

Analysis on Supply and Demand of Abu Bakar Ali Yogyakarta Motorcycle Parking Lot

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Abstract— Parking is an absolute requirement to support activities in a commercial area. Recently, parking lot of Abu Bakar Ali Yogyakarta is quite busy to accommodate motorcycle that will go to Malioboro, Yogyakarta. Hence, this study aims to analyze the demand and supply Abu Bakar Ali Yogyakarta motorcycle parking lot. The method employed in this study was a field survey to count the number of motor cycle entering and exiting the parking lot and to estimate the parking capacity. The analysis results show that the maximum accumulation parking of motorcycle occurs on the weekend, which was equal to 401, while on weekdays, there were 192 motorcycles. The static parking space was 2760 m² with a configuration using a 90-degrees pattern accommodating 1306 motorcycles whereas the parking volume was 1492 motorcycles. Therefore, the demand is higher than supply of motorcycle parking lot, especially during the weekend. Moreover, the parking system is operated manually. Hence, the users need a longer time for the parking process. In addition, the information on parking space available for the users cannot be accessed just in time that leads to less efficient services. Thus, it is very important to apply Intelligent Transportation System, particularly to manage the motorcycle parking lot in this area efficiently.

Keywords—Parking, Motorcycle, Abu Bakar Ali, Yogyakarta, Intelligent Transportation System (ITS)

I. INTRODUCTION

The number of vehicles in Indonesia reached 140 million from 2012 to 2016, with an average growth of 8.19% per year. Based on the vehicle type, it is known that the number of motorcycles is the highest number of vehicles in Indonesia, which amounted to 105.15 million, and then followed by passenger cars as many as 14.58 million. Moreover, freight or goods transports and buses occupied the third and fourth ranks with a number of about 10 million [1]. The high growth of these vehicles is one of the causes of traffic congestion in urban roads, especially in commercial areas [2,3,4]. In addition to the problem of congestion, the growth of motorized vehicles will also have an impact on the needs of a larger area for parking spaces of vehicles, especially for motorcycle parking lots, as motorcycle is the most dominant vehicle used in many cities in Indonesia.

The city of Yogyakarta is the center of economy, education, tourism, and culture in Indonesia [5,6]. The city of Yogyakarta is the capital of Special Region of Yogyakarta Province. The total area of Yogyakarta city is 32.5 km², with a population of about 412,704 people. Hence, the population density of Yogyakarta city is 12,698 persons per km² [1]. The area of Malioboro is a well-known city center and a commercial area in the city of Yogyakarta. This area is the main destination point, causing the traffic becomes crowded which tends to increase annually. The high volume of vehicles in this region requires appropriate regulation of traffic systems. Therefore, the provision of parking facilities with adequate management is mandatory so that motorized vehicles, especially motorcycles, do not park on the road and cause traffic congestion.

To increase the attractiveness of the area of Malioboro, especially for tourists visiting Yogyakarta, the Provincial Government of Yogyakarta establishes the regulation concerning free motorized vehicles on Malioboro Street starting from 2019. To achieve smooth traffic and the convenience of road users, the management of motorized vehicle parking around the area of Malioboro to be taken into account. Thus, this study aims to analyze the parking volume, parking demand and parking space available (supply) for motorcycle, as well as the importance of implementing Intelligent Transportation System (ITS) for parking system in Malioboro area, especially at Abu Bakar Ali Parking Lot, Yogyakarta.

II. LITERATURE REVIEW

A. Parking

According to Law Number 22 of 2009 concerning Indonesian Road Traffic and Transportation, parking is defined as the condition of the vehicle stopping or not moving for a while and being left by the driver [7]. In addition, based on the Decree of Directorate General of Land Transportation Number 272 / HK.105 / DRJD / 96, Department of Transportation the Republic of Indonesia, parking is defined as the immovable condition of a vehicle that is not permanent. Traffic or vehicle runs towards a particular place, after reaching destination, will need a stop, which is generally called a parking space [8]. The

increase in the number of vehicles and the number of trips will result in need of high parking spaces. It means that the high of traffic growth, the high parking facilities will be needed. In order to create a good transportation system, the places or buildings that potentially generate movement/travel such as business and commercial areas should provide adequate parking service facilities.

Purwaningsih and Kusmarianto [9] highlighted the requirements for parking places as stated in the Technical Guidelines for the Implementation of Parking Facilities [8], amongst others: It can guarantee the safety and smoothness of traffic inside and outside of the parking building by implementing Traffic Impact Analysis; It is easy to reach by the users; if it is in the form of a parking building, it should meet the construction requirements in accordance with the laws and regulations; if it is in the form of a parking park, it must have certain limits and if it is in a parking lot, the circulation and parking position of the vehicle is guided by traffic signs or road markings.

Hobbs [10] stated that parking management and control is to prevent traffic barriers and reduce accidents, to park vehicles effectively and efficiently, to maintain the condition of the environment by structuring parking in its place, and to create a mechanism for the use of road effectively and efficiently, especially on roads that are potential for traffic congestions.

According to the regulations of the Indonesian Department of Transportation (1996), the types of parking facilities can be divided into on-street parking and off-street parking (parking outside the road). Furthermore, off-street parking can be in the form of public parking facilities, which are places in the form of parking buildings or public parking parks and are managed as separate activities and parking as supporting facilities, which are places in the form of parking buildings or parking lots provided to support activities in the main building. In addition, parking control is applied mainly to reduce road barriers and to improve traffic on the road, by replacing on-street parking with off-street parking [8].

The urban parking and urban traffic systems are essential components of urban transportation. The urban parking system can affect traffic performance and total driven distance (environmental conditions). On the other hand, traffic performance can also affect the time drivers spent searching for parking and parking usage [11]. To assess the availability and performance of parking space, the data regarding parking characteristics are required, such as parking accumulation, parking turnover, parking index, and parking volume [12].

B. Intelligent Transportation System (ITS)

One of the Intelligent Transportation System (ITS) related to parking is Parking Space Information System. Some parking building managers, especially in shopping centers and malls, are recently using information systems on the availability of parking spaces. However, the information system is not currently integrated between one building and another. Some of the benefits of setting up an information system for the availability of integrated parking spaces including reducing the length of travel of road users, reducing the time of vehicles queue entering the parking area/space, and reducing traffic congestion on road segments around the location of shopping centers. Some studies related to ITS have been conducted in different cities in Indonesia [13,4,14]. Limantara et al. [13] had

constructed the parking system by employing ultrasonic sensor and internet of thing (IoT) in Kediri, East Java province. A programmable chip placed in every parking lot so it can send digital information signal to a server or parking user's gadget (with special software). This solution can be useful for parking management and parking users. In addition, Suyuti [4] gave several options for applying ITS in Jakarta by the integration and optimization of the existing ITS application for solving traffic congestion. This system can be used by people, road users and other stakeholders by integrating with other tools for solving traffic congestion such as mass transportation system implementation, transportation network capacity expansion and other supporting transportation policy [4]. Sabang et al. [14] had also conducted a study to build a prototype of the Arduino Microcontroller-Based Parking Information System. This study focused on designing a tool which can inform the users (drivers) and then direct the drivers to a vacant parking space using a microcontroller. The parking information system used several common parts such as LDR sensor, laser pointer, Arduino Uno, ATmega328 microcontroller, a computer or laptop, and LCD to inform about the vacant and occupied parking spaces displayed on the screen.

III. METHODS

The study was started by an observation survey around Malioboro area, especially for mapping the parking space of motorcycle. Further, the secondary data collection was carried-out in Transportation Office, the Central Statistics Agency (BPS), and as well as the library in Yogyakarta to obtain data of population and number of a motorcycle in Yogyakarta. These data were required to predict the growth of motorcycle and to forecast the parking space of the motorcycle needed in the future. Primary data collection from field survey was essential to grasp a good understanding of the existing parking system. Then, measuring the parking lot, Abu Bakar Ali Yogyakarta was conducted to estimate the available parking space in the supply side. Moreover, counting the number of motorcycle and time duration of parking were carried-out to estimate the parking volume and demand. The data obtained from the survey were then analyzed by employing a computer program to estimate parking accumulation, parking volume, parking index, parking turnover, and parking capacity to assess the parking performance.

Parking accumulation is important to estimate the number of motorcycles parking on a period of time at parking lot. Parking accumulation (PA) can be determined by using the equation of

$$Parking\ Accumulation\ (PA) = E_i - E_x \quad (1)$$

where E_i is the number of motorcycles enter parking lot in a certain period and E_x is the number of existing motorcycles that have already parked in parking lot.

Parking volume is defined as the total motorcycles in the parking lot during the operation time. It can be estimated as follows:

$$Parking\ Volume\ (PV) = T + E \quad (2)$$

Where T is the total number of motorcycles entered and E is the number of existing motorcycles.

Parking index (PI) is the parameter used to describe the use of motorcycle parking space (in percentage) and it can be calculated using the following equation.

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

Parking turnover (TO) is the usage level of motorcycle 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 motorcycles in parking lot at maximum parking accumulation. It can be differentiated as two types, which are known as static (SPS) and dynamic parking space (DPS). The following equation can be used to estimate static parking capacity.

$$\text{Static Parking Space (SPS)} = \frac{\text{TAPL}}{\text{PSU}} \quad (5)$$

Where TAPL is the total area of parking lot and PSU is the parking space unit. As mentioned earlier, the parking space unit for motorcycle is 1.5. In addition, dynamic parking space is then calculated by employing equation below.

$$\text{Dynamic Parking Space (DPS)} = \text{SPS} \times \text{TO} \quad (6)$$

Where SPS is the static parking space and TO is the turn over.

At the end, the parking volume (demand) is compared to the parking capacity (supply) to assess the parking performance.

IV. RESULTS AND DISCUSSIONS

Based on the survey conducted on weekdays and weekends in December 2018, the illustration of Abu Bakar Ali Yogyakarta motorcycle parking lot is as shown in Fig. 1 with the circulation of vehicle flow in the parking lot as described in Fig. 2. Parking configuration was 90 degree (see Fig. 3), with a total area of parking lot 2760 m². By considering the parking space unit for motorcycle is 1.5, the parking capacity can be estimated around 1306 vehicles.



Fig. 1. Abu Bakar Ali Yogyakarta motorcycle parking lot

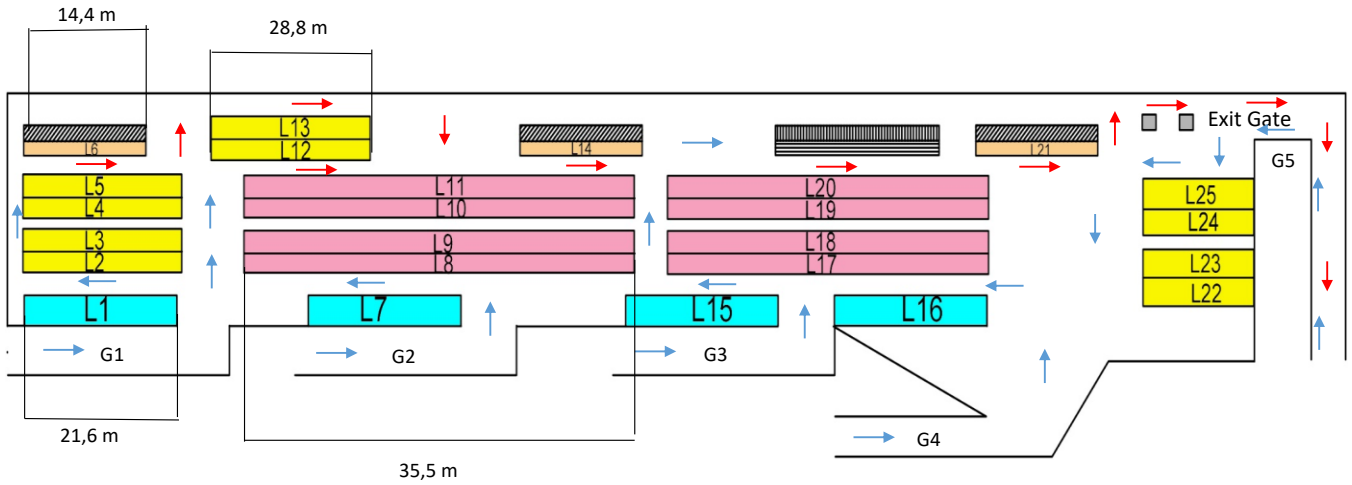


Fig. 2. The circulation of motorcycle entering gate G1 to G5 (blue arrow) and exiting gate (red arrow) in Abu Bakar Ali Yogyakarta parking lot

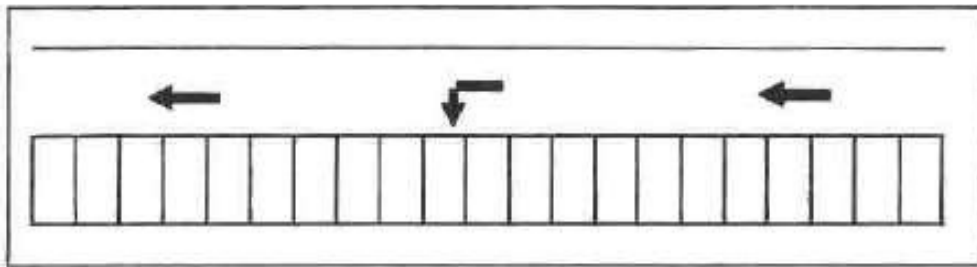


Fig. 3. Motorcycle parking configuration

Parking accumulation is defined as the number of parked vehicles in a period, which was considered 15 minutes for each. According to the field survey, the parking accumulation of motorcycle during the weekdays and weekends are as presented in Fig. 4. The survey was conducted from 08.00 AM to 8.00 PM with a total time of 12 hours, either during the weekdays and weekends. The maximum of motorcycles

parked occurred around 17.15 – 17.30 (weekdays) with maximum vehicles of 192 unit and from 16.45 to 17.00 (weekends) with maximum vehicles of 401. In addition, the maximum headway during the weekday was 7.5 and during the weekend was 1.67, as illustrated in Fig. 5. Based on the data obtained, it can be concluded that the maximum vehicle with minimum headway occurred during the weekend.

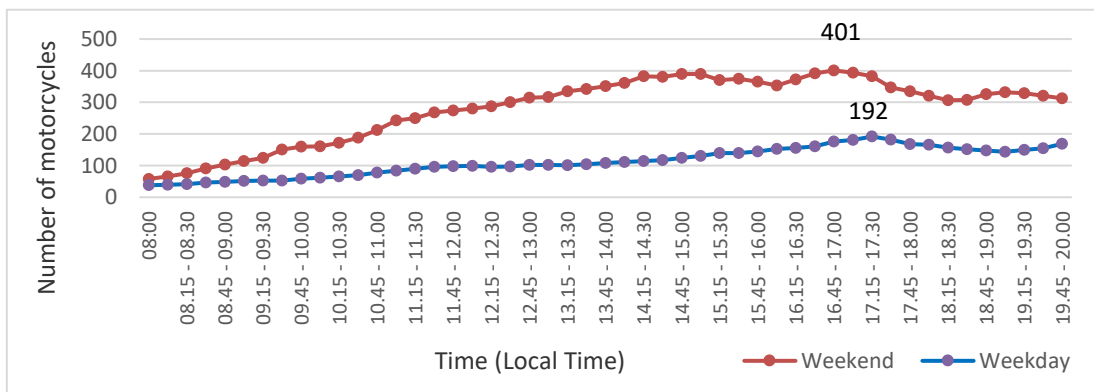


Fig. 4. The comparison of parking accumulation on weekdays and weekends

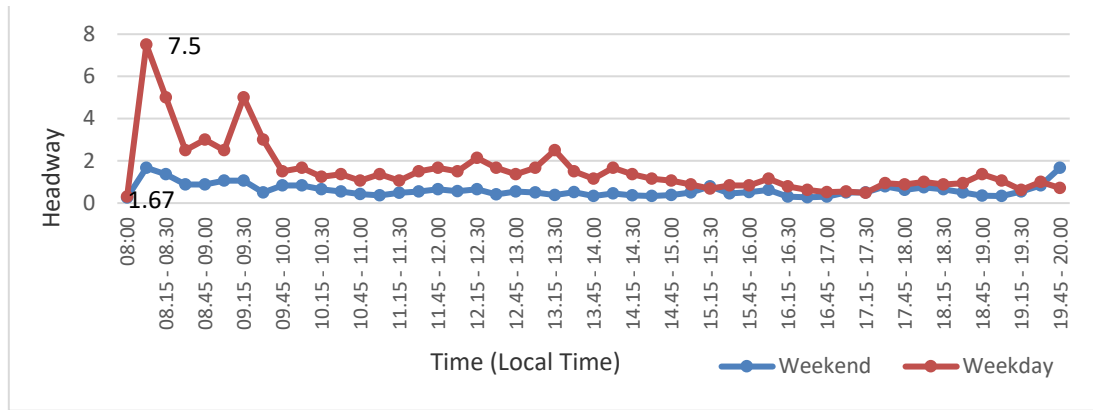


Fig. 5. The comparison of headway on weekdays and weekends

Parking volume is the total number of parked motorcycles during the operational time in a day. The result of the analysis shown that that the maximum parking volume for motorcycles during the weekdays was 724 and volume on the weekends was 1492 motorcycles (see Table I).

Total parking lot (m ²)	Parking Volume (vehicles)	Static Parking Space (vehicles)	Parking Turn Over	Dynamic Parking Space (vehicles)
2760	1492	1306	1.14	1489

TABLE I. PARKING VOLUME OF MOTORCYCLES ON WEEKDAYS AND WEEKENDS

Day	Number of vehicles		Parking volume (vehicles)
	Entry	Existing	
Weekends	1434	58	1492
Weekdays	674	50	724

The dynamic parking space available was 1489 motorcycles, whereas the parking volume was 1492 motorcycles (as shown in Table II). It can also be concluded that the demand is higher than supply of Abu Bakar Ali Yogyakarta motorcycle lot, especially during the weekend.

The estimated time for the parking process of the motorcycle was also calculated with the result as presented in Fig. 6 below. In general, the maximum time required for parking was 52 seconds and 33.5 seconds on average. The longer time of the parking process was most probably due to the manual parking system. All process of parking was carried out manually, and there was no information about parking space available for the users. Therefore, the application of Intelligent Transportation System is needed to reduce the time of the parking process, the queue length as well as the delay. The proposed parking management by ITS application as illustrated in Fig. 7, where all motorcycles entering and exiting the parking lot are detected by the system and display on the screen just in time. It is expected that the parking system becomes more efficient in the future.

TABLE II. THE PARKING SPACE REQUIRED FOR MOTORCYCLES

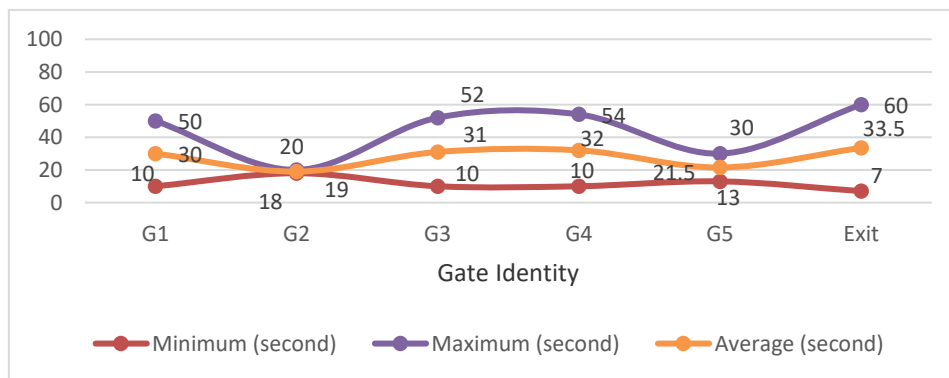


Fig. 6. The estimated time for the motorcycle parking process

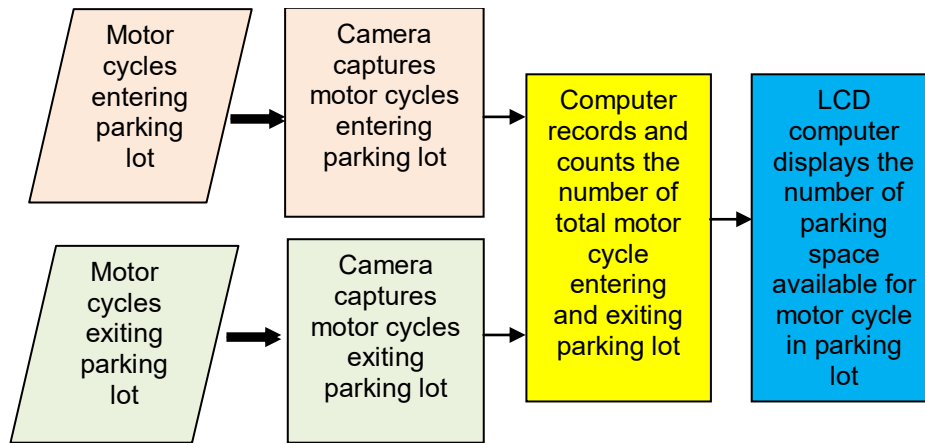


Fig. 7. The proposed ITS application for motorcycle parking management

V. CONCLUSIONS

The growth of motorized vehicles will also have an impact on the needs of a larger area for parking spaces of vehicles, especially for the motorcycle parking, which is the dominant vehicles used in many cities in Indonesia, including Yogyakarta. Based on the survey, the total area of the parking lot was 2760 m² with parking configuration of 90 degrees and parking capacity around 1306 vehicles. The maximum accumulation (demand) motorcycle on weekdays and weekends were 192 and 401 units respectively. The result of the analysis was also shown that the maximum parking volume during the weekday was 724 and on the weekend was 1492 motorcycles. However, the maximum dynamic parking space can only serve 1489 motorcycles on the weekends. Therefore, the demand is higher than supply of Abu Bakar Ali Yogyakarta motorcycle parking lot, especially on the weekend. It can also be concluded that the maximum accumulation of motorcycles, maximum volume, and maximum parking space with minimum headway were occurred during the weekend. In general, the maximum time required for parking was 52 seconds and 32 seconds on average. The longer time of the parking process was occurred due to the manual parking system. The proposed parking management by ITS application will count the motorcycles entering and exiting the parking lot and display on the screen to inform the users just in time. Therefore, it is expected that the parking system can be managed efficiently in the future.

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