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PROCEEDINGS OF JOHOR INTERNATIONAL INNOVATION INVENTION COMPETITION AND SYMPOSIUM 2024 (JIICaS 2024)



*“Flourish and Nurturing Sustainable
Innovation for a Prosperous Nation”*

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Preface

In the name of Allah, the Almighty who gives us the enlightenment, the truth, the knowledge and with regards to Prophet Muhammad (peace be upon him) for guiding us to the straight path. We thank to Allah for giving us guidance and strength to write this e-book.

This e-book compiles the extended abstracts that submitted to Johor International Innovation Invention Competition and Symposium 2024 (JIIICaS2024), where JIIICaS2024 is a virtual platform for all creative minds to share and present their invention and innovation. Each abstract gives a brief background on the innovation or project.

We hope that this e-book will help the readers to get to know the innovation done by the students and get some ideas to develop future innovation products.

Foreword Rector



Assalamualaikum warahmatullahi Wabarakatuh,
Salam Sejahtera, Salam Malaysia MADANI and
Salam UiTM Dihatiku.

In the name of Allah, the Most Gracious, the Most
Merciful.

It is a great honor to welcome you to the Johor
International Innovation, Invention, Competition, and
Symposium 2024 (JIICaS 2024). This event

connects various disciplines, focusing on education and engaging educators,
students, researchers, and innovators from all walks of life.

Innovation is not just about ideas; it demands perseverance, creativity, and
determination to turn those ideas into reality. The remarkable projects
showcased today highlight the dedication and spirit of all participants.
Initiatives like this not only explore new technologies but also cultivate skills
and leadership among our youth. At Universiti Teknologi MARA (UiTM) Johor
Branch, we are fully committed to fostering a dynamic culture of innovation,
promoting the commercialization of new products, and encouraging
meaningful collaborations with industry and society.

As we celebrate this event, I would like to extend my heartfelt gratitude to all
sponsors, judges, the College of Computing, Informatics and Mathematics,
UiTM Pasir Gudang Campus as the event organizer, as well as to the
researchers and participants for their hard work in making this event a
success. Let us continue striving for innovation and excellence. May the
ideas presented today inspire us and lay the groundwork for future
achievements.

Thank you.

Associate Professor Dr. Saunah Zainon
Rector
Universiti Teknologi MARA (UiTM)
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(A-ST047) OPTIMIZATION OF THE PARKING LOT DESIGN: A MATHEMATICAL MODELING APPROACH

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ABSTRACT

Nowadays, having a car is essential for easy transportation at any time. The use of private vehicles is increasing, especially in urban areas, due to rapid economic growth. Currently, the number of registered vehicles exceeds the total number of people living in Malaysia. In this case, the state of the parking lot should play an important role in keeping the area in top condition and preventing overcrowding while prioritizing safety. The Pizza/KFC outlets at Seremban 2, Negeri Sembilan, are struggling with a parking shortage that must be fixed so that employees, managers, and customers can utilize it without crowding in. The mathematical model aims to optimize the best parking layout, maximize the number of parking spaces, and prioritize user safety. This research developed a parallelogram concept approach to maximize parking lot numbers. This study presented two different parking design types: diagonal (angle) parking and perpendicular parking, each with various angles and three types of measurements for calculating parking space areas. After analyzing this case study, the researchers have found that the number of parking lots for Pizza/KFC outlets is affected by the angle, length, width of parking spaces, and width of parking lot lanes. Thus, the parallelogram concept is used to identify the design. As a result, by comparing these three measurements, an angle of 90 degrees will accommodate 23 parking lots appropriate for the area using standard measurements in 2018. Even though using standard measurement in 2018 got fewer parking lots compared to the current number, this study still considered the safety of users followed by the size of cars nowadays. So, the findings of this study have proven that the mathematical model can be applied to calculate the parking capacity in specific areas, especially in limited areas.

Keywords: Parking layout, Mathematical model, Optimization, Parallelogram concept, Area

1.0 INTRODUCTION

Parking lots play a crucial role in the transportation infrastructure required to develop various areas, including universities, shopping complexes, and apartments (Prasath & Ahmed, 2021). These days, having a car is essential for getting around easily and having constant access to transportation. The economy's rapid growth has led to a significant increase in private vehicle use, especially in urban areas. Regarding the number of cars on the road as of October 2023, Transport Minister Anthony Loke stated that Malaysia has more registered vehicles than people living there. In Malaysia,

there are currently more than 36.3 million registered cars, compared to 32.4 million people living there as of the previous year. Cars account for the largest percentage of registered vehicles (17, 244,978), followed by motorbikes (16,773,112) and vehicles used for goods transportation (1,429,403). In this scenario, the parking lot should play an important role in maintaining the area in top condition and preventing overcrowding while ensuring safety.

Furthermore, the maximum number of parking places in the available space will be achieved by a well-designed parking area with an appropriate traffic movement-friendly layout (Morrow, 2020). According to Abdullah et al. (2012), they offered three different layout options: parallel parking, perpendicular parking, and diagonal parking, also referred to as angle parking. To make sense of the three primary designs, parallel parking is the practice of parking a row of cars in front of or behind another vehicle. This parking is usually seen in structures and parking lots next to the road. Vehicles are parked side by side at a 90-degree angle in perpendicular parking, while diagonal parking involves cars parked at an acute angle to the aisle based on the approach direction.

Kementerian Kesejahteraan Bandar, Perumahan dan Kerajaan Tempatan Malaysia stated that parking lots can be planned with various parking angles which consist of 0°, 30°, 45°, 60°, and 90°. The angle of parking space plays a significant role in the optimization of parking lot circulation and space capacity of the parking (Prasath & Ahmed, 2021). Table 1 shows the standard dimensions for the parking lot with different angles.

Table 1: Dimension for standard parking area

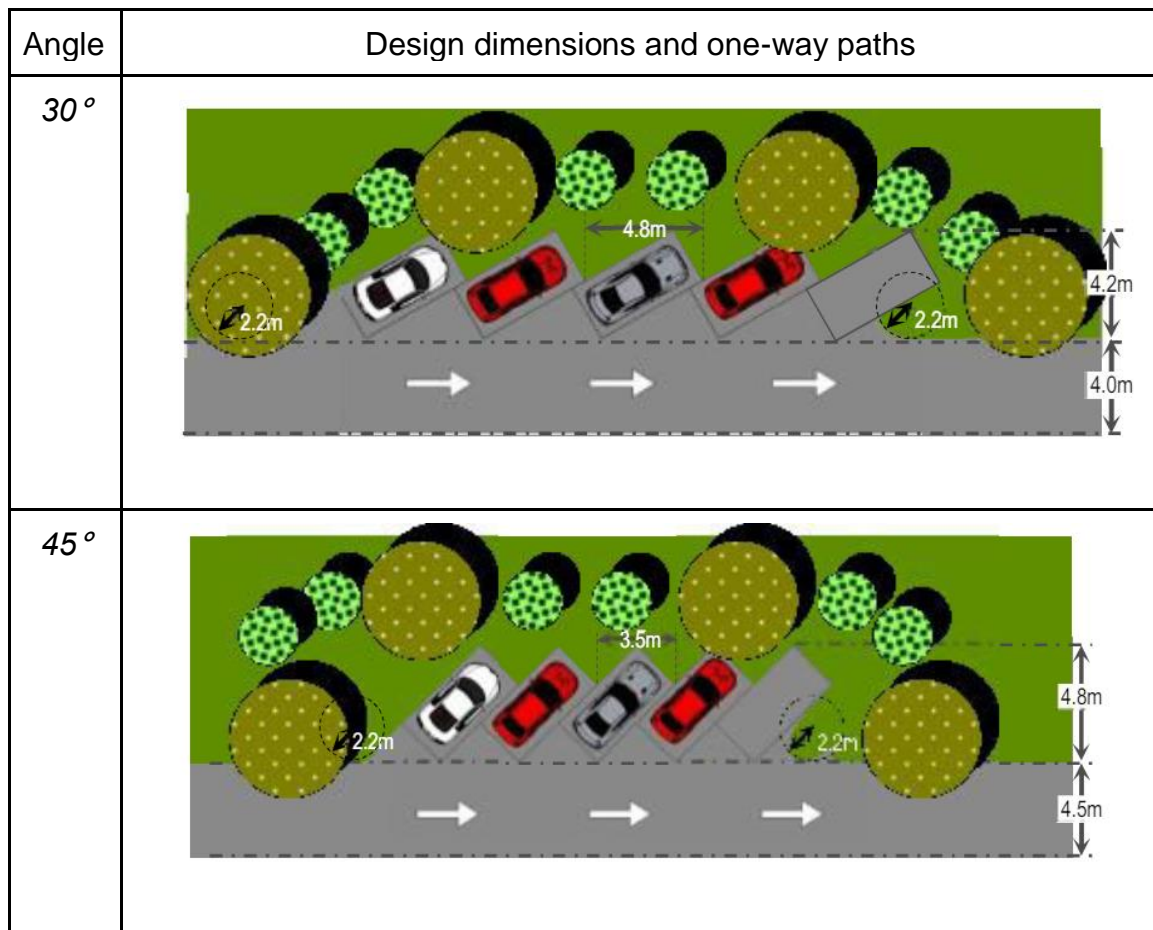
Parking Angle (°)	Width (ft)	Length (ft)	Lane Width (ft)
0	8.2	19.7	13.1
30	13.8	15.7	13.1
45	15.7	11.4	14.8
60	18	9.8	15.7
90	15.7	8.2	19.7

Moreover, as stated in the 2018 Parking Planning Guidelines, the design of the parking lot the design of the parking lot should prioritize safety for both users and physical structures. To make sure mishaps, theft, property damage, and traffic jams are minimized, researchers carefully considered space design, environmental impact, and strategic vehicle placement. Types of vehicles such as passenger cars,

The suggestion is obtained according to Bingle et al. (1987) in the Designing the Optimal Placement of Spaces in a Parking Lot (Mohd Sidek et al., 2023). This figure, we can come out with three pieces of information that can be considered:

- i. $\angle bce = \theta, \angle aec = 90, \angle cae = 90 - \theta$
- ii. \overline{dg} is parallel to \overline{lh}
- iii. $\overline{lh} = W$, hence, $\overline{ae} = R - W$ and $\overline{be} = D$

To accomplish our objective, this study employed two parking lot designs: diagonal (angle) parking and perpendicular parking, to optimize the best parking layout at Pizza/KFC outlets at Seremban 2, Negeri Sembilan and use the measurements that have been standardised. Dimensions of parking spaces in 2018 for each parking angle are shown in Figure 1 in detail.



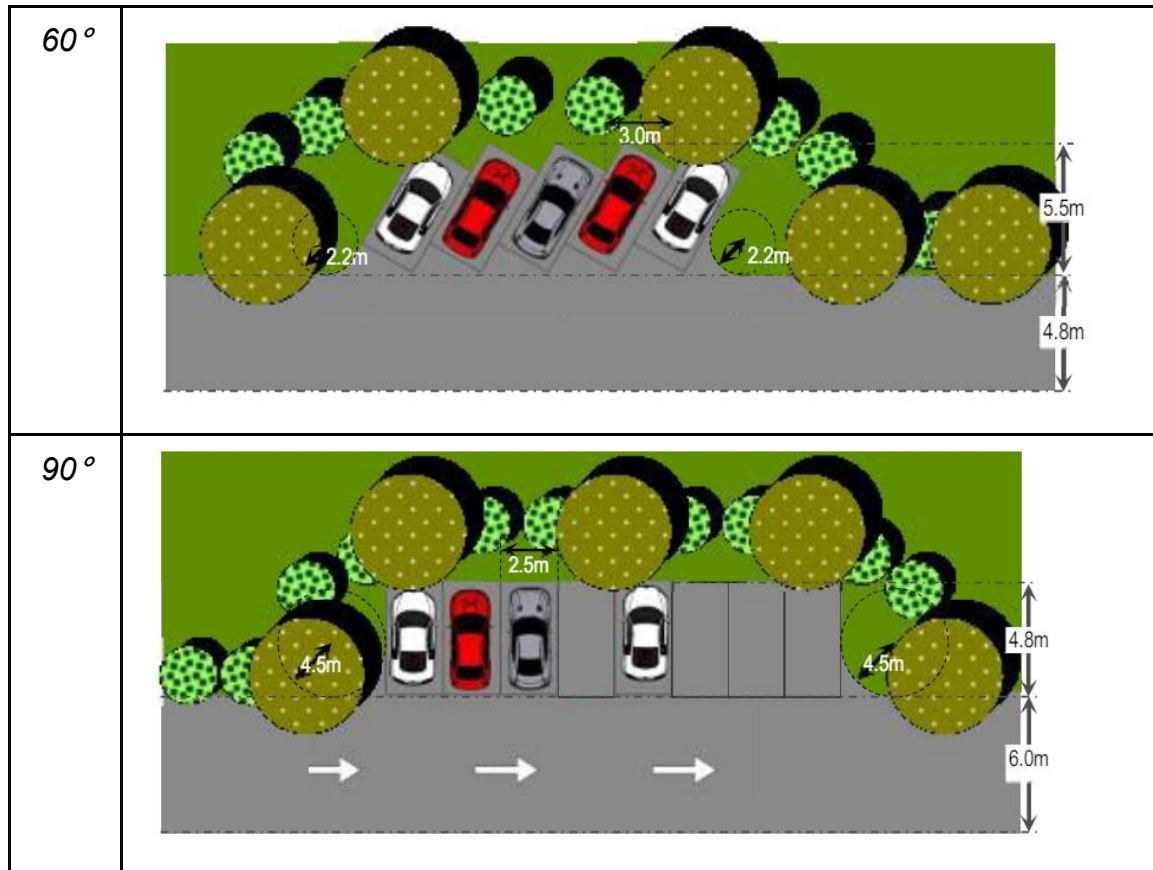


Figure 2: Dimensions of parking spaces in 2018

According to the previous research done by Bingle et al. (1987), the focus of the study involves creating the most effective layout for parking lot spaces, with considerations including access lane width, R , parking space length, L , parking space width, W , and parking space angle, θ (Mohd Sidek et al., 2023). The formula for determining the area, A , taken up by a vehicle at any angle is as follows:

$$A(\theta) = W[L + R \cos \theta + (2W - R) \cot(\theta)] \quad (1)$$

In our research, we will explore the application of the parallelogram concept to find out the car's occupied area. Hence, this study can calculate the number of parking lots using the equation:

$$\text{The number of parking space} = \frac{\text{Total area}}{\text{Area taken up by a vehicle}} \quad (2)$$

In this research, researchers use the same data that have been provided in the previous article including the width, length, and area of the place, while the angle of the parking lot was obtained from Kinovea Software by capturing a picture. The collected information includes:

Table 2: Data Collection from KFC's manager

Information	Value
Total area of Pizza/KFC building (ft^2)	10,090.3
Total area of parking space (ft^2) <ul style="list-style-type: none"> • 24 spaces → standards vehicle • 2 spaces → disable people 	3970.9
Length of parking space (ft), L	16
Width of parking space (ft), W	8
Angle of parking space, ($^\circ$)	40 $^\circ$
Access lane width, R	35.8

Step 1: This study initially identified which measurement we needed to utilize before beginning our calculation.

Table 3: Standard Measurement

Parking Angle ($^\circ$)	Width (ft)		Length (ft)		Lane Width (ft)	
	2018	2014	2018	2014	2018	2014
0	8.2	8	19.7	24	13.1	36
30	13.8	9	15.7	16	13.1	28
45	15.7	9	11.4	19	14.8	34
60	18	9	9.8	21	15.7	39
90	15.7	9	8.2	18	19.7	42

Step 2: This research needs to calculate the total area of parking spaces occupied by a car for every angle using Equation (1) and the number of parking spaces acquired in Equation (2). We are using the 2018 standard measurement for these calculations to compare it to the 2014 standard measurement and the original measurement. This will help us optimize the parking layout at Pizza/KFC outlets in Seremban 2, Negeri Sembilan.

Table 4: Used standard measurement 2018

Standard Measurement 2018				
Parking angle ($^\circ$)	30	45	60	90
Length (ft) (L)	15.7	11.5	9.8	8.2
Width (ft) (W)	13.8	15.7	18	15.7
Lane width (ft) (R)	13.1	14.8	15.7	19.7
Area parking lot (ft^2)	924.8	769.8	713.7	438.0
Number of parking spaces	11	13	14	23

This is the number of parking spaces from the previous study using the original measurement and standard measurement 2014:

Table 5: Original measurement

Original Measurement				
Parking angle (°)	30	45	60	90
Length (ft) (L)	16	16	16	16
Width (ft) (W)	8	8	8	8
Lane width (R) (ft)	35.8	35.8	35.8	35.8
Area parking lot (ft ²)	426.44	374.63	367.25	414.4
Number of parking spaces	23	26	27	24

Table 6: Used standard measurement 2014

Standard Measurement 2014				
Parking angle (°)	30	45	60	90
Length (ft) (L)	16.83	19.8	21	18
Width (ft) (W)	9	9	9	9
Lane width (R) (ft)	28.83	34.83	39	42
Area parking lot (ft ²)	501.59	470.31	485.18	540
Number of parking spaces	20	21	20	18

4.0 RESULTS

From that, researchers can summarize the total number of parking spaces using 3 measurements:

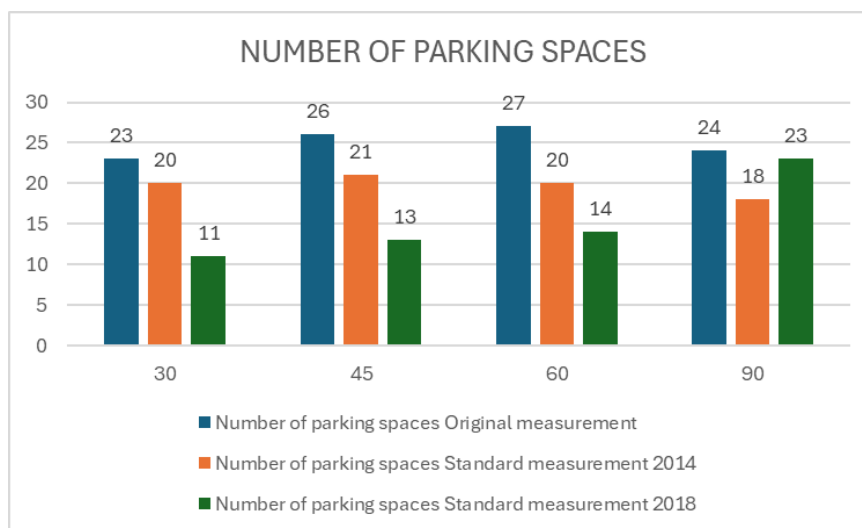


Figure 3: Total number of parking spaces using 3 measurements:

This study discovered that the current parking at Pizza/KFC outlets in Seremban 2, Negeri Sembilan have 26 parking spaces. Based on Table 4, researchers know that by using the original measurement the angle of 60 degrees gets the highest number of parking lots. However, according to our objective, we focus on the requirements outlined in parking requirements that are stated in the Kementerian Kesejahteraan Bandar, Perumahan dan Kerajaan Tempatan Malaysia including ensuring that parking spaces are comfortable and spacious, particularly for the disabled. Next, they are easily accessible with strategic entry and exit routes placed within a convenient distance for all users. Additionally, the design should prioritize safety for both users and vehicles, incorporating features that minimize the risk of accidents, theft, property damage, and congestion.

Therefore, based on comparing these three measurements, we chose an angle of 90 degrees that would be suitable for accommodating 23 parking lots according to standard measurements in 2018. A perpendicular design parking lot is a more suitable design than a diagonal (corner) parking lot. Even though this method resulted in fewer parking lots than the current standard, this study prioritized user safety and the dimensions of modern-day vehicles.

5.0 CONCLUSION

According to this study, researchers have learned that the dimensions of the parking corner lane significantly impact the comfort and safety of the parking space. This study shows that when optimizing parking lots, factors like parking space angles, widths, lengths, and access lane widths lead to significantly varied results. Based on the calculation, a perpendicular design parking lot is a more suitable design than a diagonal (corner) parking lot. Hence, using mathematical models will indirectly give a little contribution to employees, managers and customers in maintaining personal safety and easy to enter and exit the parking lots. This useful mathematical approach may be applied to reduce parking lot issues in limited areas. Then, parking at Pizza/KFC outlets in Seremban 2, Negeri Sembilan should be modified using the standard measurement 2018 to optimize the best parking layout at Pizza/KFC outlets at Seremban 2, Negeri Sembilan.