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THE CHARACTERISTIC AND GREEN DESIGN FOR MOTORCYCLE PARKING IN THE UNIVERSITY

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ABSTRACT

The increasing number of students at campus has led to a problem in parking spaces. The lack of parking spaces caused the society of academicians to park their vehicles in disarray. Otherwise, many of them parked their vehicles in the roadside causing a traffic jam. On the other side, we have to create green design at campus as the model to reduce pollution. The purposes of this research is to analyze parking characteristic of motorcycle parked at campus to create the best design of parking needs to reduce pollution inside the campus from the parking side.

The method of this research is quantitative descriptive, to describe the characteristic and parking needs of motorcycle. To find the parking characteristic, primary data is needed through direct observation in all parking areas along the operational time.

As the research results, 83.33% of motor cycle parking locations at Universitas Islam Indonesia shows that the index value is more than 1. It means that the motorcycle parking space cannot accommodate the needs anymore, especially at peak hours. A recommendation from this study is to design centralized parking space at the gate access of campus. The concept is to reduce the pollution inside the campus by minimizing the mobilization of the motorcycle. Since the available space is not too large, vertical building of parking space is mostly recommended. In order to support the centralized parking space, it will be better to facilitate the campus with bike station, shuttle bus to connect in each building, and convenient infrastructure for pedestrian.

*Keywords***:** Characteristic; Green design; Motorcycle parking

1. INTRODUCTION

Nowadays, motorcycle is the most widely used vehicle in developing countries, such as Indonesia. Besides cheaper, it is faster to reach the destination because of its small size to easily overtake and win the position from the others. With the big number of motorcycle, there is a huge need of parking space to to meet at the campus.

Universitas Islam Indonesia (UII) Yogyakarta is the oldest private university in Indonesia and also has the most number of faculties in special region of Yogyakarta. Physically, UII campus has been progressing so rapidly, including the development of academic activities. Based on the UII master plan 2013-2023, the buildings are designed to accommodate until 25.000 students. This condition affects the high frequency of student mobility on campus so that private transportation such as motorcycles and cars is increasing. The greater the volume of traffic activity either in and out of the campus requires greater need for parking spaces. The need of parking spaces should be met adequately. The huge number of vehicles entering the campus area resulted in

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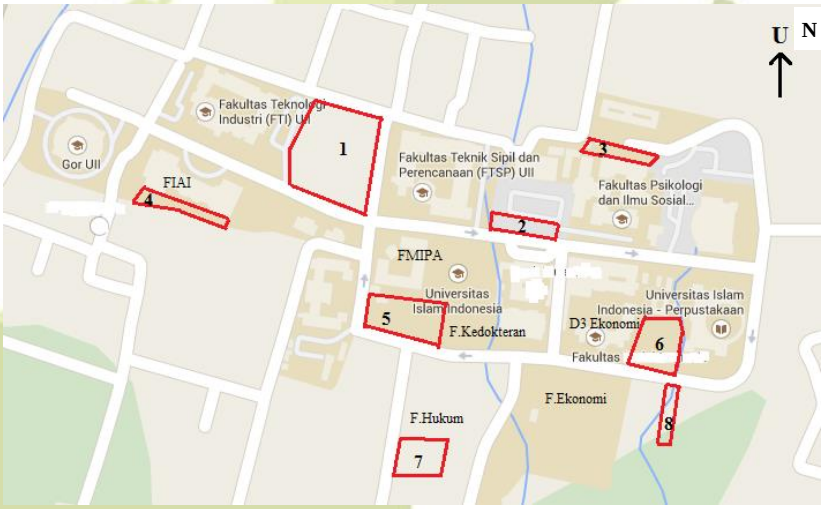
difficulties for motorists to get adequate parking. With 12723.37 m^2 for motorcycle parking lot, the parking problem in the parking area of Universitas Islam Indonesia is worth to study deeper. If the parking is not adequate, the vehicle will be parked in the roadside around the parking area, causing the traffic disarray. To accommodate private vehicles that continue to increase, the need for parking facilities is absolutely required by the Campus to serve the parking needs for the residents. On the other hand, the green design of the parking facilities is very important to support the idea of green campus to increase the environment quality.



1 : Motorcycle Parking at Civil and Industrial Engineering Faculty (CIEF)
2 : Motorcycle Parking at Social- Culture Faculty (SCF)
3 : Motorcycle Parking at Medical Faculty (MF)
4 : Motorcycle Parking at Islamic Religion Faculty (IRF)
5 : Motorcycle Parking at Science Faculty (SF)
6 : Motorcycle Parking at D3 Economy (D3F)
7 : Motorcycle Parking at Law Faculty (Future planning at UII Masterplan 2013-2023)
8 : Motorcycle Parking at Economy Faculty (Future planning at UII Masterplan 2013-2023)

Figure1 Motorcycle Parking Location of UII

2. MOTORCYCLE PARKING CHARACTERISTICS

Characteristics of motorcycle parking are intended as the basic properties that provide an assessment of parking services and parking problems that occur in the study area. Based on the characteristics of the parking, we will come to know the parking conditions that occur in areas of study, such as accumulation, parking volume, parking index, parking capacity, and the need for parking spaces.

The accumulation of parking is the number of vehicles parked somewhere at a certain time which can be divided according to category and type of travel intentions (Munawar, 2004). Besides, the accumulation of parking is the total number of vehicles parked in an area at a given moment (Transportation Department, 1996). To calculate the accumulation of parking, we can use the following equation (1):

Accumulated Parking = (Ei - Ex) (1)

Ei = Entry (vehicles that enters the parking lot)

Ex = Exit (vehicles that exit the parking lot)

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Based on Hoobs, 1995, the parking volume is the total volume of vehicles using the parking lot, including vehicles already in the parking lot before, per unit time. Volume was calculated by summing the vehicles using the parking lot in a day, as equation (2):

Parking Volume (V) = Ei + Ex (2)

Parking space capacity (static parking capacity) is the maximum space capacity to accommodate the vehicles. It counts the vehicles in terms of the entering process, parking, and then exiting the parking area. The equation is (3) used to calculate the parking capacity (Munawar, 2004):

Parking capacity (KS) = S / D (3)

KS = Parking capacity/ static parking capacity (Stall/ h)
S = Number of parking plots (Stall or SRP)
D = average time duration of parking (h /veh)

Dynamic of parking capacity is the maximum capacity of the space to accommodate the parking vehicles which are based on the capacity of the parking area, turnover, and parking duration. The equation is (4) used to calculate the dynamic parking capacity (Munawar, 2004):

Dynamic Capacity (KD) = (KS x P) / D (4)

KD = Dynamic Capacity (veh)
KS = static capacity (veh)
P = Length of time (hours)
D = Duration (hours)

The index is a percentage of the amount of available parking space (theoretically) by the number of parked vehicles that occupy (that happens) (Hoobs, 1995). The index value can show how big the parking capacity has been filled or in other words, the index can be used as the assessment size of the parking space needed whether the capacity of existing parking spaces can still accommodate the parking demand. The equation (5) to calculate the index (Hoobs, 1995):

IP = Accumulated parking / parking capacity (5)

The magnitude of this parking index will indicate whether the parking area is in trouble or not, if the parking index value is as follows (Hoobs, 1995):

1. IP < 1 means that the parking facilities are not problematic, where the parking need is less than the capacity,
2. IP = 1 means that the parking need is balanced with the capacity / normal capacity, and
3. IP > 1 means that there are a problem of parking facilities, where parking demand exceeds the capacity.

Parking space need is the number of places needed to accommodate the vehicles requiring parking based on comfort and functionality of a land use. To determine

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parking demand in an area, it is important to find the purpose of parking area (Hoobs, 1995).
The equation (6) to calculate the parking space requirements are as follows:

$$Z = (Y \times D) / T \quad (6)$$

Z = Parking space needs (stall)
Y = the number of vehicles parked in the unit time
D = average time duration of parking (h /vehicle)
T = duration of the survey (hours)

However, based on Ministry of Transportation of Indoneisa (1996), the standardization of parking spaces is based on the number of students. It stated that 1 SRP or stall for passenger car must be delivered for 50 students.

3. METHODOLOGY/ EXPERIMENT

Data that has been used in this research consist of primary and secondary data. Primary data is acquired through survey and field measurement in the campus parking area. The survey was taken to get several data: motorcycle parking lot space for existing condition, off street parking inventory for motorcycle, parking duration, and the vehicle ID/ number when entering and exiting the parking area. The primary data was taken in three weekdays from 08:00AM- 5:00 PM during the campus operation. While secondary data is acquired through the technical guidelines for the implementation of parking facilities from Ministry of Transportation of Indonesia, 1996 and UII Master plan 2013-2023 such as the future planning of parking situation sketch and maximum capacity of students for integrated campus. Analysis data includes the parking characteristics and the future green design of the parking lot for campus area. From the analysis results, conclusions and suggestions are arranged.

3. RESULTS

Table 1. Motorcycle Parking Characteristics at UII Campus in Existing Condition

Parameter \ MC parking location	Civil - Industrial Engineering Faculty (CIEF)	Social Culture Faculty (SF)	Medical Faculty (MF)	Islamic Religion Faculty (IRF)	Science Faculty (SF)	D3 Economy Faculty (D3F)
Parking Accumulation at Peak Hour (veh/hour)	2,118	815	522	227	556	545
Parking Volume (veh/hour)	4,891	1,978	1,229	614	1,321	1,464
Static Parking Capacity (Stall)	1,762	746	421	124	510	678
Maximum Turnover (veh/stall)	27.758	26.515	29.195	49.516	25.902	21.593
Parking Index at Peak Hour	1.220	1.09	1.24	1.83	1.09	0.804
Average Parking Duration (hour)	3.28	3.51	3.37	3.31	5.19	3.39
Dynamic Capacity (Stall)	4,835	1,913	1,124	337	884	1,800
Parking Needs based on equation (stall)	1,783	772	461	226	762	552

Table 1 above presents the accumulation of motorcycle parking at peak hour for six locations. Mostly, the peak hour occurs in the morning around 8:30 AM – 10:30 AM. The time is the second session for course schedule after the first session at 7:50 AM. Many students come at this session since it is not too early in the morning andis timely to do the learning activities. The highest accumulation occurs at CIEF location that

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counts more than 2000 motorcycles/hour as many as the motorcycle parking volume counts almost 5000 vehicles/hour. The lowest parking volume number at IRF counts around 600 vehicles /hour. However, the average duration of motorcycle parking around 3 - 4 hours in all locations except SF with more than 5 hours duration. The parking duration values greatly affect the value of the dynamic parking capacity and parking needs in the parking lot.

The motorcycle parking spaces capacity obtained from the methods shows that the average of it is no longer able to accommodate the highest accumulation of motorcycle parking properly. From the analysis of the parking spaces capacity it shows that 84% of parking area has no capacity for motorcycles to park in the parking lot already. Thus, the quality improvement of motorcycle parking in the study area is necessary.

4. DISCUSSION

Parking Index

In this study, the parking index value of the peak hour occurred at CIEF with the amount of 120%, and others: at SCF it reaches 109%, at MF it counts 123%, at IRF it counts 183%, at SF it reaches 109%, and D3F is in the amount of 0.80 or 80%. From the results, we can say that the parking index of 5 motor cycles parking areas from 6 locations on the integrated campus of UII is more than 1. In other words, it means that motorcycle parking area was no longer able to accommodate the needs of existing parking vehicles at peak hour (08:30 AM -10:30 AM). However, the actual condition is different from the results of index parking analysis. The parking lots can still accommodate MC parking since the students parked them very tightly with another vehicle and the other put it on the aisles. Consequently, this condition is very disturbing for the entering and exiting activities for other vehicles. Therefore, the motorcycle parking area in Integrated Campus of UII needs to be improved in order to foster the quality of parking facilities. The results of the parking index is shown at Figure 2.

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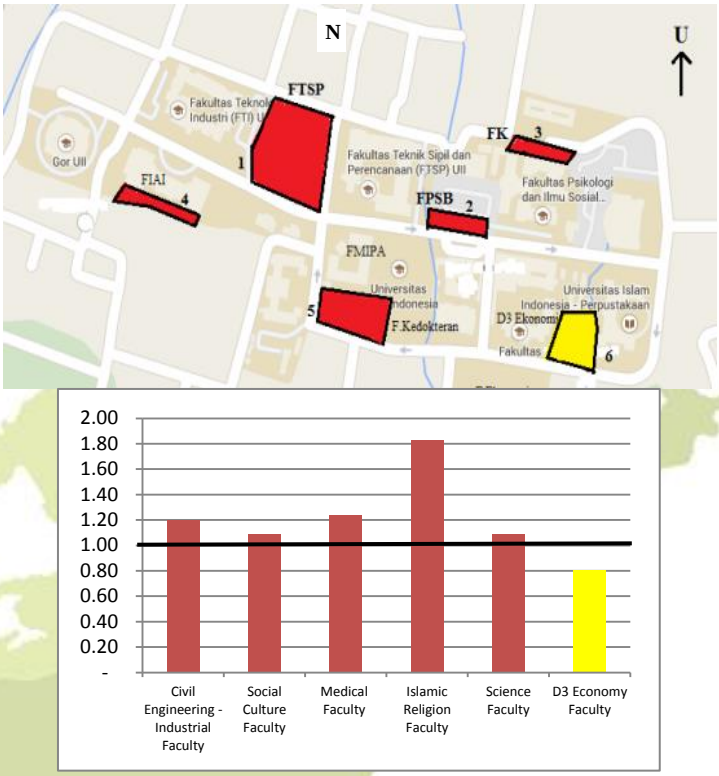

Description:
Red = Critical Conditions (> 1)
Yellow = nearly Critical (1 to 0.8)
Green = Safe (< 0.8)

Figure 2 Motorcycle Parking Index at Peak Hour of UII

Parking Needs

Based on equation (6) as stated in table 1, the total parking needs for all locations is **4556 SRP motor cycles** or **13,668 m^2**. In other words, it needs more 944.63 m^2 or 7% from the existing condition.
However, based on the MOT (1996), the parking need at university is 1 SRP of passenger car (parking space or stall) for 50 students. The calculation of Universitas Islam Indonesia parking space needs are as follows.
Total students of UII = 15,195 students.
Parking needs (SRP car) = 15,195/50 = 304 SRP.
Total Capacity Parking needs (m^2) = parking needs (SRP car) × (the unit of SRP car)
= 304 × 25 m^2 = 7,600 m^2
Car: Motor Cycle (MC) parking space = 36%: 64% (Actual parking lot proportion)
MC Parking Needs (m^2) = 64% × 7,600 m^2 = **4,864 m^2**
MC Parking Needs (SRP MC) = 4,864 m^2 / 3 m^2 = **1,621 SRP Motor**.

As is previously stated, motorcycle parking lot at UII covered 12,723.37 m^2. This means that the parking lot space of motorcycles at the existing condition exceed the MOT requirements as much as 61.77%. Yet, the requirement is in contrast with the actual condition since the index value is more than 1. Despite of this condition, it is still

possible to implement in the actual condition with other compulsion such as private vehicle prohibition for the new students, shuttle bus around campus, bike campaign, etc

Parking Needs for The Next 5 Years

Parking requirements prediction is needed to find out how many parking lots are needed in the future. Based on the master plan, maximum capacity of students for integrated campus is 25,000 students. Moreover, the area of motorcycle parking according to the Master plan is = 9143.3025 m^2

Existing Condition
Total number of students = 15,195
The parking accumulation of MC on peak time = 4,783 motorcycle (31.47% from total students)

The parking needs for the next 5 years based on parking accumulation on peak time
Total students of UII 2021 = 25,000
Number of motorcycle on the peak time = 25,000 × 31.47% = **7,868 MC**
The number of stall needs based on the number of motorcycle on the peak time = **7,868 SRP MC**

The parking needs for the next 5 years based on MOT regulation
Total students of UII 2021 = 25,000
Parking needs (SRP car) = 25,000/50 = 500 SRP.
Total Capacity Parking needs (m^2) = parking needs (SRP car) × (the unit of SRP car)
= 500 × 25 m^2 = 12,500 m^2
Car: Motor Cycle (MC) parking space = 36%: 64% (Actual parking lot proportion)
MC Parking Needs (m^2) = 64% × 12,500 m^2 = **8000 m^2**
MC Parking Needs (SRP MC) **= 8,000 m^2 / 3 m^2 = 2,667 SRP MC**

Parking capacity based on Master plan = Parking area/ (the unit of SRP MC)
= 9143.3025 m^2 / 3 m^2= **3,048 SRP MC**

From the calculation of MC on peak time, prediction for motorcycle parking needs for the next 5 years at the study site is 7,868 SRP motor while the static capacity of the motorcycle parking area based on the Masterplan are available to 3048 SRP motors, which means the capacity is not enough. Thus, it can be concluded that the parking of motorcycles cannot accommodate the need of parking space for next 5 years. However, based on the calculation of MOT, the spaces of MC parking is enough to cover the students' needs.

RECOMMENDATION

Vertical Parking Building

Based on the data examined, it can be seen that the number of vehicles entering Integrated Campus of UII has exceeded capacity. Therefore, it required a system to limit the number of such vehicles such as a ban policy to the new students to bring private vehicles to campus.
Besides, to facilitate the other vehicles, centralized parking such as vertical parking building is one of the important facilities in the campus transportation, as well as the migration modes of transport (public transport-private vehicle-bicycle-pedestrian). In

addition, it will be the good meeting point. The development of vertical parking building can be developed by more accompanying some facilities such as a restaurant /cafe, minimarket, photocopy facilities, Automatic Teller Machine, etc. The concept used is to force the student motorists who want to go to Campus to park their motorcycles in the centralized parking at spacious provided location. Meanwhile, the existing parking lot inside the campus is dedicated only for lecturers, staffs and visitors who should receive first priority for convenience (ITE,1992). Students who had parked their motorcycles in the centralized parking at the vertical parking building can go to the intended campus using provided bicycles or by walking if it is close to campus buildings. This facility is very important to decrease the pollution inside the campus.

Due to the big number of students' motorcycle in the campus such as UII, it is necessary to find spacious location to accommodate them. According to the regulation from Ministry of Transportation of Indonesia (1996), the needs of parking space of the integrated campus such as UII are 4,864 m^2. Due to the limited land, the solution for parking areas will be made in vertical building. With the available land of about 2,500 m^2, then it only needs = 4,864 m^2 / 2.500 m^2 = 1.94 ≈ 2 floors. To meet the next 5 years needs, it should facilitate = 8,000 m^2 / 2,500 m^2 = 3.2 ≈ 3 floors.

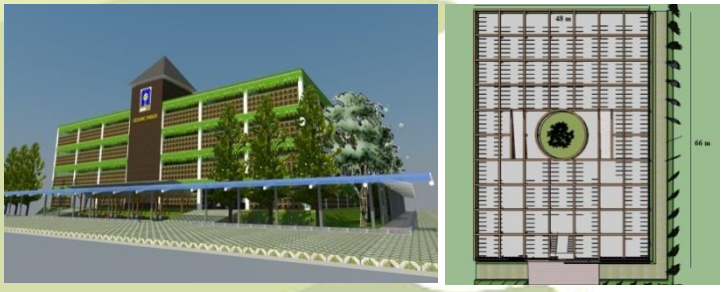

Figure 3 Vertical Parking Building

Bike Station and Shuttle Bus Facilities

To provide the centralized parking for motorcycles, we need some facilities, such as the provision of cycles at the bike station and the shuttle bus facilities through each centre point at the campus. Beside to connect the centralized parking to the last destination of the students, this facility is useful to build the green campus. Some requirements for the shuttle bus are the fix and on time schedule, speed limit regulation, and availability for the disable. Therefore, the bike station should meet some requirements as follows.

1. The location of bike station is near to the doorway of the campus building.
2. The location of bike station and the capacity should be adjusted to proportion of student needs.
3. The bike station must be connected with the buildings and the connections should be protected from the heat and rain.
4. The location of bike station must be close to the security post to facilitate supervision and regulation.
5. Strict lending rules for students such as lending the bike by the student card.

Improving Pedestrian Facilities

In addition to provide a bike station near the parking space, the pedestrian facilities also need to be prepared. For examples are resting facilities within walking breaks, drinking

water facilities, safe and comfortable (protected) walking space which by creating a canopy along the way and liaison between the faculty in order to be protected from the sun and the rain.

Figure 4 **(a)** Bike Station; **(b)** Pedestrian facilities

6. CONCLUSION

The highest parking accumulation and volume occurs on 08:30-10:00 AM. The parking location at CIEF has the highest number of them. Therefore, parking turnover value or maximum turnover has 2 vehicles/stall. This means that 1 stall parking space serves more than 2 vehicle parking. From the results of observations, the average duration of motorcycle parking is more than 3 hours/ motorcycle in all location except at SF with more than 5 hours/vehicle. From the analysis of the index value of the Integrated Campus of UII it shows that from 6 locations of motorcycle parking, 5 parking locations or 83.33% showed an index parking value which is more than 1 on average between peak time. This means that the motorcycle parking area could not accommodate the needs of vehicles parked at the time. Therefore, the MC parking area needs the better facilities in order to improve the qualities.

The total parking space requirement is 4,556 stalls for MC. But, based on MOT, the need of parking spaces for UII only 1,668 stalls for MC. This condition still possible and recommend implementing with other compulsion such as private vehicle prohibition for the new students, shuttle bus around campus, etc.

Motorcycle parking needed for the next 5 years is 7,868 stalls for MC [4]. Yet, based on the MOT, it only needs 2,667 stalls. However, the static capacity based on master plan is 3,048 stalls. It can be concluded that the motorcycle parking area still accommodate the parking needs for the next 5 years with other compulsions.

As the recommendation for better car parking facilities are vertical parking building, bike station and shuttle bus, then improving pedestrian facilities. The concept used for vertical parking building is to force the students with motorcycle who want to go to Campus to park their motorcycles in the centralized parking with vertical building at spacious location that has been provided. Therefore, the existing parking lot inside the campus is only limited for the lecturer and staffs. The vertical parking building is one of the important facilities in the campus transportation, as well as the migration modes of transport (public transport-private vehicle-bicycle-pedestrian) in addition to decrease the pollution inside the campus. However, supporting facilities of the parking centralization can be built by the availability of bicycles at the bike station and the shuttle bus facilities through each center point at the campus. Besides connecting the centralized parking to the last destination of the students, this facility is useful to build the green campus atmosphere. In addition to provide a bike station near the parking space, the pedestrian facilities also need to be prepared. For examples there are resting facilities within walking breaks, drinking water facilities, walking space that is convenient and safe such as a canopy along the way and liaison between the faculty in order to protect the vehicles from the sun and the rain.

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7. REFERENCES

Departemen Perhubungan Direktorat Jendral Perhubungan Darat (1996), *Pedoman Teknis Penyelenggaraan Fasilitas Parkir*. Jakarta.

Hoobs, F. D. (1995). *Perencanaan dan Teknik Lalu Lintas*. Terjemahan oleh Suprapto TM dan Waldijono. Gajah Mada University Press. Yogyakarta.

Institute of Transport Engineering. (1992). *Traffic Engineering Handbook*. Prentice Hall. United Stated of America

Munawar, Ahmad. (2004). *Manajemen Lalu Lintas Perkotaan*. Beta Offset. Yogyakarta.

Universitas Islam Indonesia, Marterplan Kampus Terpadu 2013-2023. (2014). Universitas Islam Indonesia. Yogyakarta

Warpani, Suwardjoko P. (2002). *Pengelolaan Lalu Lintas dan Angkutan Jalan*. Penerbit ITB. Bandung.