

The Study of Hybrid Parking System

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Abstract: With the number of vehicles registered is continuously increasing in nowadays, almost of the country in the world used car as the dominant mode of transportation, thus affecting to the traffic flows and limitation for parking lots in every city and suburban area. Therefore, provision of quality services is the one of problem solving for parking facilities and management, since the parking system plays an important role in controlling the traffic flow. This study aims to assess the level of satisfaction among the public and users of parking facilities and services in Kuala Terengganu. Specifically, it focuses on aspects of frequency of using the facility, instruction signs, capacity and payment of parking facilities services. To test the hypothesis the use of automated systems in parking facilities is getting higher intention from users, an online survey of questionnaire was distributed to assess the level of satisfaction among the public and parking users in Kuala Terengganu. At the end of the analysis show most of respondent with 74.0 % were agreed to select the horizontal system with automated movement in multi-storey parking facilities as a new parking facility to be establish. This system known as the hybrid parking system which has achieving the same result as hypothesis study based on the recommendation from the respondents. On this study, the assessment of level satisfaction among the user play an important role in development of facility in public area. Therefore, we can overcome the problems occur in the future, and help to improve the existing parking system in Kuala Terengganu.

Keywords: Quality Services, Parking Facilities, Satisfaction

1. Introduction

In this study, Kuala Terengganu is selected to measure the service quality of parking facilities and user satisfaction. A parking lot, or also known as a car park, is a cleared space that is intended for parking vehicle. As a service product, common parking service rendered to building or lands includes parking revenue collection, parking management, provide customer service, management of traffic, development of parking equipment and technology, maintenance of parking facilities and provide safety and security elements with the parking facilities. However, the uses of car as the dominant mode for transportation and affecting to the parking lots as the features in every city and suburban area. Due to

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the increasing of the number vehicles and traffic congestion causes the flow for parking rates. Therefore, a total of RM575,143 was collected in August 2020 while the remaining RM184,398 in traffic summonses payment was recorded in September.

Traffic congestion is a condition on transport that is characteristic by slower speeds, longer trip times, and increased vehicular queueing. Malaysian public dissatisfied and complaint on how service quality has been demonstrated in parking facilities. The efficient evaluation of a parking facility performance is important to parking service planning, design and operation. This study is carried out to examine whether the original dimension of service quality including the security and safety in service quality dimensions is relevant to customer satisfaction for parking services, which located in Kuala Terengganu, as shown in Figure 1, and to recommend the most appropriate design facility of hybrid parking system model with horizontal circulation movement [1][2].

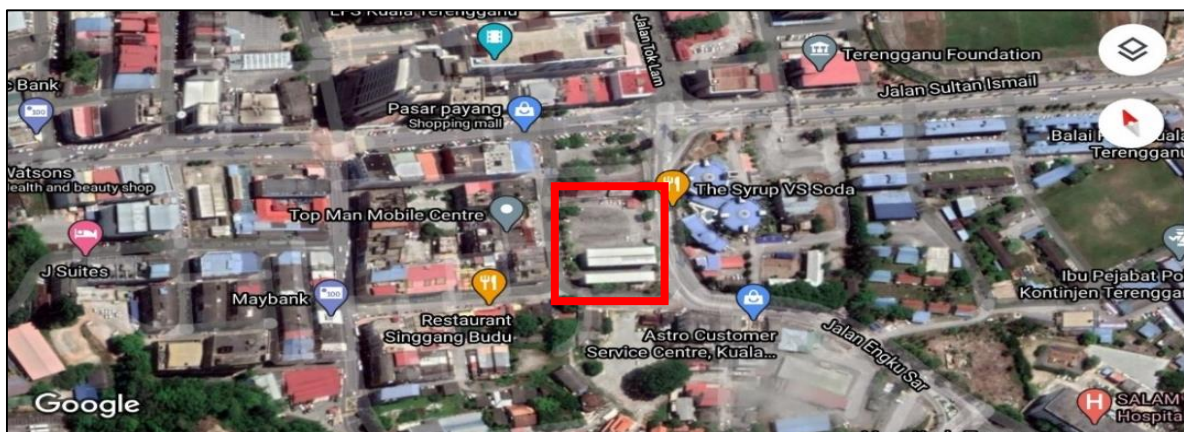


Figure 1: Proposed area for establish the new hybrid parking system in Kuala Terengganu

1.1 Parking facilities

There are 4 types of parking facilities that have been discussed in this study, which are open parking space, street parking, underground and multi storey. These different types of parking have their own characteristic that distinguish it from others even though they have the same function which to provide the parking lots for people to park their car in the right place. As the public property for open parking space and its free payment for the user, the level of security for the car is under responsible of the owners and the parking don't have any specific time to use it, so people can park the car at any time except when the parking space is full. [3]. For the street parking has divided into two categories which are on-street parking and off-street parking. Both of these types can park the vehicle on one side of the street, the different is on-street parking has provided the parking permit as the payment and off-street parking is a free to use [4]. Therefore, government has provide the use of on-street parking than off-street parking.

Next, underground parking is structured below the ground level, whether it can be multiple level or only one level provided, it doesn't not affects for traffic flow or expose for the pedestrian risk because it is only for parking use [5]. Lastly, multi-storey parking also can be considered as parking garage but the different is it can be two or more levels in one building or structure. Multilevel car park is design specifically limited to 5 to 6 stories with the total capacity up to 500 cars per lot [6]

Nowadays in certain country, many of parking system has redesign into an automated system using the rotary parking and mechanical system with applied the of IR 4.0 technology such as RFID components, wireless sensor network and Internet of Things (IoT). These combinations of technologies can help the drivers find the empty space easily and control the management system in parking facilities. Therefore, all of these four types facilities with their own characteristic has been shown in Table 1 below.

Table 1: Characteristic of each parking facilities

Features	Open parking space	Street parking	Underground parking	Parking garage
Capacity	Unlimited, (<i>based on the space area provided</i>)	Limited (<i>only in one line at the roadside</i>)	One-level - 150 cars Multilevel -300cars	Multilevel 250 – 400 cars (<i>based on number floor</i>)
Traffic flow	Bad	Bad	Very good	Good
Security	Very bad (<i>no parking guard incharge</i>)	Very bad (<i>no parking guard incharge</i>)	Very good	Single level: Low Multilevel: High
Time to use it	Medium	Bad (<i>one-way lanes</i>)	Good (<i>use ramps</i>)	Good (<i>automated system</i>)
Environment effect	Bad (<i>CO2 & gas emission from the car</i>)	Bad (<i>CO2 & gas emission from the car</i>)	Good (<i>exhaust fan to control and eliminate odors & circulate air</i>)	Medium
Technology applied	No	No	- RFID - Wireless Sensor Network	-RFID -Wireless Sensor Network - (IoT)

1.2 Facility management

Facility management is relevant for an organization whether in the public or private sector. A facility management system can improve the quality of services, provides safety, and enhances the health and comforts of occupants through efficient documentation and management of facilities or infrastructures [7]. The outcome of facility management is lower operating cost by efficient utilization of facilities, detecting risk, and failure that helps in preventing costly repair, rehabilitation work; thus, its lower life cycle cost [8].

1.3 Customer Satisfaction

Customer satisfaction is defined as a measurement that determined how happy customers are with a company's product, services and capabilities. For this study, the customers consist of parking users and the publics located in Kuala Terengganu, has joined this survey, including the rating to recommend the most suitable parking facilities that need to be establish in the future, can help the researcher determine how to improve or make changes by proposing a new design for the facilities and services. Therefore, customer satisfaction should be considered a vital component of any business or services because it provides crucial information to understand what aspects are successful and where improvements need to be made [9].

2. Methodology

Research methodology is a systematic way to solve a problem and to achieve the objectives of this study. This study was conducted to find out the truth which is hidden and gather from the public views on the problem that often occur at parking facility in order to assess the user satisfaction on facilities and service provided at Kuala Terengganu thus, to improve the existing parking system. Starting from the problem identification by observation at case study to identify problem that occur in the parking facilities. When all of the data were collected, a questionnaire was conducted to assess the level of satisfaction among the users and public of services quality and facility management for existing parking system in Kuala Terengganu. The procedure of research in case study is shown in Figure 2.

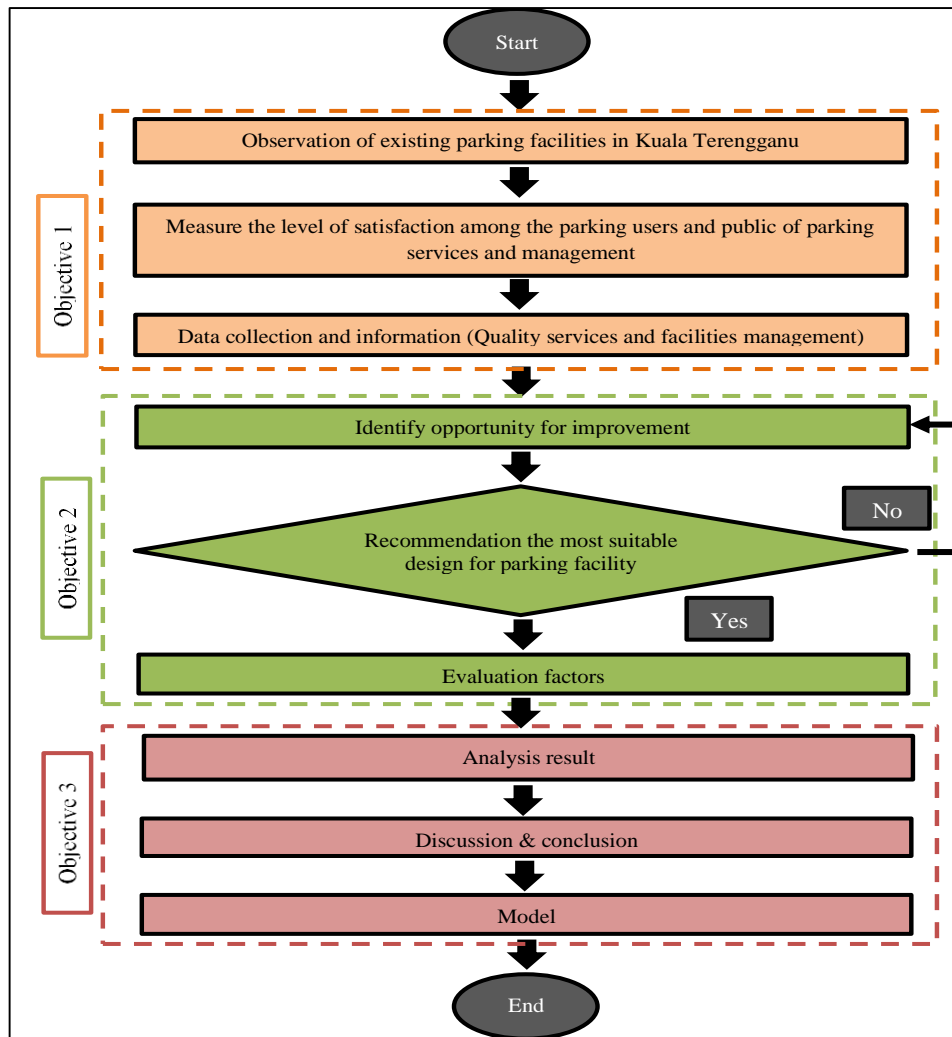


Figure 2: Flowchart of case study

2.1 Questionnaire survey

There are only 47 respondents are targeted to answer the questions via online survey on the website give. From this survey, the parking users and public has to determine the level of their satisfaction on services quality and facilities management of existing parking facilities in Kuala Terengganu.

There four parts of question of the questionnaire distributes, and the respondents need to answer all of question given, which are:

- i. Part A: Frequency of using the parking facilities.
- ii. Part B: Level of satisfied on the services quality of existing facilities.

- iii. Part C: Recommendation for the most suitable parking facilities in Kuala Terengganu.
- iv. Part D: Recommendation the most appropriate system for multi-story parking facilities.

2.2 Data analysis

Data collected through the questionnaire is quantitative data, which is using descriptive statistic to get the mean and standard deviation in order to meet the objective that have been set. Using Likert scale, respondents were given the opportunity to indicate the level of quality services and facility management based on the experiences, perceptions and opinions. The following are the distribution of descriptive value min used in Table 2.

Table 2: A descriptive table mean score modified from table Landell

Min Scores	The Level of Learning
1.00 – 2.33	Low or Weak (no, disagree, not clean, improper, inappropriate, irresponsible)
2.34 – 3.679	Medium (less frequently, less exuberant, less secure, less organized, less encourage, less comfortable, less fit, less responsible)
3.68 – 5.00	Higher or good (often, agree, secure, adequate, appropriate, clear, responsible)

3. Results and Discussion

Statistical analysis was conducted based on the two main objectives in this study, which is first stage is to identify the level of satisfaction among the users of parking facilities and services quality in Kuala Terengganu, and the second stage is to recommend the most appropriate system to improve the user's satisfaction on parking facilities and services. There are 47 of respondents were answered this survey which located at Kuala Terengganu. To achieved these objectives, an observation was conducted to identify the main problem happened at existing parking facilities in Kuala Terengganu before collecting the data from the user by questionnaire and online survey. There are six main questions in the survey and the respondents need to answer all of the questions given.

3.1 Percentage of using parking facility

Started with Part A as shown in the Table 3, the highest percentages of using the parking facilities is open parking space with 43.00 %, compared to multi-storey parking with no record of respondent use it. This is because there are many open parking areas are provided in Kuala Terengganu, and the multi-storey parking only provided at one place with limited space. Therefore, in certain time especially during the peak hours, a few problems occur related to the traffic flow near the parking lots because at that time, people are rushing to find the available space to park the car.

Table 3: The percentage of facility use among the users

	Frequency	Percentage (%)	Cumulative Percentage (%)
Open Space Parking	20	43	43
Street Parking	10	21	64
Underground	17	36	100
Multi-Storey Parking	0	0	100
Total	47	100%	

3.2 Services quality for existing parking facility

Followed with Part B, the answers must be related to the answer in Part A. For the average mean value of service facilities on existing parking system in Kuala Terengganu is recorded 2.97 which can classified as medium or less dissatisfied with the service quality because most of the service are in manual system, and the users need some effort to used it. For example, when looking the available free parking space, the facilities are not required the automated system to inform the parking user, where the empty spot, and they spent much time for that. This issue can be the one of the factors influence the assessment from the parking users.

Table 4: Services facility for existing parking system

No	Question	Mean	Std. Deviation
1.	Parking signboard at main road	3.02	0.103
2.	Instruction for using parking space	3.13	0.120
3.	Safety & Security of the vehicle	3.02	0.127
4.	Capacity parking space	3.04	0.149
5.	Electronic Service fee	2.77	0.193
6.	Cash Service fee	3.53	0.152
7.	Notification for available parking space	2.81	0.179
8.	Distance with other facilities	3.23	0.147
9.	Online booking for parking space	2.47	0.182
10.	Emergency bell in parking facility	2.66	0.188
	Total	2.97	0.154

3.3 Maintenance services of parking facility

For the maintenance of existing parking system in Kuala Terengganu can be categorized as preventive maintenance because open spaces, underground and street parking, are not require frequent maintenance because it does not have applied more automatic system. Besides, multi-storey parking which provide automatic and mechanical movement, it requires more maintenance work in a month to prevent damage from occurring in that facilities. Table 5 below shows the maintenance of facilities with the average mean value of 2.98, considered as less satisfied from the users.

Table 5: Maintenance of Facilities

No	Question	Mean	Std. Deviation
1.	Automatic system	2.72	1.136
2.	Maintenance of facilities	3.23	0.937
	Total	2.98	1.037

3.4 Time using the facility

Table 6 shows the average of mean value is 3.24 which means the respondent less satisfied with the time management at existing parking facility. The time management can be considered as the time for searching empty space, time in and out from the facility, waiting time to park the car and others as stated in Table 6 below.

Table 6: Time management

No.	Question	Mean	Std. Deviation
1.	Time for searching empty space	3.23	1.005
2.	Time in/out from facility	3.28	0.902
3.	Notice of operation	3.11	0.890
4.	Term of notification for parking facility	3.23	0.983

5. Decrease of waiting time	3.36	0.754
Total	3.24	0.907

3.5 Recommendation of suitable parking facility in Kuala Terengganu

Part C has discussed the recommendation from the user which facility is suitable to be established in Kuala Terengganu. From the Table 7, multi-storey parking was recorded the highest percentage of 47.00 % from the users, as we know the multi-storey has provided the automatic system which can help the drivers with the better services.

Table 7: Recommendation for new parking facility in Kuala Terengganu

	Frequency	Percentage (%)	Cumulative Percentage (%)
Open Space Parking	12	26	26
Street Parking	2	4	30
Underground	11	23	53
Multi-Storey Parking	22	47	100
Total	47	100	

3.6 Recommendation for the most suitable system in multi-storey parking facility

As the most of the respondents were chosen the multi-storey is more suitable to build in Kuala Terengganu, there are two types of multi storey are provided, which are in vertical system and horizontal system, and the users need to choose one system the most suitable based on its characteristic. Table 8 shows the result of the selection and horizontal system was recorded the higher percentage with 74.00 % chose this system compared with vertical system.

Table 8: Multi-storey parking infrastructure selection

	Frequency	Percentage (%)	Cumulative Percentage (%)
Vertical System	12	26	26
Horizontal System	35	74	100
Total	47	100%	

Based on the selection in Table 9 below, the average of mean value for the characteristic of multi-storey parking is 1.67, which the value in between 1.0-2.0, meaning most of the respondent agreed to choose the horizontal system to be establish in Kuala Terengganu

Table 9: Characteristic of multi-storey parking

No	Question	Mean	Std. Deviation
1.	Strong Infrastructure & not easily collapsed	1.85	0.360
2.	Low pressure to earth crust	1.94	0.036
3.	High capacity of car	1.51	0.074
4.	High level of security	1.74	0.064
5.	No collision between cars	1.36	0.071
6.	System is more organized	1.62	0.072
7.	Low waiting time for enter/out from facility	1.68	0.069
8.	Less traffic congestion	1.53	0.075
	Total	1.65	0.103

4. Recommendation

Based on the result in the Table 8 above, a new hybrid parking system has been designed to meet the user request as shown in Figure 3. The idea of hybrid parking system is from combination of technology automatic system with rotary parking by horizontal movements is functions to improve the quality services and facility management, and also help the users to minimize the time when using the parking facility and reduce the traffic congestions and road accidents near the facility.

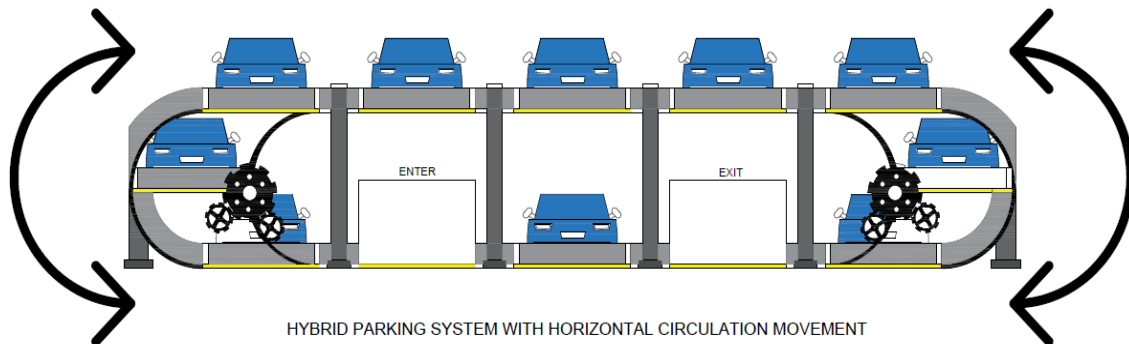


Figure 3: Sketch for hybrid parking system with horizontal circulation movement

Based on the result in the selection of suitable system that need to be applied in multi-storey parking facility, a working model is developed to support the hypothesis of horizontal system is the most suitable to be establish in Kuala Terengganu. Horizontal infrastructure is the most appropriate structure because it has less effect on the earth's crust compared with vertical system that can be high parking building which need to support more than 10 cars at the same time in long term. It may be quite dangerous to the users and public nearby.

Figure 4(a), 4(b) and 4(c) show the working model with different elevation. The working model which known as hybrid parking system required the driver to parks their car at the ground level at the required place. After the driver left the car, the system automatically moves the car to the next place by mechanical system. the circulation movement can be move in clockwise and anticlockwise, so the driver no need to wait in long time to take out their car from the facility because the system can move in both circulations.

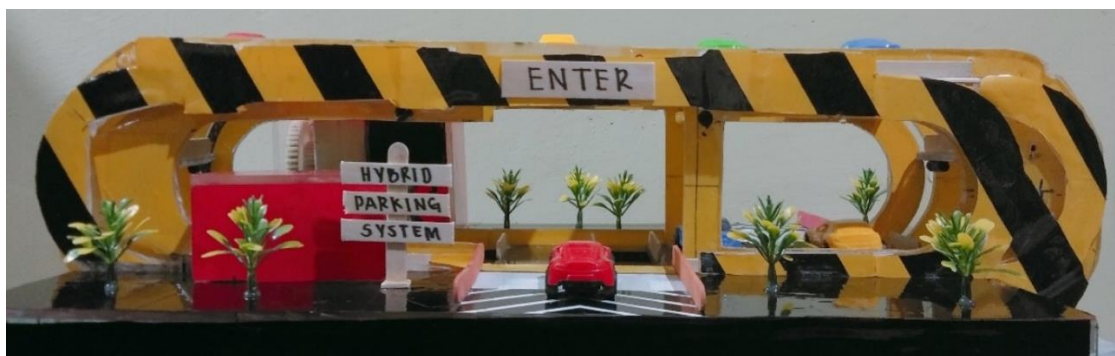


Figure 4(a): Front elevation



Figure 4(b): Rear elevation



Figure 4(c): Floor plan elevation

5. Conclusion

At the end of this study has responded and success to achieve the objectives which are the first is to assess the level of satisfaction among the parking users and public on facilities services and management in Kuala Terengganu, and the second objectives is to recommend the new hybrid parking system with the help from the respondents to select which the best for multi-storey parking system, whether in vertical movement or horizontal movement system.

Overall analysis results found that the users and public in Kuala Terengganu agreed to choose the horizontal movement system as the best selection for multi-storey parking facilities with 74.00 % of respondents. In addition, this study will also help the facility managements to understand the factors that influence customer satisfaction that need to be apply in order to enhance the effectiveness of the work facility based on desire, response and consideration from the users against the quality of services provided. Therefore, the facility management should be always maintained the work performances and improve the quality works.

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