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MATHEMATICS LETTERS
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Optimizing Parking Space: Strategies For Urban Fast-Food Establishments

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Received: 17/10/2026 Revised: 21/10/2026 Accepted: 25/10/2026 Published: 31/10/2026

ABSTRACT

The KFC/Pizza location at Seremban 2, Negeri Sembilan, is the subject of this research, which optimizes parking lot layouts for fast-food restaurants in urban neighbourhoods. Particularly during peak hours, the increasing need for efficient parking leads to issues like wasted space, traffic jams, and disgruntled customers. The goal of this research is to determine the best parking angle design to maximize vehicle capacity and reduce unnecessary space while preserving easy implementation and seamless traffic flow. Using mathematical modelling and general techniques, the research evaluates five common parking angles (30°, 45°, 60°, 90°, and 180°) in compliance with national parking design guides. The simulations and layout images were made with Microsoft Visio, and they were validated using Maple. According to the findings, the 60° angled design works best, resulting in 39 parking spaces (26 double-sided parking spaces and 13 single-sided parking spaces) with little dead space and a 4.8m lane width. This configuration strikes the optimal blend of use, practicality, and space efficiency without requiring large structural alterations. The research achieves the project's objectives of reducing space inefficiencies and maximizing parking capacity. Future parking improvements in similarly constrained commercial contexts might be guided by this model.

Keywords: Double-sided parking, Fast-food establishment, Mathematical modeling, Off-street parking, Parking lot design, Space optimization.

INTRODUCTION

Urban transit systems rely heavily on off-street parking infrastructure, which serves as a crucial link between vehicular movement and commercial activities. With rising private vehicle ownership, business establishments in dense commercial areas—particularly high-turnover fast-food outlets—face persistent challenges with parking availability, severe space wastage, and localized traffic bottlenecks during peak operational hours. The joint KFC and Pizza Hut establishment located in Seremban 2, Negeri Sembilan, Malaysia, illustrates these operational difficulties (Zafirah et al., 2023). Due to an inefficient parking layout, the site struggles to accommodate customer demand during lunch, dinner, and weekend rush periods, leading to entry and exit traffic jams, extended search times for empty bays,

and heightened customer dissatisfaction.

To address space inefficiencies in land-constrained commercial settings without expanding physical infrastructure, mathematical optimization provides a robust, non-invasive, and cost-effective approach (Huang et al., 2020). While off-street parking research explores various stall orientations—including parallel (180^o), perpendicular (90^o), and angled configurations (30^o, 45^o, and 60^o)—real-world commercial implementations often lack rigorous algorithmic design that balances site geometry with vehicle maneuverability and municipal standards (Khanna et al., 2016). Standard planning guidelines, such as those prescribed by the Kuala Lumpur City Hall (DBKL), (2018), specify fixed stall dimensions (2.5m x 4.8m) and variable access lane widths (4.0m to 6.0m) based on the parking angle (Department of Urban and Rural Planning (PLANMalaysia), 2018).

Successfully integrating these national standards within fixed site boundaries requires systematic geometric computation (Huang et al., 2020). The research conducted by Babushkina et al. (2021) served as the design. It integrated government standards into its entire research as part of the industry standard for the parking design process. The article focuses on the design desk, which must meet certain basic specifications that specify the parking lots' measurements and amenities. It also includes a specific measurement for regular vehicles and a designated place for People with Limited Mobility (PLMs). According to the research, optimization models help balance compliance with government criteria with practical designs.

The research by Liu et al. (2021) focuses on upgrading the parking space optimization technique from the conventional Dijkstra algorithm to an enhanced Dijkstra algorithm. By employing latitude and longitude data to determine the distance between automobiles and all available parking spaces, the system aims to streamline the procedure. Although this enhancement of Dijkstra's algorithm offers significant benefits regarding parking space management optimization, its success necessitates striking a balance between cost and data accuracy since it depends on intelligent infrastructure and real-time data upkeep.

While an ADMM-based distributed algorithm balancing the parking demand and costs across lots was suggested by Kim et al. (2020), the method is chiefly limited by static quotas and predetermined costs; thus, these limitations render it less fit in dynamic urban conditions. In contrast, this study attempts to push parking optimization toward real-time factors, including changeable geometric arrangements (e.g., adaptive parking angles).

The primary motivation of this study is to establish an optimal, space-efficient parking lot design for the KFC/Pizza Hut Seremban 2 premises using a geometric optimization model and layout algorithm (Huang et al., 2020; Zafirah et al., 2023). By evaluating both double-sided and single-sided parking arrangements across five standard orientation angles (30^o, 45^o, 60^o, 90^o and 180^o), this research aims to identify the configuration that maximizes total vehicle capacity while eliminating dead space between parking bays and driveways. The research directly addresses key operational questions regarding optimal stall spacing, access road dimensions, and one-way vehicular traffic flow to alleviate queueing congestion.

This study is focused strictly on the paved ground parking area of the KFC/Pizza Hut outlet in Seremban

2 within its existing site footprint. The model assumes regular private automobiles, excluding heavy vehicles such as trucks and buses, and assumes full driver compliance with parking norms and one-way routing. Mathematical formulations and capacity computations are verified using Maple, while visual blueprint layouts and flow diagrams are generated via Microsoft Visio (Huang et al., 2020). The resulting optimization model offers a practical, low-cost solution for the KFC/Pizza Hut site while providing an adaptable template for other commercial establishments operating under tight spatial constraints.

METHODOLOGY

Data Collection

The data that was utilized in this research was taken from a previous study (Zafirah et al., 2023). A car's design is influenced by a number of components, including the road lane width (G), parking space length (L), parking space width (W), and parking space angle (θ). The gathered information is presented in Table 1.

Table 1

Data Collection for KFC/Pizza Outlets Premises

Information	Value
Total area of KFC/Pizza building (m^2)	3075.52344
Total area for parking lot spaces (m^2)	1210.33032 (24 spaces for standard cars, 2 spaces for disabled)
Length of parking space (m), L	4.8768
Width of parking space (m), W	2.4384
The total length of the parking spaces (m), Ls	41.6709

Table 1 shows the original data for the design of the parking area at the KFC/Pizza premises, comprising the total building site area (3075.52 m^2) and the parking area (1210.33 m^2) with 26 spots (24 regular, 2 disabled). Each area is 4.8768m long by 2.4384m wide, with a parking angle of 40° and a traffic lane width of 10.91m. This data was acquired from Zafirah et al. (2023) research and utilized to optimize parking design.

Analysis of Double-Sided Parking Layout

Double-sided parking is a frequent arrangement where parking spaces are placed on both sides of the roadway. Let G be the width of the traffic lane, Hs be the width of the space occupied by the layout, Nc be the maximum number of parking compartments that can be given in the layout, L be the length of the parking lot, W be the width of the parking space, and θ be the angle between the parking strip and the straight line.

Values for h1 and h2 must be obtained using the following formula to obtain the Hs value, where h1 =

L sin θ and h2 = W cos θ. From the geometric relationships, Hs is given by Equation 1:

$$Hs = G + 2(h1 + h2) \quad (1)$$

The following formula may be used to determine the number of Nc parking spaces, once the entire length of Ls is known, as Equation 2:

$$Nc = 2 \cdot [(Ls - l - ((Ls - l) \% Lr)) / Lr] \quad (2)$$

This formula uses the modulus operator (%) to determine how many parking spaces (Nc) can fit along the whole length (Ls) of the space, taking into consideration the space used by a car along the border (Lr) and any excess space that remains. The expressions for l and Lr are as follows, Equation 3 and Equation 4:

$$l = (L - Lr \cos \theta) \cos \theta \quad (3)$$

$$Lr = W / \sin \theta \quad (4)$$

The final expression for double-sided parking capacity Nc is obtained by combining the formulation in Equation 5:

$$Nc = 2 \cdot ([Ls - (L - W \cos \theta / \sin \theta) \cos \theta] / (W / \sin \theta)) \quad (5)$$

Analysis of Single-Sided Parking Layout

A single-sided parking space in a path is referred to as the parking lane layout. There isn't an area on the other side due to space limitations. This arrangement is used as a supplement to the remaining area. The overall width Hs1 and capacity Nc1 for single-sided parking are expressed in Equation 6 and Equation 7:

$$Hs1 = G + h1 + h2 \quad (6)$$

$$Nc1 = ([Ls - (L - W \cos \theta / \sin \theta) \cos \theta] / (W / \sin \theta)) \quad (7)$$

Compliance with National Standards

The prior KFC/Pizza research did not employ standard municipal parking guidelines. This research makes use of the 2018 measurements and designs from the Ministry of Housing and Local Government and Kuala Lumpur City Hall (DBKL) Infrastructure guidelines as shown in Table 2.

Table 2

Dimension for Standard Parking Space

Parking Angle, θ	Width of Traffic Lane (m), G	Width (m), W	Length (m), L
180°	4.0	2.5	6.0
30°	4.0	2.5	4.8
45°	4.5	2.5	4.8
60°	4.8	2.5	4.8
90°	6.0	2.5	4.8

Table 2 displays the average size of a parking space, categorized by various parking angles. While the bay width is kept at 2.5m, the length and traffic lane widths vary according to the angle. Angled parking (30°, 45°, 60°, and 90°) requires 4.8m space length, with varying access lane widths to ensure safe and easy maneuvers.

RESULT AND DISCUSSION

A quantitative comparison of the five parking angles based on standard layout parameters and mathematical computations is summarized in Table 3.

Table 3

Result of the Number of Parking Spaces for Double-Sided and Single-Sided Parking for Each Angle

Angle, θ	Length, L (m)	Width, W (m)	Access Lane, G (m)	Double-Sided (Nc)	Single-Sided (Nc1)	Total Parking Spaces
30°	4.8	2.5	4.0	16	8	24
45°	4.8	2.5	4.5	22	11	33
60°	4.8	2.5	4.8	26	13	39
90°	4.8	2.5	6.0	32	16	48
180°	6.0	2.5	4.0	12	6	18

As shown in Table 3, capacity varies significantly across parking angles. The 180° parallel layout yields the lowest capacity (18 spaces), while 30° generates 24 spaces and 45° yields 33 spaces. Although 90° theoretically yields the highest count (48 spaces), it requires a 6.0m access lane, which compromises driving maneuverability in tight commercial compounds. The 60° angle generates 39 spaces with a 4.8m road width, offering the most balanced and practical arrangement.

The 30° angle arrangement yields 24 parking spaces (16 double-sided, 8 single-sided). While it requires a narrow 4.0m access lane that makes entry effortless, its overall capacity is insufficient for a high-turnover fast-food establishment. The 45° layout produces 33 spaces (22 double-sided, 11 single-sided) with a 4.5m lane width. This angle provides smooth diagonal entry and decent capacity, but falls short of maximizing the site's potential compared to 60°. The 60° parking layout produces 39 parking spaces

(26 double-sided, 13 single-sided) alongside dedicated accessible bays. Requiring a 4.8m access lane, this layout provides efficient one-way traffic circulation, easy vehicle entry and exit, and minimal unused dead space, making it the most optimal solution for the KFC/Pizza Seremban 2 site. The 90° perpendicular layout generates 48 spaces (32 double-sided, 16 single-sided). However, it demands a wide 6.0m driving lane and wider turning radii, which increases congestion and difficulty during parking maneuvers in constrained spaces. The 180° parallel parking layout produces only 18 spaces (12 double-sided, 6 single-sided). This configuration is the least space-efficient and is unsuitable for commercial fast-food parking lots.

CONCLUSION

Among the five evaluated angles (30°, 45°, 60°, 90°, and 180°), the 60° parking angle configuration was identified as the optimal layout. It achieves 39 parking spaces (26 double-sided and 13 single-sided) with a 4.8m traffic lane, effectively expanding capacity from the original 20-26 spots to 39 spots while maintaining smooth vehicle mobility. The vehicle capacity was maximized substantially within the existing physical site boundaries, and unused dead space between parking bays and driveways was minimized through geometric optimization and proper angle alignment. Implementing the 60° angled parking layout offers immediate practical benefits, including reduced traffic congestion, enhanced customer convenience, streamlined one-way flow, and low implementation costs without requiring major structural or property changes.

ACKNOWLEDGEMENT

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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