# Motorcycle parking building layout design at Nusa Putra University

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**Abstract.** The increase in educational activities and infrastructure at universities often leads to a rise in vehicle volume on campuses in Indonesia. This study aims to gather information on the characteristics and parking space needs at Nusa Putra University, predict parking space needs for the next 5 years, and determine effective parking building layout designs at Nusa Putra University. Data collection involves direct field observation through parking space inventory surveys and cordoning parking surveys. The collected data is analyzed using statistical forecasting with the least square method and comparative value statistics. The results show that the current capacity of 254 parking space unit (PSU) for two-wheelers cannot meet the demand of 539 PSU. Additionally, there are two proposed layout and location plans for a parking building to meet Nusa Putra University's predicted 2028 needs of 1059 PSU: Plan A (south of the auditorium) with a 7-story building accommodating 1076 PSU, and Plan B (east of Building B) with a 4-story building accommodating 1012 PSU.

## 1 Introduction

Parking issues are not new but have become a common problem in transportation systems. With the increasing levels of vehicle ownership and usage, parking has become a significant concern worldwide [1,2]. Parking difficulties often arise and can disrupt the flow of transportation, especially in high-activity areas [3,4]. To address this issue, it is essential to have enough parking space and design a parking system suitable for the existing land conditions. Balancing the demand for parking space with the supply of parking facilities is crucial, and this must be tailored to the parking characteristics of a specific location [5–7].

Parking problems can occur in various places, including campus environments [8–11]. The high number of students using private vehicles poses a challenge in managing and providing parking facilities on campus [12]. This situation can lead to further impacts, such as discomfort for students searching for parking spaces, vehicles parked outside designated areas, and other related issues [13]. One campus facing parking issues is Nusa Putra University in Sukabumi.

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Nusa Putra University currently has the highest number of students among private universities in Sukabumi Regency, with a total of 8,581 students. The number of incoming students is not balanced with those graduating, leading to a large student population. The significant number of students who bring and use motorcycles makes the available parking area insufficient to accommodate all these vehicles.

Some students who cannot be accommodated in the parking area are directed by the parking management to use the sports field as a parking space. Therefore, efforts are needed to address this limitation, such as adding parking space or constructing a parking building to accommodate motorcycles at Nusa Putra University for the next five years.

Constructing a parking building is one alternative to address the limited parking space at Nusa Putra University, which currently has a motorcycle parking area of 600 m². To realize this effort, the author conducted a study titled " Motorcycle Parking Building Layout Design at Nusa Putra University" This study will discuss the planning of a two-wheeler parking building at Nusa Putra University to meet the parking space needs for the next five years.

## 2 Material and Methods

### 2.1 Research Location

The research location focuses on the parking area at Nusa Putra University campus, with coordinates 6°54'19"S 106°52'25"E. The selection of this location is based on the consideration that Nusa Putra University is the largest private university in terms of student population compared to other higher education institutions in Sukabumi Regency. Additionally, Nusa Putra University is the institution where the researcher is currently pursuing their undergraduate studies. The research location map is shown in Fig. 1.


**Fig. 1**. Research Location Map

### 2.2 Data Collection Methods

The method used for data collection is direct field observation through field surveys. The data used in this research consists of two types: primary data and secondary data.

#### *2.2.1 Primary Data*

Primary data is data obtained directly through direct observation or surveys conducted at the research site. Examples of data that fall into this category include :

- Parking lot inventory survey
- Cordon parking survey

### *2.2.2 Secondary Data*

Secondary data is data that supports primary data. Secondary data is obtained through data collection methods such as literature review and from other relevant sources or institutions. Secondary data in this research consists of:

- Parking layout of Nusa Putra University.
- Number of academic community members at Nusa Putra University from 2019 to 2023

### *2.2.3 Research Flow Chart*

The flowchart below illustrates the flow diagram (Fig. 2)

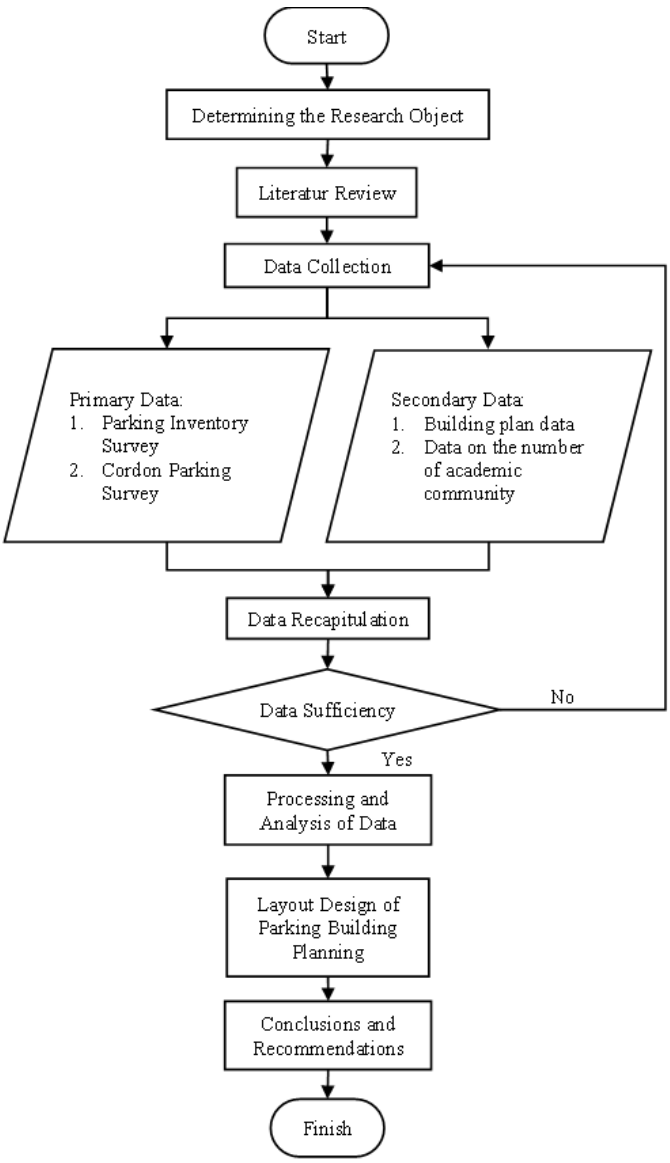


**Fig. 2** Research Flowchart

# 3 Results and Discussion

## 3.1 Existing Parking Condition at Nusa Putra University

The survey conducted in the parking lot in front of the Nusa Putra University Auditorium revealed a uniform parking pattern, namely angled parking at a 90-degree angle. This parking area has a total of 254 PSU with an area of 600 m2. The existing parking condition can be seen in Fig. 3 and Fig. 4 below:

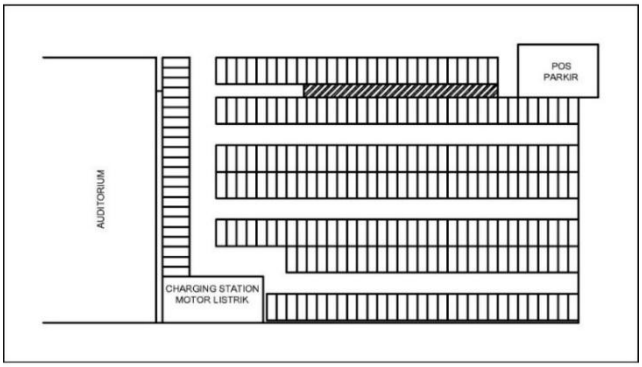


**Fig. 3**. Motorcycle PSU Layout

Fig. 4 Documentation of Motorcycle PSU Survey

Based on the observations made, the available SPU at this research site are unable to accommodate the parking needs for motorcycles. As a result, some vehicles are redirected to park at the sports field to fulfill the parking requirements.

## 3.2 Parking Characteristics Analysis

Parking characteristic analysis involves calculating the number of vehicles entering and exiting, including various calculations such as parking volume, accumulation of parking, parking duration, turnover rate, parking capacity, and parking index [14,15]. Below are the results and analysis from the cordon survey conducted on September 18, 2023.

**Table 1**. Documentation of Motorcycle PSU Survey

| Vehicle Types | Volume (vehicles) | Maximum Accumulation (vehicles) | Average Duration (h) | Parking Capacity (PSU) | Parking Turnover (vehicles/PSU) | Parking Index |
|---|---|---|---|---|---|---|
| Motorcycle | 1090 | 539 | 3,12 | 254 | 4,29 | 2,12 |
| Passenger car | 35 | 20 | 2,22 | 25 | 1,4 | 0,8 |

Based on Table 1 above, the parking characteristics at Nusa Putra University include a parking volume of 1090 motorcycles and 35 passenger cars. The maximum accumulation is 539 motorcycles and 20 passenger cars. Furthermore, it has an average parking duration of 3.12 hours (3 hours 7 minutes) for motorcycles and 2.22 hours (2 hours 13 minutes) for passenger cars. The parking capacity is 254 PSU (parking slots for motorcycles) and 25 for passenger cars. The parking turnover is 4.29 vehicles/PSU for motorcycles and 1.4 vehicles/PSU for passenger cars. The parking index is 2.12 for motorcycles and 0.8 for passenger cars. Thus, the motorcycle parking demand (> 1) exceeds its capacity, indicating that the available parking spaces are insufficient.

## 3.3 Parking Space Requirement Analysis

### *3.3.1 Parking Space Requirement*

Parking space requirement analysis refers to the number of spaces needed to accommodate vehicles requiring parking based on the facilities and functions of a land use plan. The calculation of parking space requirement is done using the maximum accumulation method. Maximum parking accumulation is the largest number of vehicles parked in a certain area during a specific time interval. From this method, the parking space requirement for motorcycles is equal to the maximum parking accumulation of motorcycles, which is 539 PSU.

### *3.3.2 Parking Space Requirement Forecast for the Next Five Years*

Based on the analysis results obtained and as a basis for determining the parking space capacity for the future, the compiler attempts to project the number of academic community members for the past five years (as seen in table 2) with the conditions expected for the next five years.

**Table 2.** Data on the Number of Academic Community Members at Nusa Putra University

| Year | Number of Academic Community Members |
|---|---|
| 2019 | 2858 |
| 2020 | 3571 |
| 2019 | 2858 |
| 2020 | 3571 |
| 2019 | 2858 |
| 2020 | 3571 |

To determine the number of academic community members for the next five years, we will use statistical analysis with the least squares forecasting method and statistical calculations of comparative values [16–20].

The results of the forecasting calculation using the least squares method indicate that the number of academic community members in the year 2028 is projected to be around 15,430 individuals. Furthermore, based on the results of the statistical equation calculation of the comparative value between the number of academic community members and the parking space requirement, it can be inferred that in 2028, Nusa Putra University is predicted to require at least 969 PSU to fulfill its parking space needs.

### *3.3.3 Planning the Design Layout of Nusa Putra University Parking Building*

In planning the construction of a parking building to meet the parking space needs at Nusa Putra University, suitable land is required for the construction of this parking building. There are two locations on the campus of Nusa Putra University that the author considers for finding effective land for the construction of the parking building: Location Plan A (south of the Nusa Putra University Auditorium) and Location Plan B (east of Building B at Nusa Putra University). For a clearer view, please refer to Fig. 5 below :


**Fig. 5** Location of Parking Building Plan

- Parking Building at Location Plan A
  The available land area at Location Plan A is 600 m2. Meanwhile, the planned area for the parking building is 470.4 m2, and the building's height for each floor is planned to be 2.5 m. The design layout plan of the parking building from the 1st to the 7th floor can be seen in Fig. 6 Fig. 7.

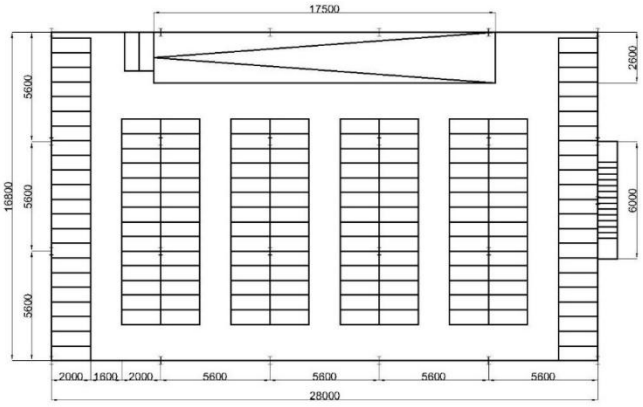


**Fig. 6** Design Layout of Floor 1 at Location Plan A

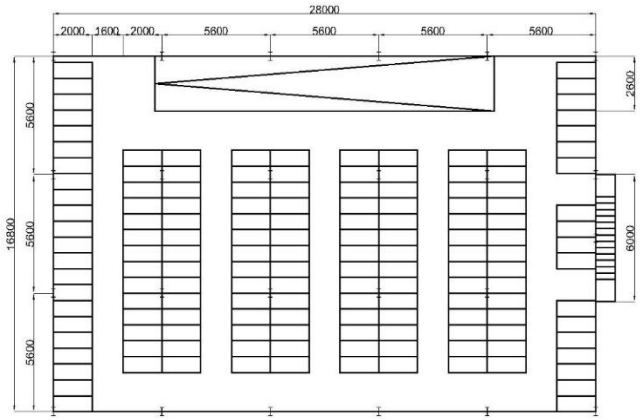


**Fig. 7** Desain Design Layout of Floors 2-6 at Location Plan A

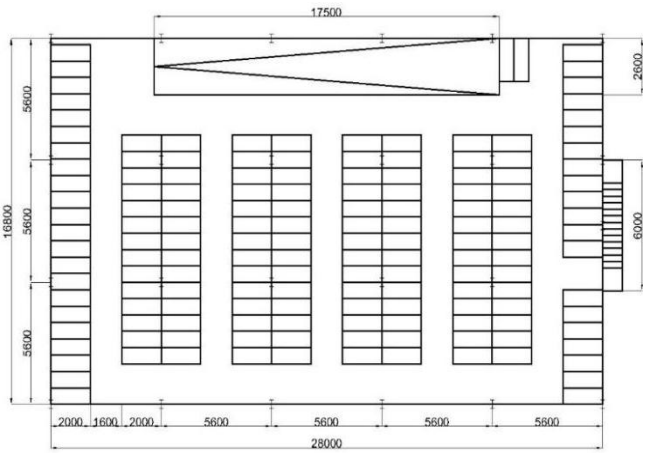


**Fig. 8.** Design Layout of Floor 7 at Location Plan A

- Parking Space Unit (PSU) planning
  The determination of PSU for motorcycles is 0.75 m x 2.00 m . On the 1st floor, there are 158 PSU, on floors 2 to 6, there are 152 PSU each, and on the 7th floor, there are 156 PSU. Therefore, the parking building at Location A is planned to accommodate 1074 PSU.
- Alley Planning
  For the two-way alley width determination for motorcycles, it should be at least 1.6 m. The width of the planned alley complies with the parking guidelines by the Directorate General of Land Transportation (1996).
- Ramp Planning
  For the ramp type in the parking building, straight ramps with a width of 2.6 m, a track length of 17.5 m, and a ramp slope angle of 8 degrees are planned.

- Parking Building at Location Plan B
  The available land area at Location Plan B is 828 m2. Meanwhile, the planned area for the parking building is 752.64 m2, and the building's height for each floor is planned to be 2.5 m. The design layout plan of the parking building from the 1st to the 4th floor can be seen in Fig. 9. Fig. 10, Fig. 11 below :

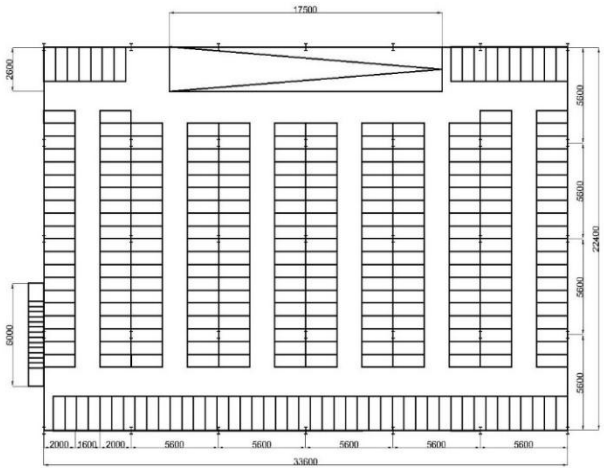


**Fig. 9** Design Layout of Floor 1 at Location Plan B

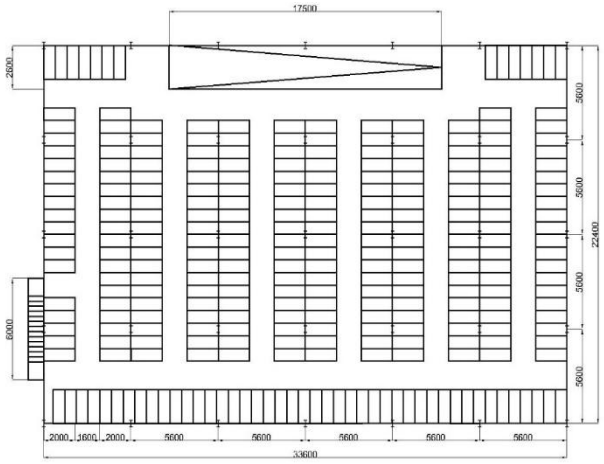


**Fig. 10**. Design Layout of Floors 2 and 3 at Location Plan B

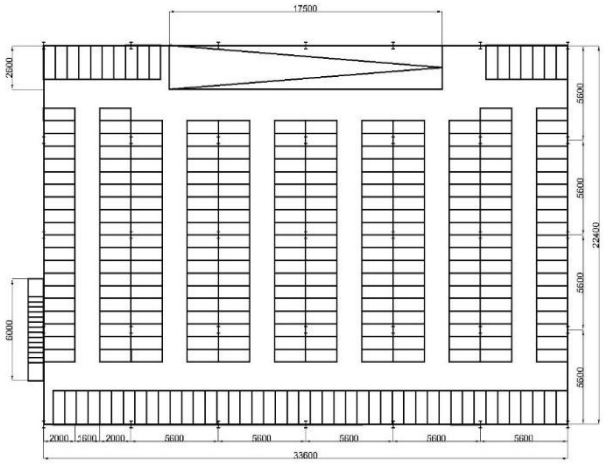


**Fig. 11**.Design Layout of Floor 4 at Location Plan B

- Parking Space Unit (PSU) Planning
  The determination of PSU for motorcycles is 0.75 m x 2.00 m. On the 1st floor, there are 293 PSU, on the 2nd and 3rd floors, there are 288 PSU each, and on the 4th floor, there are 293 PSU. Therefore, the parking building at Location B is planned to accommodate 1162 PSU.
- Alley Planning
  For the two-way alley width determination for motorcycles, it should be at least 1.6 m. The width of the planned alley complies with the parking guidelines by the Directorate General of Land Transportation (1996).
- Ramp Planning
  For the ramp type in the parking building, straight ramps with a width of 2.6 m, a track length of 17.5 m, and a ramp slope angle of 8 degrees are planned.

- Comparison of Parking Building Planning at Location Plan A and Location Plan B
  The comparison of parking building planning at Location Plan A and Location Plan B can be seen in the following Table 3.

**Table 3.** Comparison of Parking Building Planning at Location Plan A and Location Plan B

| No. | Planning | Plan Location A | Plan Location B |
|---|---|---|---|
| 1 | Land area available | 600 $m^2$ | 828 $m^2$ |
| 2 | Building area | 470,4 $m^2$ | 752,64 $m^2$ |
| 3 | Building hight | 2,5 m/floor | 2,5 m/floor |
| 4 | Number of floors | 7 floors | 4 floors |
| 5 | PSU size | 0,75 m x 2 m | 0,75 m x 2 m |
| 6 | Number of PSU per floor | floor 1 = 158 PSU<br>floor 2 = 152 PSU<br>floor 3 = 152 PSU<br>floor 4 = 152 PSU<br>floor 5 = 152 PSU<br>floor 6 = 152 PSU<br>floor 7 = 158 PSU | floor 1 = 293 PSU<br>floor 2 = 288 PSU<br>floor 3 = 288 PSU<br>floor 4 = 293 PSU |
| 7 | Total PSU | 1074 PSU | 1162 PSU |
| 8 | Alley width | 1,6 m | 1,6 m |
| 9 | Ramp width | 2,6 m | 2,6 m |
| 10 | Length of ramp traverse | 17,5 m | 17,5 m |
| 11 | Ramp inclination angle | 8˚ | 8˚ |

## 4 Conclusion

Based on the analysis and discussion in this study, several conclusions can be drawn:

- The characteristics and parking needs of the parking area at Nusa Putra University campus are as follows:
  - Characteristics of motorcycle parking: parking volume of 1090 vehicles, maximum accumulation of 539 vehicles, average parking duration of 3 hours 7 minutes, parking capacity of 254 PSUs, parking turnover of 4.29 vehicles/PSU, parking index of 2.12. Whereas the characteristics of passenger car parking are: parking volume of 35 vehicles, maximum accumulation of 20 vehicles, average parking duration of 2 hours 13 minutes, parking capacity of 25 PSUs, parking turnover of 1.4 vehicles/PSU, parking index of 0.8.
  - The parking space requirement (PSR) to be provided for motorcycle parking is 539 PSU. Whereas the parking space requirement for passenger cars is 20 PSU.
- The prediction of parking space requirement at Nusa Putra University in 2028 is 969 PSU.

- There are two alternatives as location options for planning and layout of parking buildings: location plan A (south of Nusa Putra University's auditorium) with a 7-story building that can accommodate 1074 PSU, and location plan B (east of Building B at Nusa Putra University) with a 4-story building that can accommodate 1162 PSU.

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