand in commercial area (Department of Transportation the Republic of Indonesia, 1998)

Total Area of Commercial Building (100 m^2)	Parking Space Unit (PSU)
10	59
20	67
50	88
100	125
500	415
1000	777
1500	1140
2000	1502

understanding of the existing parking system. Then, measurement the parking in Malioboro Mall and Perwakilan street Yogyakarta were conducted to estimate the available parking space in the supply side. Moreover, counting the number of passenger cars and time duration of parking was carried out to estimate the parking volume and demand.

The data obtained from the survey were then analyzed by employing a computer program to predict the parking characteristics. Based on Parmar et. al., 2020, parking characteristics amongst other parking accumulation, parking volume, parking index, turnover, parking duration, parking capacity and parking demand, that can be used to assess the parking performance.

Parking accumulation (Ap) is the number of passenger cars parking on a period at parking area. It can be determined by using the Eq. (1).

$$\text{Parking Accumulation (Ap)} = Ei - Ex + X \quad (1)$$

Where Ei is the number of passenger cars enter parking area in a certain period, Ex is the number of passenger cars exit parking area in a certain period, and X is the number of existing passenger cars already parked in parking area.

Parking volume (Vp) is defined as the total passenger cars in the parking area during the operation time. It can be estimated by employing Eq. (2).

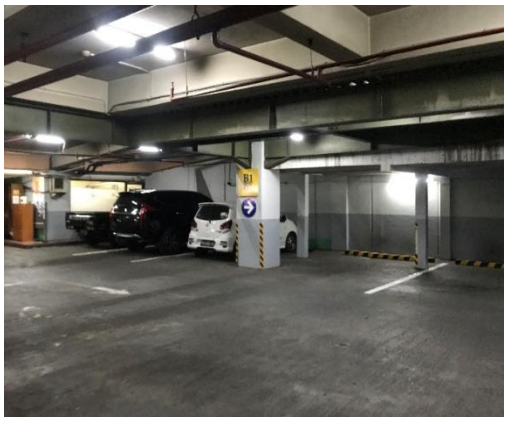
$$\text{Parking volume (Vp)} = Ei + X \quad (2)$$

Where:

Ei= the total number of passenger cars enter

X= the number of existing passenger cars

Parking index (Ip) is the parameter used to describe the use of passenger car parking space (in percentage) and it can be calculated using Eq. (3).



(a)

(b)

Fig 3. Off-street parking of passenger car in Malioboro Mall and on-street parking on Perwakilan street, Yogyakarta

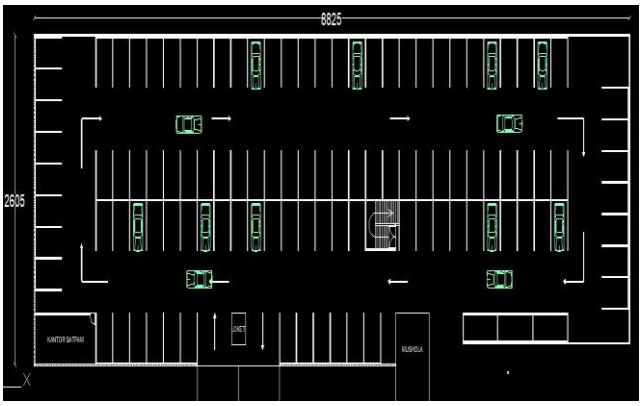


Fig 4. The circulation of passenger car entering and exiting Malioboro Mall parking area

$$\text{Parking Index } (Ip) = \frac{\text{Max. Parking Accumulation}}{\text{Available Parking Space}} \times 100\% \quad (3)$$

Parking turnover (TO) is the usage level of passenger car parking space, and it is calculated as follows:

$$\text{Parking Turnover (TO)} = \frac{\text{Parking Volume}}{\text{Available Parking Space}} \quad (4)$$

Parking space demand is defined as the total area required to park passenger cars in parking area at maximum parking accumulation. In this case the static parking space (PS) is calculated by utilizing Eq. (5)

TABLE 3.

Parking volume of passenger car (Vp)

Parking Location	Type of Parking	Parking Volume (Passenger Car)
Malioboro Mall	Off-street parking	421
Perwakilan Street	On-street parking	183

TABLE 4.

Parking index

Parking Location	Max Parking Accumulation (Passenger Car)	Available Parking Space (Passenger Car)	Parking Index (%)
Malioboro Mall	123	105	1.171
Perwakilan Street	55	55	1.00

TABLE 5.

Parking turns over

Parking Area	Max Parking Volume (Passenger Car)	Available Parking Space (Passenger Car)	Parking Turn Over
Malioboro Mall	421	105	4.01
Perwakilan Strees	183	55	3.32

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$$\text{Parking Space (PS)} = \frac{\text{TAPS}}{\text{PSU}} \quad (5)$$

Where the total area of parking space is namely TAPS and the parking space unit for passenger cars is namely PSU respectively. According to Department of Transportation the Republic of Indonesia (1998), the parking space unit for different type of passenger car is as shown in Table 1. In addition, to estimate the off-street parking space demands, it was considered 3 attributes namely the total floor area of commercial building, total visitors of commercial building, and the parking duration of passenger cars.

Secondly demand, Dmax2 is the parking demand estimated by considering the number of visitors of commercial building and occupancy rate of passenger car by utilizing Eq. (6).

$$\text{Dmax}_2 = \frac{\text{Number of visitors}}{\text{Occupancy rate of passenger car}} \quad (6)$$

Finally, Dmax3 is the parking demand estimated by considering the maximum parking accumulation and parking duration of passenger car at parking space, which can be calculated using equation below.

$$\text{Dmax}_3 = \text{Parking Accumulation x Parking Duration} \quad (7)$$

At the end, all estimated parking demand is compared to the parking capacity (supply) to evaluate the parking performance of passenger cars.

III. RESULTS AND DISCUSSION

Based on the survey carried out on the weekends (Saturday) in April 2020, the off-street parking area in Malioboro Mall and on-street parking at Perwakilan street are as shown in Fig. 3. The total off-street parking area in Malioboro mall of 2552 m2 and the available on-street parking space on Perwakilan street was 688 m2.

By considering the parking space unit for passenger car type I is 2.3 x 5.0 m2 (see Table I) the parking capacity in Malioboro

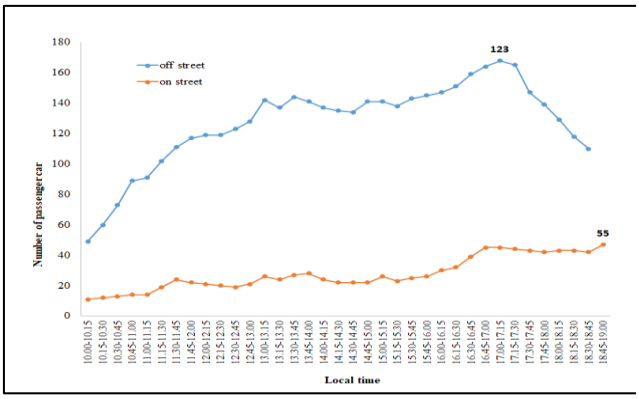

Fig 5. The comparison of on-street parking and off-street parking accumulation at Perwakilan street and Malioboro

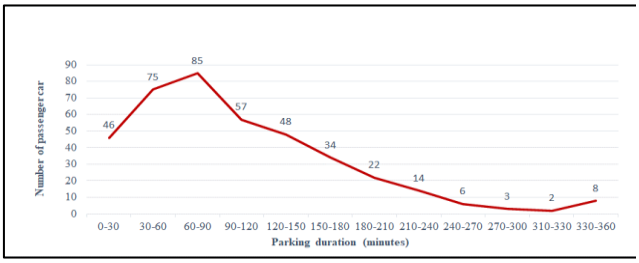

Fig 6. The off-street parking duration in Malioboro Mall

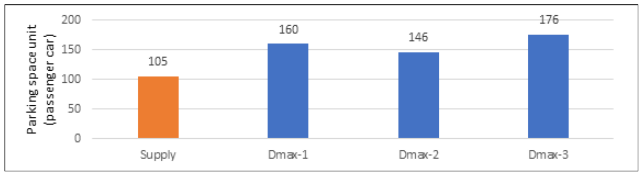

Fig 7. Comparison of parking demands and supply in Malioboro Mall

Mall and Perwakilan street were estimated 105 and 55 passenger cars respectively.

The circulation of vehicle flow in parking area of Malioboro mall as illustrated in Fig. 4 by employing 90 degree of parking configuration. Parking accumulation is the number of parked vehicles in a period, which was considered 15 minutes for each. According to the field survey, the on-street and off-street parking accumulation of passenger cars (Ap) during the weekends are as presented in Fig.5. The survey was conducted from 10.00 AM to 20.00 PM with a total time of 10 hours. The maximum off-street parking at Malioboro Mall occurred around 17.15 – 17.30 PM with maximum passenger cars of 123 units and on-street parking from 19.30 – 19.45 PM with maximum vehicles of 55. In addition, the off-street parking duration is as shown in Fig. 6 with an average duration time is 1.43 hours.

Parking volume is the total number of parked passenger cars during the operational time in a day. The result of the analysis showed that the maximum off-street parking volume of passenger cars was 421 and on-street parking volume was 183 passenger cars (see Table 3).

Parking index (Ip), which is also namely occupancy factor, is the percentage of space occupied by vehicles for parking. It is a measure of efficiency of parking space. The result shows that the off-street and on-street parking index are 1.171 and 1.00 (see Table 4). These results indicate the demand for off-street and on-street parking is higher than the capacity of available parking space.

The parking turns over (TO) is a degree of occupancy of individual parking lot in the parking space (Ottossan et. al., 2014) and can be calculated by using Eq. (4). The analysis results are as presented in Table 5. Based on the result, it is known that during the operation time the use of one parking space unit off-street parking in Malioboro Mall is more than 4 times in a day. Meanwhile the use of one parking space unit on Perwakilan street is about 3 times a day.

The parking demands in commercial buildings can be predicted by employing Table 2 for Dmax1 and by utilizing Eq. (6) for Dmax2 and Eq. (7) for Dmax3. The first parking demand (Dmax1) is 160 parking space unit, and it is obtained by referring Table 2 where the total floor area of Malioboro Mall is about 22000 square meters. Further, Dmax2 is 146 parking space unit, which was estimated by considering the maximum visitor of 341 persons and the occupancy rate of passenger car was 2.35 (Sugiyanto et. al., 2011). Finally, the Dmax3 is 176 parking space unit, that is obtained by multiplying maximum parking accumulation of 123 by average parking duration of 1.43 hours. The comparison of parking demands and parking capacity in a commercial building is presented in Fig. 7. It can be concluded that off-street parking demands in Malioboro Mall are much higher compared with the parking space available, so additional parking space is required.

IV. CONCLUSION

The increasing number of passenger cars will impact the parking demand space, especially in commercial areas like Malioboro, Yogyakarta. The result of the analysis showed the maximum on-street parking demand on Perwakilan street was the same as the capacity of 55 parking space units. In contrast, off-street parking space capacity in Malioboro Mall was 105 and estimated off-street parking demand were 160, 146, and 176 parking space unit respectively. In general, it can be concluded that the parking demand of passenger cars exceeds the parking capacity (supply), so additional parking space is required.

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