# PARKING CHARACTERISTICS OF MULTI-LEVEL PARKING FACILITIES AT BERJAYA MEGAMALL, KUANTAN

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Thesis submitted in fulfilment of the requirements for the award of the degree of Bachelor (Hons.) of Civil Engineering and Earth Resources.

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## SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor (Hons.) of Civil Engineering and Earth Resources.

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## STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently for award for other degree.

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”I dedicated this to my beloved father, mother, brothers and all my friends.”

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# ABSTRACT

This project is a researched about Parking Characteristics of Multi-level Parking Facilities in Berjaya Megamall, Kuantan. In case study, a method of study has been done, which is key-in the data collected from the authorities into the microsoft excel to get the duration in and out of each vehicle. The data collection have been key-in from starting operation of the day till Berjaya Megamall closed. So, from the data collected, the results and analysis were obtained which are, duration of parking, accumulation, parking turn-over (PTO), index parking (PI), and average of parking duration. Besides that, data were collected on weekends and weekdays during salary week and salary week. As the result, the highest parking demand is 06/02/2016 (Saturday) and followed by 27/02/2016 (Saturday) with values of 186 vehicles per hour and 157 vehicles per hour respectively. Next, from data analysis, the maximum parking accumulation is on 06/02/2016 (Saturday) and followed by 27/02/2016 (Saturday) with values of 411 vehicles and 343 vehicles respectively which is less than the parking capacity provided. Thus, there will be less traffic congestion at the parking spaces. Then, for non-salary week an average of parking duration at Berjaya Megamall on weekday shows the highest time which is on 09/02/2016 (Tuesday) with 1 hour 55 minutes, while for salary week, the highest time shows on weekend, 27/02/2016 (Saturday) with 1 hour and 48 minutes. As conclusion, parking bays at Berjaya Megamall, Kuantan were sufficient on both weekends and weekdays during salary weeks and non-salary weeks.

# ABSTRAK

Projek ini merupakan satu kajian mengenai Ciri-ciri Tempat Meletak Kenderaan Jenis Bertingkat di Berjaya Megamall, Kuantan. Dalam kajian ini, proses yang telah dilakukan adalah memasukkan maklumat yang telah diperolehi dari pihak berkuasa untuk mendapatkan tempoh masuk dan keluar bagi setiap kenderaan. Maklumat yang dikumpul untuk satu hari adalah dari permulaan waktu pembukaan sehingga waktu penutup. Sehubungan itu, dari maklumat yang telah dikumpul, keputusan dan analisis telah diperolehi iaitu, Tempoh Meletak Kenderaan, 'Parking Turn-Over' (PTO), 'Parking Index' (PI), dan Purata Tempoh Meletak Kenderaan. Selain itu, maklumat yang telah dikumpul adalah pada hujung minggu dan hari bekerja semasa minggu bukan gaji dan minggu gaji. Oleh itu, permintaan tempat letak kenderaan yang paling tinggi ialah 2016/06/02 (Sabtu) dan diikuti oleh 27/02/2016 (Sabtu) dengan nilai 186 kenderaan setiap jam dan 157 kenderaan setiap jam masing-masing. Seterusnya, daripada analisis data, tempat letak kereta pengumpulan maksimum adalah pada 2016/06/02 (Sabtu) dan diikuti oleh 27/02/2016 (Sabtu) dengan nilai 411 kenderaan dan 343 kenderaan masing-masing yang kurang daripada kapasiti tempat letak kenderaan yang disediakan. Oleh hal demikian, kurang kesesakan lalu lintas di tempat letak kereta. Kemudian, untuk minggu bukan gaji purata tempoh letak kereta di Berjaya Megamall pada hari minggu menunjukkan masa yang tertinggi iaitu pada 2016/09/02 (Selasa) dengan 1 jam 55 minit, manakala bagi gaji minggu, masa yang paling tinggi menunjukkan pada hujung minggu, 27/02/2016 (Sabtu) dengan 1 jam dan 48 minit. Sebagai kesimpulan, tempat meletak kenderaan di Berjaya Megamall, Kuantan mencukupi di kedua-dua hujung minggu dan hari bekerja semasa minggu gaji dan minggu bukan gaji.

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# CHAPTER I

# INTRODUCTION

## 1.0 BACKGROUND OF STUDY

Pahang is located at the south east of Malaysia. It is the largest state in Peninsular Malaysia which consist of 14 district. Kuantan is the state capital of Pahang which have about 1623 200 people on year 2015. The population density are being estimated on (year 2010) is 43.8 $km^2$ while its population are 1500.8 (‘000) on the same year. The immensity of Kuantan area are about 35960 ($km^2$) which is 10.9 % from total of the area around Pahang state.

Kuantan is the main town in Pahang, it is a busy place where it have a lot of attractive places, such as mall, recreation place and many more. Berjaya Megamall, East Coast Mall, Kuantan Parade, Kompleks Teruntum are a few famous malls that are located in Kuantan.

Berjaya Megamall is one of the malls at Kuantan that attract people's attention to go. It is located at the center of Pahang which is near the East Coast Mall and near the UTC Kuantan. Berjaya Megamall, Jalan Tun Ismail, Sri Dagangan, Kuantan 25000, Malaysia, is a mall with 3th floor storey building, including Golden Cinema Complex, Bowling, Popular, Kfc, Pizza Hut and many more. It also includes the multi-level parking which use the autopay machines (RM2.00 per entry).


**Figure 1.1**: Location Map of Berjaya Megamall

Parking bays provided by the malls usually not enough especially when there is an event or on the salary week. People keeps going to the malls, to buy food, accessories and many more, but they will reluctant to go to the malls due to no parking bays for their vehicles. Due to not enough parking bays, there will be vehicles that make double-park, which will make the road crowded. These situations will slow down the traffic circulation which will make the vehicles moves slowly.

## 1.1 PROBLEM STATEMENT

Parking supply (number of parking bays) is less than the demand (number of vehicles to park). Therefore, the unmet demand will try to find available parking bays elsewhere (outside the building, on the adjacent roads), which will affect traffic circulation. It is necessary to make assessment of the levels of supply and demand of parking spaces in order to propose a solution to the problem.

## 1.2 OBJECTIVES

To study on:

1) To determine the parking characteristics (duration, turn-over, demand, accumulation) at Berjaya Megamall.
2) To determine the required number of parking bays.
3) To suggest improvement of Berjaya Megamall parking.

## 1.3 SCOPES OF STUDY

Berjaya Megamall multi-storey car park, which is under management of Cempaka Properties Sdn. Bhd. Parking. This scope only focuses on the customers of Berjaya Megamall, Kuantan which does not include parking area outside the building which is operated by Majlis Perbandaran Kuantan (MPK). This research focuses on:

The data calculation is about parking parameters which consists of:

i. Parking Duration
ii. Parking Accumulation
iii. Parking Turn-over (PTO)
iv. Parking Volume
v. Parking Capacity
vi. Parking Index (PI)

## 1.4 SIGNIFICANT OF STUDY

It is important to have a good database on supply and demand of parking spaces in Kuantan in order to have a better parking management. The parking study at Berjaya Megamall is one of the series conducted at major commercial centers in Kuantan.

# CHAPTER II

# LITERATURE REVIEW

## 2.0 INTRODUCTION

A literature review discusses about published information in a particular subject area, and information in this particular subject area within a certain time period. Literature review is being made to gain the understanding and to get the background data of the research topic from the beginning of the project. This research has been supported with the related reading materials which are from the previous research about the parking characteristics. The topic that being research is about Parking Characteristics of Multi-level Parking Facilities in Berjaya Megamall, Kuantan. All the reading materials have been used as the references to describe and explain about the factors of parking characteristics (duration, accumulation, turn-over) and method to get the data collected.

## 2.1 CONCEPT OF PARKING

Parking is the process that put a halt of the vehicles into the parking space provided or by the side of the road. According to Wahab (1991), parking is the space which is being used by people to park their vehicles in certain period of time and then the drivers continue to drive or do other activities.

Transport itself give a meaning of moving something in one place to another place. Transport fields consists of infrastructure, vehicles and operations. In this case, parking is a part of vehicles which a person use a vehicle to park. For road transportation, according to Carter and Homburger (1994), parking itself have a lot of examples which

are garage, mall or private entrance hall, bus stop, taxi stand, loading/unloading zone, parking lot are provided.

Shopping malls are the place for people buying foods (main), clothes, watching movies and many more. It is important for each of the shopping malls to have a lot of parking bays and must be located at the center of the city. According to Chung, Yu, Amy (2015), they stated that, an excellent shopping malls should provide a lot of parking space for vehicles, to fulfill their customer demand and parking. People loves to go for a shopping by using private vehicle, but because there are not enough parking spaces, they declined to go there. They only go on demand or on the salary week. If there is less parking bays provided, it will make the parking spaces cramp when any event take place and on the salary week, because the vehicles are more than the parking spaces occupied.

Parking is very important as it is used for every people to park their own vehicles and this also include the public transport which have to park the vehicles they used. As at the shopping malls or hypermarket, usually people go there by using their own vehicles to ease their way to carry back the things they bought before. When people reached the parking bays, they usually take times to search for the empty space which it was a waste of time. According to Chung, Yu, Amy (2015), customers have to circling around after find the parking lot full before they can find the empty parking space at the other floor. The parking system management should plan a great parking space for people that use their service, in order to get the satisfaction of their customers. They should plan for the tagging for the parking space should be and where the exit, this is to easier their customers to find their vehicle and the exit without wasting their time. Then, according to Chung, Yu, Amy (2015), the scenario of searching for vehicles and the exit is a waste of time. Thus, for good parking system, the management of parking for each institution or building must plan and manage the space provided for an effective parking space.

Next, management of parking system should give the limitation time for each vehicle to park their vehicle in the parking space provided. This is to make sure there are enough parking space for the new comers. Chung, Yu, Amy (2015), report that, the management parking system should search for other options to increase the service of shopping and easy parking that can decrease the customers complaints during the

shopping exchange parking hours. The time limit for each vehicle is important especially when the malls have any event or on the weekend so that there will be no vehicle making double park or park at the road which will disturb the congestion of the traffic system.

Parking management at the institution or malls should be concern about the minimum requirement vehicles that would park at the space provided at certain time. According to Shoup (1999), the minimum parking spaces should reach the demand at peak time for every parking. This is important for them to estimate number of vehicle that going to park at the peak demand and there will be no unmet parking space for the all vehicles that use the parking services.

The parking space should be inspected by routine to make sure all the vehicles that enter the parks get the parking or else there will be unsatisfied customers rounding the mall just to find the empty space to park their vehicles even though they paid for the rental park. According to Thompson and Richardson (1996), the vehicles should be inspected to identify their attributes also to know the left parking bays of the buildings.

People nowadays keep paying attention to the traffic system or we can called it traffic jammed. They did not pay attention to the cause of the traffic jammed, which one of the caused may be develop from the congestion of parking of some buildings which might cause the vehicle to park by the side of the road. At the moment, when reached the peak hour, all the vehicles exit at the same time and due to narrow space of the road, it may cause accident of vehicles which increase the traffic jammed. The people should park their vehicles to the parking provided so that there traffic jammed and the accident of the vehicles can be prevent. According to Jackson (1973), in the report of Highway Research Board, he tells that parking area is the lot which use to park the vehicles.

## 2.2 BACKGROUND OF PARKING CHARACTERISTICS

Before each institutions or malls or buildings operated, the management of the company should revise back the space they provided for operation of the buildings especially the parking space. This is to ensure there will be no traffic congestion on the parking space. Traffic congestion also known as traffic jam happen when the transport

network used is keep increase, which takes longer times and characterized as slower speeds of all vehicles also cause the queuing at the road.

Parking management should have known how many parking needed for the buildings at the peak demand which are at the weekend and salary week. At the peak demand, people usually go to the building for some activities and it might be all of the customers/people go there at the same time. This can cause traffic congestion if the parking management did not take serious action on the parking needed at the peak demand.

Parking characteristics includes thee duration, accumulation and the parking turn-over (PTO). Duration can be define as time for something stays which it calculate when it enter in and stop when it exit. Duration of vehicles is important so that, the parking management can calculate the average duration of each vehicles and they can estimate the maximum duration for each driver to park their vehicles into the parking area. This is one of the effective way to decrease the traffic congestion on the parking and by the side of the road.

Accumulation brings the meaning of quantity of object or something which gather at the same place. As the place or building is the institution or the malls, both of the place have many visitors or users. The vehicles that entering the building should be count according to which types such as lorry, vans, buses, car, motorcycles and many more. The parking space provided must be including these vehicles which the space for all of the vehicles are different. Parking management should consider the consumer of the motor and car more as these two vehicles are the common usage in the community.

Parking turn-over (PTO) is define as the average usage of the each parking space for the building. These PTO is quite important as it calculate the usage of the parking and the management can know how many vehicles entering the parking space. Thus, the parking management can assume how many vehicles that arrive during the peak demand.

This research was being done to estimate the quantity of the vehicles as it can help the parking management of Berjaya Megamall to know the usage of parking provided is

enough or not at the peak demand. Thus, this research can be as a good reference before the other parking construction takes place at the mall or institution that have many user.

As the conclusion, before construct the parking lot of each institution or malls, the management should consider the number of residential around, number of customers during peak demand.

## 2.3 VARIATION OF PARKING

In general, parking have two categories which are on street parking and off street parking that have been state by Wahab (1994).

### 2.3.1 ON STREET PARKING

On street parking means that the vehicles park on the street. Usually the case of on street parking is being controlled by the government agencies. There are many types of on street parking, which includes parallel parking, 30’ parking, 40’ parking, 60’ parking and right angle parking.

### 2.3.2 OFF STREET PARKING

In many urban areas, off street parking was develop to prevent the congestion of traffic. As all of us know, the urban is well develop city. Many vehicles and a lot of people focus on the urban area as there have many job appliances. In some cases, the off street parking may also be develop at compacted cities like in Pulau Pinang. The management of building did built the off street parking to save the space area. It is better having off street parking rather than parking by the site of the road that might cause traffic congestion. These off street parking usually having the parking facilities such as parking lot, garages and driveways. It may also be in two types which are indoors and outdoors. The typical of off street parking are as shown below:

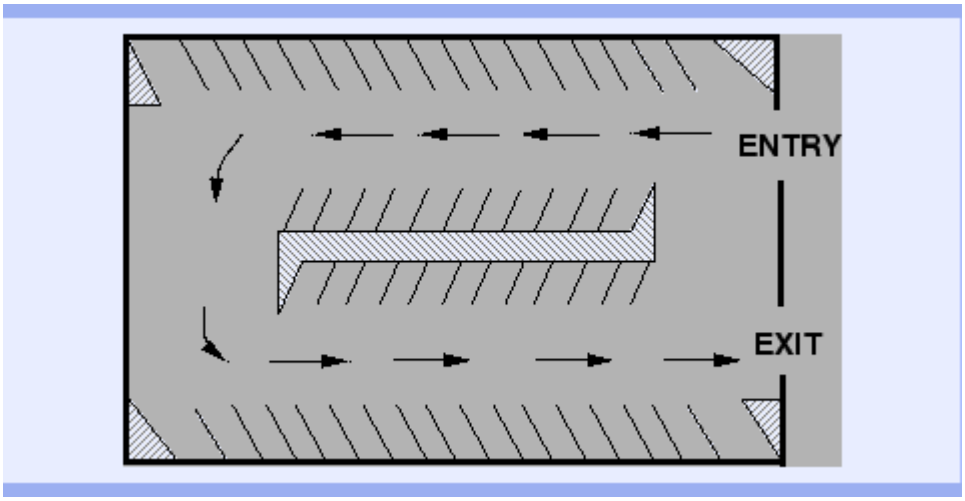


**Figure 2.1**: Off Street Parking

i. Surface Parking

Davies E, 1968: 195 stated that, the characteristics of surface parking are non-roof parking and in a huge area where the bays are being provided. Surface parking has its own main entrance and exit. This type of parking can be seen usually at the school or universities. This is because the quantity of vehicles usage is less. So that the government provide space for them to park their vehicles in the institution. Surface parking are as shown below:

**Figure 2.2**: Surface Parking

ii. Multi-Level Parking

Multi-level parking is being built to decrease the parking space. This kind of parking is good enough as the vehicles user can find the empty space to park their vehicles. Usually this type of parking can be find at the multi-level housing area (flat, condominium, apartment), big company and malls.

There are some regulations that the management should follow before build the multi-level parking such as the fire alarm system, lighting system, suitable temperature and good air ventilation. The multi-level parking are as shown below:

**Figure 2.3**: Multi-Level Parking

iii. Underground Parking

Underground parking usually being built at the hotel and big company. Besides, it is constructed below the ground. The underground parking must be inspected before the user use it. The management should consider the same aspect for the underground parking which are fire alarm system, lighting system, suitable temperature and good air ventilation. Figure below shows the example of underground parking:

**Figure 2.4**: Underground Parking

iv. Rooftop Parking

Rooftop parking usually can be seen on the building that were built in Japan or country that well developed. This type of parking cannot be built if the building is more than 6 floors. In our country, Malaysia, this type of parking is not famous as it is quite expensive. The roof-top parking are as shown below:

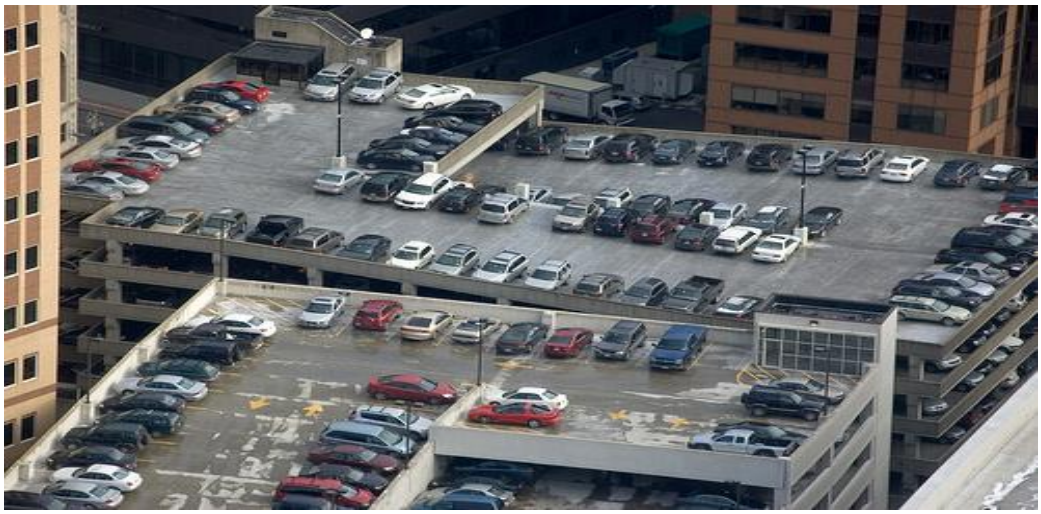

**Figure 2.5**: Rooftop Parking

## 2.4 MODEL OF PARKING SYSTEM

In Malaysia, there are a lot of parking model system which being used by the agencies or by the government. Thus, below is the examples of model parking system that being applied not in Malaysia only but in the whole world.

### 2.4.1 FREE PARKING SYSTEM

When the parking system is being introduce at the earlier stage, the fee is free of charge. Once before the parking system is upgraded, the parking provided is at the field or at the stranded land. The space were is not fixed. Users can park their vehicles at the place they want in any direction. This is quite disturbing the others as the parking space is not big enough if the system is still applied now.

### 2.4.2 RECEIPT PARKING SYSTEM

Receipt parking system usually being operated at the field/stranded land which the parking lot is on the ground. It was the first parking system that applied the payment to all the user of parking lot. Usually the fee of the parking is fixed for example; RM2.00 per vehicles. This parking system will not charge the user higher or lower even when the usage is too long or too short.

The advantages of this parking system is that the number of the vehicles that entering the parking lots can be control because usually there will be someone that guide the user to parking their car at the empty parking space.

The disadvantages of these system is, when it reach about 00:00 am, there will be no person in charge to collect the money from the user that entering the parking space. This will be loss in profit to the management of parking. Figure below is the example of receipt parking system:


**Figure 2.6.0**: Receipt Parking System

### 2.4.3 METER PARKING SYSTEM

During 90's, meter parking system was very famous. In front of each parking have the meter for the user to enter their money and the meter will count the duration of the vehicles park at the space.

Usually the meter parking use coins to start the counts. The meter will count from the first 10 minutes up to 3 hours of parking duration. The price will keep increasing as the duration longer. This is one of the effective ways to make sure that the vehicles that use the parking space use it for the important purpose only and this gives the chance for other vehicles to park as the replacement of the earlier vehicles that had just go back.

The benefit of using meter parking system is that the duration of parking can be control and less worker needed. For the obstruction of the system is it is quite expensive which it depends on the duration of the parking. The longer the duration of the parking the higher the cost it takes. Meter parking system are as shown below:


**Figure 2.6.1**: Meter Parking System

### 2.4.4 COUPON PARKING SYSTEM

Customers that want to use the parking space under coupon parking system must have the coupon before park their vehicles. At Singapore, the fees for motorcycles and motor car coupon parking are different. For the motor car parking coupon, it divided into four categories; hourly or half-hourly day, whole day, night and monthly parking coupon (MPC). At Malaysia, this system had been organized by Majlis Perbandaran of each cities. They have the authorities to sue users that does not showed the coupon at the vehicles but use the service provided. Below is the figure of coupon parking system:


**Figure 2.6.2**: Coupon Parking System

### 2.4.5 TICKET PARKING SYSTEM

For this system, the user must take the ticket at the entrance by pushing the button at the machine provided. Once the ticket getting out from the machine, the bar in front will open the way for the vehicles to enter the parking space. On the ticket, the user time entering the parking entrance will be noted. For each ticket, the number of they get will be different as it will represents the vehicles counts.

Before the user exit from the parking space, they must pay the fee of the parking by entering the money at the autopay machines provided at the building. By using the same ticket users got when entering the parking space, they must push the ticket into the machines before the users going through the existence of the parking. The malls that use this kind of system at Kuantan are East Coast Mall (ECM) and Berjaya Megamall. The sample of ticket parking system can be seen below:


**Figure 2.6.3**: Ticket Parking System

### 2.4.6 AUTOMATIC PAY AND PARK SYSTEM

This type of parking system is being introduced in Europe and getting spread over the other country like United Kingdom, Canada and France. This Automatic pay and park system use the computer to record and print the data of the vehicles that passed by the entrance. This system have two types which are electronic and digital. The system can receive coins, electronic coins and debit card. Figure below shows the automatic and park system:


**Figure 2.6.4**: Automatic Pay and Park System

### 2.4.7 CASH KEY PARKING SYSTEM

By using this system, the user must take the cash key or can also be called as token from the person in charge at the counter by paying such amount needed. The user should use the token to be insert in the cash key machine before park their vehicles. Before exit from the parking space, the user must entering back the token into the cash key machine to par for the rental of the parking lot. The price for the payment is according to the duration of parking.

For every token given, they have their own serial number which is being use by the computer system to record the ongoing and outgoing of each vehicles. This parking system is not applicable at Malaysia. Below are the figure of cash key parking system:


**Figure 2.6.5**: Cash Key Parking System

## 2.5 EVALUATION OF PARKING PARAMETERS

### 2.5.1 PARKING PARAMETERS

Parking parameter act as the function for finding the parking characteristics which includes parking duration, parking accumulation, parking turn-over (PTO), parking volume and parking index (PI). Hence, below are the explanation about the characteristics that can be obtain from the parking parameters:

### 2.5.2 PARKING DURATION

The parking duration must be calculate from each ticket to get the data of the overall vehicles that use the parking lots. The data will be obtain from the formulae below:

- Duration = $t_{out}$ - $t_{in}$ eq (2.1)

where;
- $t_{out}$ = Time of vehicles that exit from the parking space
- $t_{in}$ = Time of vehicles that enter the parking space

As the vehicles passed the entering parking space, the time will be recorded on the ticket as they push the button machine and the customers will pay the fee at the autopay machines before boarding their vehicles to exit from the parking space. Supposedly, the time will be calculated as the user park their vehicle in the parking lot provided until their vehicles moving out from the parking lot. The parking duration will be affected a bit as but in my calculation, I have minus 10 minutes for each vehicle. This 10 minutes is just a time estimate.

### 2.5.3 PARKING ACCUMULATION

Accumulation itself bring the meaning of quantity of vehicles at certain time/duration. Following are the formulae to find the accumulation of vehicles:

- Accumulation = $Q_{in}$ - $Q_{out}$ + $Q_s$ eq (2.2)

where;
- $Q_{in}$ = Total number of vehicles that enter the parking space
- $Q_{out}$ = Total number of vehicles that exit from the parking space
- $Q_s$ = Total number of vehicles that still exist in the parking space

Accumulation actually is calculation to know the total number of vehicles that entering the parking space. The size of paring can be estimate through the observations of parking volume. Hence, as the number of vehicles increased, the dimension of parking lot will also be affected.

### 2.5.4 PARKING TURN-OVER (PTO)

Parking turn-over is the ratio/average of the vehicles that using each parking lot. Following are the formulae to find the PTO.

- Turn-over = $Q_p$ / number of parking bays available eq (2.3)

where;

- $Q_p$ = Total number of vehicles that parked at the parking lots provided from the opening time

As the number of parking turn-over increased, the number of vehicles that entering the parking space of Berjaya Megamall also increased.

### 2.5.5 PARKING VOLUME

Parking volume is the quantity if vehicles that entering the parking space of Berjaya Megamall at specific time. In this research, parking volume is being estimate according to hour and day.

### 2.5.6 PARKING CAPACITY

Parking capacity can be obtain from surveying and observation of total number of vehicles during period of research. Next, the parking capacity is quite important to be calculate to know the volume of vehicles using the parking space. This is to avoid the congestion of the parking during peak demand.

This situations always happen when the peak time, there will be no empty parking lot differ from the non-peak time, there are a lot of empty parking lot to be occupied. The following is the formulae to calculate the parking capacity:

- $\text{Parking Capacity} = \frac{\text{(Number of parking bays x operation time (min))}}{\text{Average parking duration}}$ eq (2.4)

### 2.5.7 PARKING INDEX (PI)

Parking index is the percentage of accumulation divide by number of parking bays. Below are the formulae to get the PI:

- $\text{Parking Index (PI)} = \frac{\text{Accumulation}}{\text{Number of parking bays}}$ x 100% eq (2.5)

# CHAPTER III

# METHODOLOGY

## 3.0 INTRODUCTION

Methodology is the explanation of the steps that we take during the experiment or case study being conducted. The explanation of methodology are systematic and in the theoretical analysis. In this case study, its methodology will explain how the data is being key in, characteristics and the flow control of the Berjaya Megamall parking. This part also will explain the research is all about and will state clearly about the objective stated earlier in Chapter I. At beginning, all the data needed and the literature review of the related article from the previous journal were collected. This part is a bit crucial in order to reinvestigate and improve the parking system that had been constructed in the real buildings. Figure below shows the flow chart of the methodology of the research case.

For the actual reason, the data of the vehicles are being collected to estimate the flow of the traffic system in the parking space and it also being use to know the number of the vehicles that using the parking at the peak demand (peak time, weekdays and weekends).

Besides that, from the data collected before, we can obtain the parking characteristics which includes parking duration, parking accumulation and parking turn-over (PTO). Since the data collected was from the ticket parking system, the time for the parking start right after the Berjaya Megamall open until it close.

The duration of the each vehicles can be obtain from time in and time out of the vehicles itself. The information is being recorded on the ticket since at Berjaya Megamall they use that parking system. For accumulation, it can be get from the usage of the parking ticket which it refers to vehicles per ticket. The parking turn-over(PTO) can be obtain from the number of vehicles entering the parking space and the parking space provided at the malls since parking turn-over is the ratio/average of the vehicle that using each parking lot.

Lastly, the results and analysis obtained from the research can be used by third parties or the management to improve the parking system of the Berjaya Megamall and other building that have the same characteristics as the mall that being researched.

## 3.1 CASE STUDY

Berjaya Megamall is a mall that consists of Giant hypermarket, Popular, KFC, Pizza Hut, Bowling Center, Golden Screen Cinema(GSC) and many more which makes it an attractive place to go. Furthermore, the location is strategic which is at Kuantan and it is at the center of the Pahang state. This mall opens at 09:00 am and close at 02:00 am but Apple K Bar open until 04:00 am.

Next, in order to complete the research of the parking characteristics of Berjaya Megamall, we need the collections of parking ticket on weekday, weekend, non-salary week and salary week. For non-salary week, the data collected was 1 day for weekday and 1 day for weekend meanwhile for salary week, the data collected was 1 day for weekday and 1 day for weekend.

## 3.2 FLOWCHART OF RESEARCH METHODOLOGY

Figure 3.1 shows a research methodology which also including the process of key in data into the microsoft excel. Next, the data collected were being analysed to get the conclusion of the research study before a few recommendation being make to improve the parking system of Berjaya Megamall.

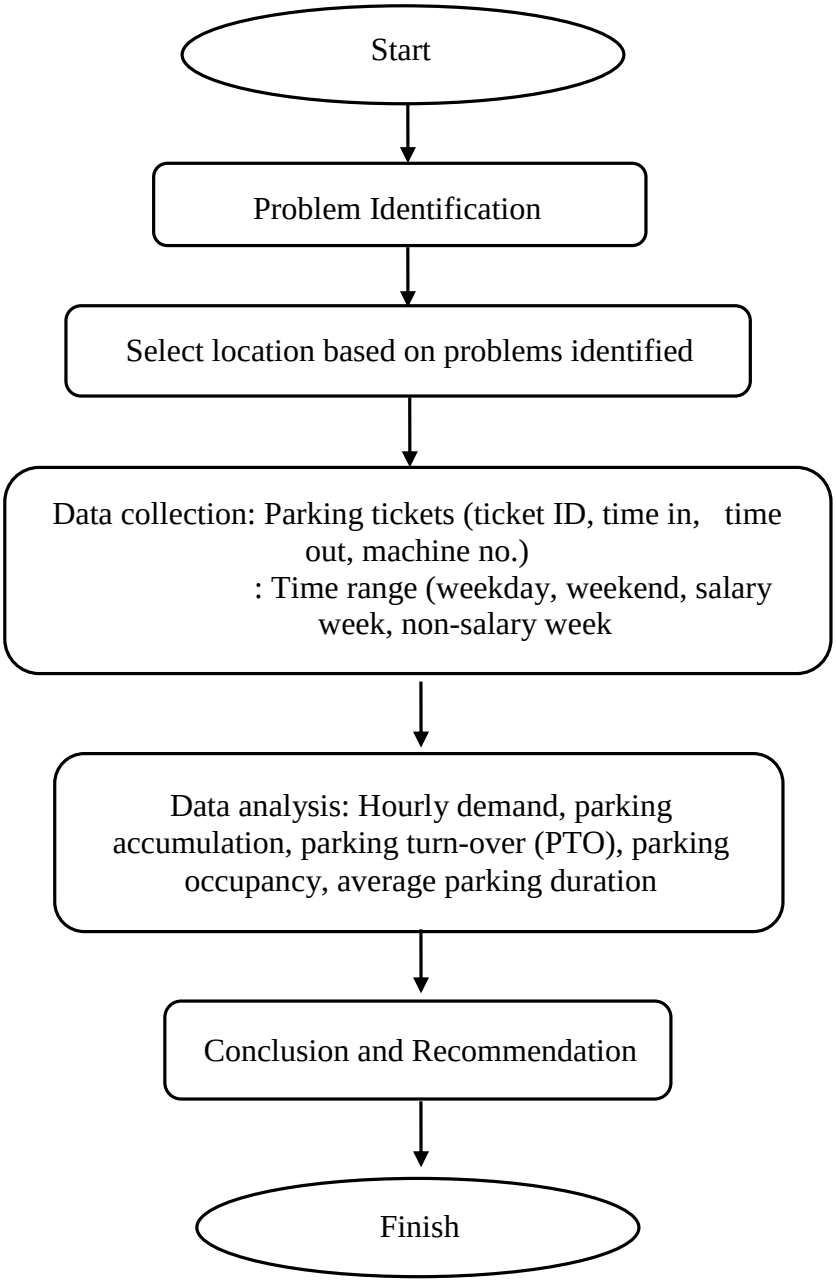


**Figure 3.1**: Flowchart of Research Methodology

## 3.3 METHODOLOGY AND DATA RESOURCES

This research design was actually a case study which involves the description and quantitative method. Research design is a technique to get the data needed then solve the problems. The common methods of collected the data are observations and recordings. For the research of this project, all data needed were collected from the following resources:

i. Journals
ii. Newspaper
iii. Books and references
iv. Internet
v. Ticket parking / data recorded

## 3.4 METHOD OF DATA COLLECTION

To get the data of each vehicles that entering the Berjaya Megamall parking lots, the method that being carried out are as following:

i. Key in the time in and time out of each vehicles that have been recorded at the ticket parking.
ii. Approaching management of Berjaya Megamall to get access to information regarding the parking facility: total number of parking stalls and the distribution (outside and inside multi-storey car park, number of entrance gate, number of auto-pay machine, etc.) and parking tickets covering weekday, weekend, salary week, and non-salary week.

### 3.4.1 RECORD OF DATA COLLECTED

In my case, all the data needed have been recorded on the ticket parking for each of the vehicles entering the parking lot. By the summation of all the ticket getting for a full day of Berjaya Megamall operation, it will give the cumulative of total vehicles using the parking lots.

The day of data collected has been chose which is 6 days in weekday and 6 days in weekend. This is to calculate the volume of vehicles that using the parking lots in which day is greater and have peak demand.

The 6 chosen date for weekdays are; 09/02/2016 (Tuesday), 08/08/2016 (Monday), 09/08/2016 (Tuesday), 23/08/2016 (Tuesday), 28/08/2016 (Monday) and 30/08/2016 (Tuesday). Next, 6 chosen date for weekend are; 13/08/2016 (Saturday), 14/08/2016 (Sunday), 06/02/2016 (Saturday), 27/02/2016 (Saturday), 27/08/2016 (Saturday) and 28/08/2016 (Sunday).

# CHAPTER IV

# RESULT AND DISCUSSION

## 4.0 INTRODUCTION

Objective of the experiment is to assess the parking characteristic for parking bays at Berjaya Megamall, Kuantan and to assess the performance of parking facility. The problem happen when the parking bays occupied by the mall is not enough on the weekend during the salary week. Thus, the suggestion is being made to overcome the problems so that there will be no traffic congestion at the parking provided.

In the research, data had been collected on the non-salary week and salary week where 6 days for non-salary week and 4 days for salary week in February and August.

To analysing the data collection, graph and table were constructed which is based on the shown in Appendix A, B and C. Graph plotted were based on the accumulation curve, and demand curve where they shows the parking characteristics occurred.

## 4.1 RESULTS FOR PARKING DURATION

**Table 4.1:** Average parking duration with maximum and minimum parking duration.

| DAYS/DATE | | AVERAGE DURATION (HOUR) | MAX. DURATION (HOUR) | MIN. DURATION (HOUR) | ST. DEV. | SAMPLE SIZE |
|---|---|---|---|---|---|---|
| NON-SALARY WEEK | | | | | | |
| WEEKDAY | 09/02/2016 (TUES) | 1:55 | 4:53 | 0:05 | 1:03 | 510 |
| | 08/08/2016 (MON) | 1:16 | 3:56 | 0:02 | 0:53 | 335 |
| | 09/08/2016 (TUES) | 1:27 | 4:27 | 0:02 | 1:05 | 211 |
| | 23/08/2016 (TUES) | 1:33 | 4:50 | 0:02 | 1:08 | 182 |
| WEEKEND | 13/08/2016 (SAT) | 1:45 | 4:42 | 0:04 | 1:01 | 609 |
| | 14/08/2016 (SUN) | 1:31 | 4:25 | 0:04 | 0:57 | 417 |
| SALARY WEEK | | | | | | |
| WEEKDAY | 29/08/2016 (MON) | 1:35 | 4:26 | 0:02 | 0:57 | 608 |
| | 30/08/2016 (TUES) | 1:42 | 4:32 | 0:04 | 0:56 | 663 |
| WEEKEND | 06/02/2016 (SAT) | 1:40 | 4:27 | 0:05 | 0:55 | 1439 |
| | 27/02/2016 (SAT) | 1:48 | 4:47 | 0:03 | 1:00 | 1044 |
| | 27/08/2016 (SAT) | 1:38 | 4:09 | 0:04 | 0:51 | 670 |
| | 28/08/2016 (SUN) | 1:42 | 4:23 | 0:04 | 0:55 | 691 |

Based on Table 4.1, according to Traffic and Highway Engineering by Nicholas Garber and Lester Hoel (1999), stated that parking duration is the length of time for a vehicle to park at the parking bay. As we all know, the average of parking duration is an indication of the frequency of a parking bays being used by the users. Hence, for non-salary week an average of parking duration at Berjaya Megamall, Kuantan on weekday shows the highest time which is on 09/02/2016 (Tuesday) with 1 hour 55 minutes, while

for salary week, the highest time shows on weekend, 27/02/2016 (Saturday) with 1 hour and 48 minutes.

To obtain the ideal of average of parking duration, as shown in the Table 4.1, outliers that have been calculated are removed. This is important so that the overall values of parking duration is not being affected. Thus, to get the outliers, there is the following Equation that have to be follow:

- Outliers of data are beyond = $\mu \pm 3\sigma$ ($x > (\mu + 3\sigma)$ or $x < (\mu - 3\sigma)$) (4.1)

In this case study that had been done, it is found that there are a few parking duration that is below than 5 minutes, which is logically unacceptable. On overall, the minimum parking duration applies to all day (researched), except for 06/02/2016 and 09/02/2016. Basically, Berjaya Megamall provided multi-storey parking, with the usage of ticket parking system. This system is systematic, which the machines will note the time enter and exit on the ticket provided to the users. There are a few of parking duration that counted to be less than 10 minutes which it is impossible for the users to find the parking. Sometimes, the users had enter the parking lot, but there are no available parking bays to be occupied so they might left. Besides that, they might enter the parking lot to drop off the passengers. This is why the data collected is less than 10 minutes, which it is not valid to be use.

Tsamboulus (2001), indicated that; users reacted negatively to increase parking charges due to longer parking duration. This is one of the reason, public want to enter the parking lot provided by Berjaya Megamall because it only cost RM2.00 per entry, no matter how long does they park their vehicles.

## 4.2 RESULTS FOR PARKING TURN-OVER (PTO)

**Table 4.2:** Parking turn-over (PTO)

| DATE | | DAYS | PTO (VEC/BAY/DAY) |
|---|---|---|---|
| **NON-SALARY WEEK** | | | |
| **WEEKDAY** | **09/02/2016 (TUES)** | Day 1 | 0.927273 |
| | **08/08/2016 (MON)** | Day 2 | 0.609091 |
| | **09/08/2016 (TUES)** | Day 3 | 0.383636 |
| | **23/08/2016 (TUES)** | Day 4 | 0.330909 |
| **WEEKEND** | **13/08/2016 (SAT)** | Day 5 | 1.107273 |
| | **14/08/2016 (SUN)** | Day 6 | 0.758182 |
| **SALARY WEEK** | | | |
| **WEEKDAY** | **29/08/2016 (MON)** | Day 7 | 1.105455 |
| | **30/08/2016 (TUES)** | Day 8 | 1.205455 |
| **WEEKEND** | **06/02/2016 (SAT)** | Day 9 | 2.616364 |
| | **27/02/2016 (SAT)** | Day 10 | 1.898182 |
| | **27/08/2016 (SAT)** | Day 11 | 1.218182 |
| | **28/08/2016 (SUN)** | Day 12 | 1.256364 |

Based on Table 4.2, parking turn-over (PTO) during non-salary week was the highest on weekend, 13/08/2016 (Saturday) that is 1.107273 vehicle per bay per day whilst the least of parking turn-over fall on weekday, 23/08/2016 (Tuesday) with value of 0.330909 vehicle per bay per day. For the salary week, the highest of parking turn-over (PTO) was on weekend, 06/02/2016 (Saturday) that is 2.616364 vehicle per bay per day whilst the least of parking turn-over fall on weekday, 29/08/2016 (Monday) with value of 1.105455 vehicle per bay per day.

## 4.3 RESULTS FOR PARKING DEMAND

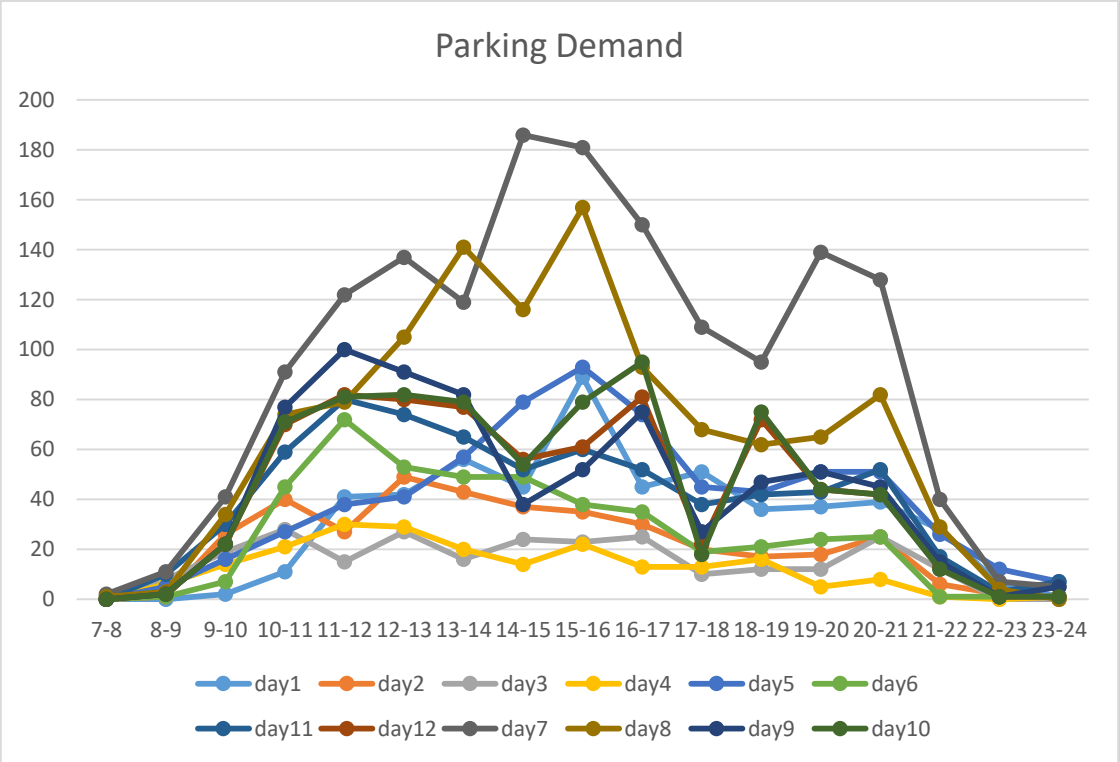


**Figure 4.1:** Demand curve for 12 days

**Table 4.3:** Legend

| Days | Legend |
|---|---|
| Day 1-4 | Weekday Non-Salary |
| Day 5-6 | Weekend Non-Salary |
| Day 7-8 | Weekday Salary |
| Day 9-12 | Weekend Salary |

Based on Figure 4.1, the curve shows the parking demand at Berjaya Megamall, Kuantan for 12 days. From the data collected, the maximum parking demand according to day 1 until day 12 are; 89, 49, 28, 30, 93, 72, 80, 82, 186, 157, 100 and 95. Hence, from data analysis, the maximum parking demand is on 06/02/2016 (Saturday) and followed by 27/02/2016 (Saturday) with values of 186 vehicles per hour and 157 vehicles per hour respectively. Both of maximum parking demand occurred on weekend and during salary week. Thus, Berjaya Megamall shall provide more parking bays so that there will be less traffic congestion at the parking lot.

## 4.4 RESULTS FOR PARKING ACCUMULATION

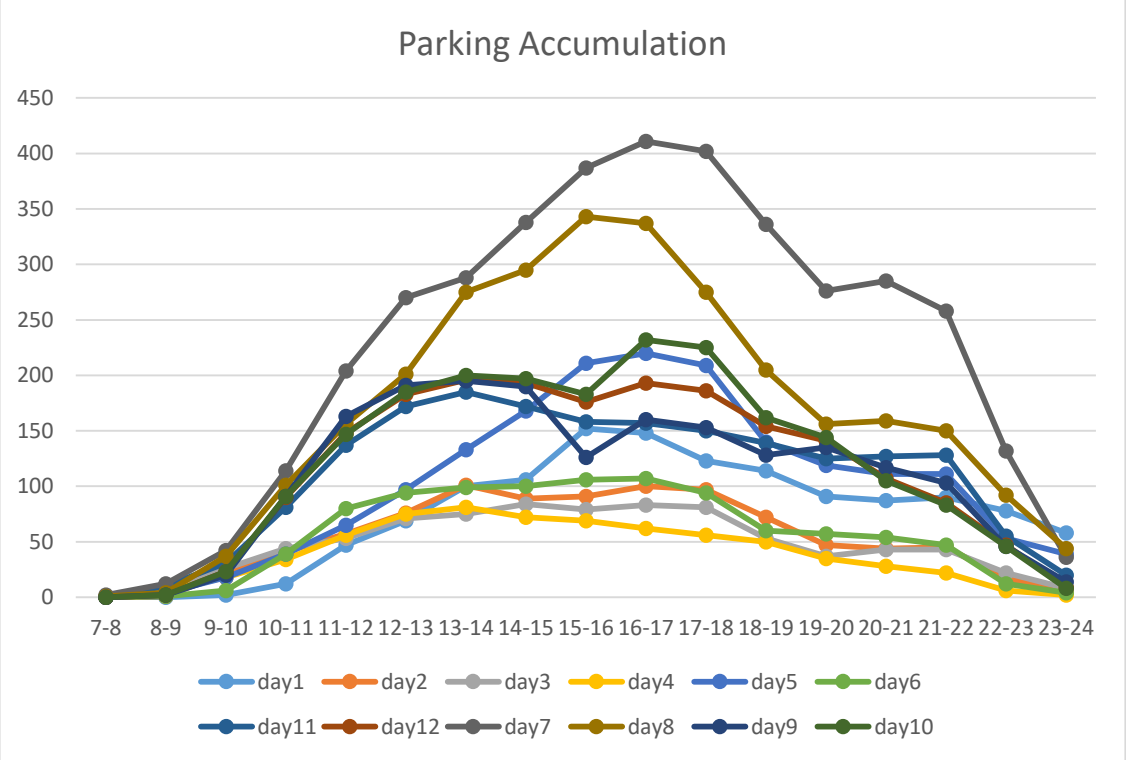


**Figure 4.2:** Accumulation curve for 12 days

**Table 4.4:** Legend

| Days | Legend |
|---|---|
| Day 1-4 | Weekday Non-Salary |
| Day 5-6 | Weekend Non-Salary |
| Day 7-8 | Weekday Salary |
| Day 9-12 | Weekend Salary |

Based on Figure 4.2, the curve shows the parking accumulation at Berjaya Megamall, Kuantan for 12 days. From the data collected, the maximum parking accumulation according to day 1 until day 12 are; 152, 101, 84, 81, 220, 107, 185, 196, 411, 343, 195 and 232. Hence, from data analysis, the maximum parking accumulation is on 06/02/2016 (Saturday) and followed by 27/02/2016 (Saturday) with values of 411 vehicles and 343 vehicles respectively. Both of maximum parking accumulation occurred on weekend and during salary week.

As we all know, people tend to shop a lot on weekend and during salary week. This is because they can spend more time looking for the things they needed without rush and they prefer to shop during salary week because they have money to buy things they needed. Thus, this is one of the factor that contribute to the accumulation of the parking.

Number of parking provided by Berjaya Megamall are 850. From the analysis above, it is known that the demand of parking is not occurring. But for the further time, Berjaya Megamall shall provide more parking bays so that there will be less traffic congestion at the parking lot.

## 4.5 DISCUSSION

Berjaya Megamall is one of the malls located in Kuantan, Pahang with a huge building including the malls and the parking lot. This mall was built-up having three levels floor with varieties of shop. The parking lot was designed with two entrance which both of them are multi-storey parking. The parking lot provided were using ticket parking system or the payment method. Users may exit the parking lot by paying such amount into the pay machines provided. This machines will note down the time exit and the vehicles series number.

Some of the machines may operate effectively but some might failed to do so. The time exit may disappeared/not clearly seen. Few factors that might contributes to the defect are the machines have not been service for a long time, factors of weather and many more. Usually, the vehicles entering the parking lot is about 500 – 1000 (per day) on non-salary week, and the value might increase beyond 1000 (per day) on salary week.

The data collection might not be accurate due to the defect that happen to the ticket on the selected day. The sample size is the number of vehicles that enter/exit the parking lot with no defect on their ticket parking. Ticket that have defect were not being inserted in the data collection because the time were not valid. Thus, the sample size calculated is not precise as some of data were not included.

As can be seen on 09/08/2016 and 23/08/2016, the sample size are so small which they do not exceed 300. These could be because of the defect on the ticket parking and one other factor is, customers keep park their vehicles on the side of the road which is the parking lot is being managed by Majlis Perbandaran Kuantan. Some of the customers find it is easier to park their vehicles at the on-street parking instead of off-street parking (multi-storey parking).

Multi-level parking have been broadly used in Malaysia even over the whole world. This kind of parking were used as it saving spaces and seems conventional and convenient to the users and the authorities. The authorities just need to put the ticket machines system or etc. instead of pay for the extra workers to claim for the payment on each of the vehicles using the parking services. There are a lot of huge building that using these type of parking such as KLIA2, Terminal Bersepadu Selatan – Bandar Tasik Selatan (TBS-BTS), East Coast Mall (ECM) and etc.

At KLIA2, the parking lot is designed with 8-storey car park which covers 6490 parking bays for motorcycles and car. About 5690 car bays and 800 motorcycles bays are provided. In addition, 52 disabled-friendly driver parking bays have been reserved at every car park level at both Block A and B. For the motorcycles, price charges is only RM 1.00 per entry. For the first 3 hours the parking rate is RM 4.00 per hour while for the next 4 hours is RM 3.00 per hour. Next, for $10^{th}$ hours and above, the parking rate is RM 2.00 per hour and the daily maximum rate is RM 46.00 per day. The compound for the losing of ticket is RM 50.00 per day. The parking payment can be made at Auto pay machines on level 1, level 4 and level 7.

At Terminal Bersepadu Selatan – Bandar Tasik Selatan (TBS-BTS), the parking lot is being provided for the cars and motorcycles. Current TBS car park rate is RM4 per entry per day for 1 car/MPV/4WD. No parking fee is charged for motorcycles. The authorities also dedicated parking lots for the disabled and people who needs special assistance much closer to the elevators and public entrances.

At East Coast Mall (ECM), Kuantan, the ample parking bays are 1142 bays which are available at basement, ground floor (outdoor), level 3 and rooftop. For parking convenience, the mall is using Auto Pay Car Park & Touch N' Go System Parking Rate which is RM 1.00 per entry (Monday – Thursday) and RM2.00 per entry (Friday – Sunday & Public Holiday). For the bikes, the price charges are RM 1.50 per entry while for the car, the first hour is RM 1.50 and the subsequent 15 minutes are RM 0.40. The grace period for the car is only 10 minutes or extra payment will be charges.

At Berjaya Megamall, Kuantan, the parking bays are being provided for both motorcycles and cars. For motorcycles, there are no parking charges while for car, amount RM 2.00 per entry will be charges. If the users lost the ticket, they have to pay for the compound about RM 50.00 per day.

For the comparison, Berjaya Megamall charges the lowest price for the using of their multi-level parking but for the convenient using of parking bays for the disabled people, KLIA2 and Terminal Bersepadu Selatan – Bandar Tasik Selatan (TBS-BTS) were chosen. This is because, at Berjaya Megamall, there are less of parking bays for disabled people. The difficulty they face will make them unwillingly to go to the malls.

The data collected are on weekends and weekdays during non-salary weeks and salary weeks. Weekend is in term of public holidays or at the end of the week which are on Saturday and Sunday, but for some state, their weekend falls on Friday and Saturday. For weekdays, it is term for working days which eventually falls on Monday till Friday or Sunday till Thursday. Next, salary is defined as a form of payment from an employer to the employee, which may be specified in an employment contract while salary week is the week where an amount of money or compensation is paid to the employee by the employer in return for work performed. Non-salary week is defined as the week where the there are no payment of wages being given to the employee by the employer.

As we all know, there are two entrance provided at Berjaya Megamall parking space which we can assume it as Park A and Park B. Both of the parking them have different parking spaces which at Park A, the parking spaces provided is more than at Park B. At Park A, the parking spaces provided are about 500 while at Park B, there are only 350 parking spaces. The total for both Park A and B gives total of 850 parking spaces provided. At Park A, the ticket machine number is 21 while at Park B, it is 22.

# CHAPTER V

# CONCLUSION AND RECOMMENDATIONS

## 5.0 CONCLUSION

From the research that had been done, parking bays at Berjaya Megamall, Kuantan were sufficient on both weekends and weekdays during salary weeks and non-salary weeks. This is because on weekend during salary week, people will going to the mall for purposes. Based on Mo, Zhang, and Yan (2008), Teknomo and Hokoa (1997); Yun etal., (2008) stated that parking type choice is related to the trip purpose.

Besides that, the parking demand will keep increasing during the peak hour, which are at noon (lunch hour), and at night. This is because, in Berjaya Megamall, they have a lot of restaurants and playground for their kids to have fun while their guardians having time for rest or eating.

Besides that, from data analysis and researched done at Berjaya Megamall, Kuantan, shows that the parking demand were only high during the peak hour, weekends and salary week. Other than that, there are less traffic congestion on the parking system provided.

## 5.1 RECOMMENDATION

Below are some recommendations for the future study of Berjaya Megamall, Kuantan which to ensure the parking characteristics of multi-level parking facilities such as parking demand and parking accumulation is not occurred. Besides that, Berjaya Megamall can make this case study as their reference to increase their performance in parking supply and to solve the parking demand during peak hours.

i. Cover at least one full month of data collection to enable analysis of the fluctuations of parking demand and accumulation during the month.
ii. Make sure the data noted on the ticket are visible so that the all of the data are valid.
iii. To avoid missing parking data, data should be digitally copied (downloaded) from the original database, not manually input in Excel spreadsheet based on parking tickets.

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# APPENDIX A


**Figure 1.1:** Motorcycle parking bays, Block B, Parking facility, KLIA2


**Figure 1.2:** Ticket machine and surveillance camera, Block B, Parking facility, KLIA2


**Figure 1.3:** Parking facility, TBS-BTS


**Figure 1.4:** Parking facility, TBS-BTS

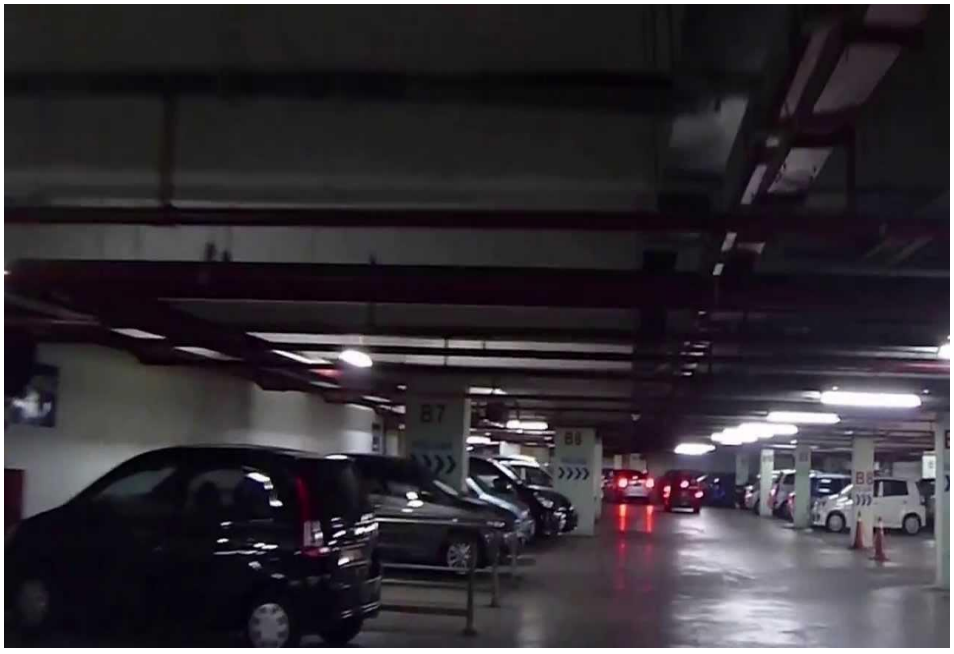

**Figure 1.5:** Parking facility, East Coast Mall, Kuantan

**Figure 1.6:** Parking facility, East Coast Mall, Kuantan


**Figure 7:** Parking facility, Berjaya Megamall, Kuantan

**Figure 8:** Parking facility, Berjaya Megamall, Kuantan

## APPENDIX B

Table B1 shows the data collection of recorded ticket parking of vehicles that arrived and departed at Berjaya Megamall, Kuantan on weekday, 09/02/2016 (Tuesday) during non-salary week.

**Table B1:** Parking duration on weekday, 09/02/2016 (Tuesday) during non-salary week.

| DATE :0 90/2/2016 | | | | | | |
|---|---|---|---|---|---|---|
| AUTO PAID MACH | IN | AUTO PAID MACH | OUT | CARS NO | TICKET NO | DURATION (HOUR) |
| 21 | 12:49 | 29 | 13:37 | 026238 | D 058900 | 0:48 |
| 21 | 11:42 | 29 | 13:34 | 026236 | D 058853 | 1:52 |
| 21 | 17:46 | 29 | 18:35 | 026494 | D 059247 | 0:49 |
| 21 | 11:32 | 29 | 13:38 | 026234 | D 058840 | 2:06 |
| 21 | 11:22 | 29 | 13:39 | 026237 | D 058832 | 2:17 |
| 21 | 15:48 | 29 | 18:36 | 026496 | D 059122 | 2:48 |
| 21 | 12:26 | 29 | 13:39 | 026235 | D 058885 | 1:13 |
| 21 | 14:30 | 29 | 20:54 | 026594 | D 058996 | 6:24 |
| 21 | 14:52 | 29 | 15:39 | 026308 | D 059028 | 0:47 |
| 21 | 12:31 | 29 | 15:39 | 026307 | D 058887 | 3:08 |
| 21 | 14:27 | 29 | 15:27 | 026302 | D 058991 | 1:00 |
| 21 | 14:53 | 29 | 15:28 | 026303 | D 090341 | 0:35 |
| 21 | 12:38 | 29 | 15:23 | 026298 | D 058890 | 2:45 |
| 21 | 12:25 | 29 | 15:24 | 026301 | D 058882 | 2:59 |
| 21 | 11:09 | 29 | 15:23 | 026299 | D 058824 | 4:14 |
| 21 | 13:47 | 29 | 15:23 | 026300 | D 058971 | 1:36 |
| 21 | 13:57 | 29 | 15:22 | 026295 | D 058978 | 1:25 |
| 21 | 13:42 | 29 | 15:22 | 026296 | D 058964 | 1:40 |

Table B2 shows the data collection of recorded ticket parking of vehicles that arrived and departed at Berjaya Megamall, Kuantan on weekend, 14/08/2016 (Sunday) during non-salary week.

**Table B2:** Parking duration on weekend, 14/08/2016 (Sunday) during non-salary week.

| DATE : 14/08/2016 | | | | | | |
|---|---|---|---|---|---|---|
| AUTO PAID MACH | IN | AUTO PAID MACH | OUT | CARS NO | TICKET NO | DURATION (HOUR) |
| 21 | 17:57 | 26 | 20:21 | 036791 | D 324807 | 2:24 |
| 21 | 11:00 | 26 | 11:36 | 036109 | D 324400 | 0:36 |
| 21 | 19:04 | 26 | 20:21 | 036790 | D 324839 | 1:17 |
| 21 | 12:35 | 26 | 13:17 | 036205 | D 324283 | 0:42 |
| 21 | 11:10 | 26 | 11:18 | 036097 | D 324407 | 0:08 |
| 21 | 13:47 | 26 | 17:29 | 036573 | D 324561 | 3:42 |
| 21 | 14:53 | 26 | 16:02 | 036430 | D 324634 | 1:09 |
| 21 | 14:33 | 26 | 18:26 | 036660 | D 324613 | 3:53 |
| 21 | 14:34 | 26 | 18:11 | 036637 | D 324616 | 3:37 |
| 21 | 20:50 | 26 | 23:42 | 036903 | D 324879 | 2:52 |
| 21 | 10:30 | 26 | 12:06 | 036128 | D 324379 | 1:36 |
| 21 | 17:01 | 26 | 18:06 | 036634 | D 324765 | 1:05 |
| 21 | 12:57 | 26 | 14:01 | 036255 | D 324498 | 1:04 |
| 21 | 12:27 | 26 | 13:12 | 036196 | D 324472 | 0:45 |
| 22 | 22:43 | 26 | 1:09 | 036905 | D 352314 | 2:26 |
| 22 | 23:26 | 26 | 1:15 | 036906 | D 352317 | 1:49 |
| 22 | 11:39 | 26 | 13:15 | 036193 | D 351590 | 1:36 |
| 22 | 12:26 | 26 | 13:15 | 036194 | D 351675 | 0:49 |
| 22 | 11:44 | 26 | 13:05 | 036182 | D 351607 | 1:21 |
| 22 | 10:29 | 26 | 21:35 | 036854 | D 351490 | 11:06 |
| 22 | 13:16 | 26 | 15:55 | 036419 | D 351760 | 2:39 |
| 22 | 14:57 | 26 | 15:49 | 036404 | D 351924 | 0:52 |

Table B3 shows the data collection of recorded ticket parking of vehicles that arrived and departed at Berjaya Megamall, Kuantan on weekday, 29/08/2016 (Monday) during salary week.

**Table B3:** Parking duration on weekday, 29/08/2016 (Monday) during salary week.

| DATE : 29/08/2016 | | | | | | |
|---|---|---|---|---|---|---|
| AUTO PAID MACH | IN | AUTO PAID MACH | OUT | CARS NO | TICKET NO | DURATION (HOUR) |
| 21 | 14:30 | 26 | 16:34 | 040988 | D 327369 | 2:04 |
| 21 | 14:28 | 26 | 16:39 | 041399 | D 327552 | 2:11 |
| 21 | 11:07 | 26 | 13:57 | 041294 | D 327479 | 2:50 |
| 21 | 11:00 | 26 | 12:35 | 041248 | D 327474 | 1:35 |
| 21 | 18:18 | 26 | 19:55 | 041514 | D 327630 | 1:37 |
| 21 | 18:15 | 26 | 19:55 | 041513 | D 327628 | 1:40 |
| 21 | 14:31 | 26 | 15:45 | 041357 | D 327556 | 1:14 |
| 21 | 12:12 | 26 | 13:55 | 041292 | D 327497 | 1:43 |
| 21 | 11:57 | 26 | 12:05 | 041238 | D 327493 | 0:08 |
| 21 | 18:22 | 26 | 19:15 | 041500 | D 327634 | 0:53 |
| 21 | 11:50 | 26 | 14:39 | 041324 | D 327488 | 2:49 |
| 21 | 16:14 | 26 | 16:44 | 040992 | D 327400 | 0:30 |
| 21 | 14:53 | 26 | 17:15 | 041020 | D 327375 | 2:22 |
| 22 | 23:22 | 26 | 0:11 | 041598 | D 357158 | 0:49 |
| 22 | 16:23 | 26 | 17:25 | 041428 | D 357046 | 1:02 |
| 22 | 15:45 | 26 | 15:55 | 041364 | D 357028 | 0:10 |
| 22 | 15:41 | 26 | 16:25 | 041389 | D 357023 | 0:44 |
| 22 | 13:03 | 26 | 14:35 | 041318 | D 356924 | 1:32 |
| 22 | 12:19 | 26 | 15:45 | 041358 | D 356888 | 3:26 |
| 22 | 13:06 | 26 | 15:50 | 041361 | D 356929 | 2:44 |
| 22 | 13:29 | 26 | 15:45 | 041359 | D 356946 | 2:16 |
| 22 | 15:26 | 26 | 16:05 | 041371 | D 357012 | 0:39 |

Table B4 shows the data collection of recorded ticket parking of vehicles that arrived and departed at Berjaya Megamall, Kuantan on weekend, 27/02/2016 (Saturday) during salary week.

**Table B4:** Parking duration on weekend, 27/02/2016 (Saturday) during salary week.

| DATE : 27/02/2016 | | | | | | |
|---|---|---|---|---|---|---|
| AUTO PAID MACH | IN | AUTO PAID MACH | OUT | CARS NO | TICKET NO | DURATION (HOUR) |
| 21 | 14:00 | 29 | 17:57 | 033564 | D 111333 | 3:57 |
| 21 | 15:22 | 29 | 17:45 | 033553 | D 111510 | 2:23 |
| 21 | 15:50 | 29 | 17:16 | 033501 | D 111626 | 1:26 |
| 21 | 15:25 | 29 | 17:43 | 033547 | D 111522 | 2:18 |
| 21 | 15:20 | 29 | 17:25 | 033516 | D 111502 | 2:05 |
| 21 | 10:53 | 29 | 22:14 | 033848 | D 111060 | 11:21 |
| 21 | 13:37 | 29 | 17:43 | 033550 | D 111252 | 4:06 |
| 21 | 14:44 | 29 | 17:27 | 033505 | D 111427 | 2:43 |
| 21 | 16:25 | 29 | 17:17 | 033498 | D 111735 | 0:52 |
| 21 | 14:59 | 29 | 17:14 | 033486 | D 111448 | 2:15 |
| 21 | 15:41 | 29 | 17:09 | 033475 | D 111590 | 1:28 |
| 21 | 16:04 | 29 | 17:09 | 033482 | D 111679 | 1:05 |
| 21 | 15:19 | 29 | 17:04 | 033470 | D 111497 | 1:45 |
| 21 | 15:25 | 29 | 17:07 | 033462 | D 111523 | 1:42 |
| 21 | 12:53 | 29 | 16:50 | 033446 | D 111176 | 3:57 |
| 21 | 13:31 | 29 | 16:59 | 033455 | D 111238 | 3:28 |
| 21 | 14:30 | 29 | 16:51 | 033448 | D 111402 | 2:21 |
| 21 | 16:02 | 29 | 16:57 | 033454 | D 111669 | 0:55 |
| 21 | 12:57 | 29 | 19:39 | 033691 | D 111181 | 6:42 |
| 21 | 13:53 | 29 | 16:53 | 033445 | D 111310 | 3:00 |
| 21 | 15:28 | 29 | 16:41 | 033423 | D 111530 | 1:13 |
| 21 | 20:18 | 29 | 22:07 | 033838 | D 111973 | 1:49 |

## APPENDIX C

Table C shows the parking duration with the outliers which been calculated from the data collection on weekend, 06/02/2016 (Saturday). Hence the range of the ideal duration are from 5 minutes to 4 hours 27 minutes.

**Table C:** Outliers of parking duration

| DURATION (HOUR) | FORMULA | DURATION (HOUR) – AFTER OUTLIERS REMOVED |
|---|---|---|
| 2:15 | ST. DEVIATION | 4:27 |
| 2:39 | 0:55 | 4:27 |
| 7:47 | MAX. DURATION | 4:27 |
| 1:27 | 4:27 | 4:26 |
| 12:12 | MIN. DURATION | 4:26 |
| 1:34 | 0:05 | 4:22 |
| 9:49 | | 4:21 |
| 10:03 | | 4:20 |
| 9:37 | | 4:19 |
| 1:45 | | 4:18 |
| 1:23 | | 4:18 |
| 1:55 | | 4:17 |
| 1:30 | | 4:17 |
| 1:45 | | 4:15 |
| 1:40 | | 4:15 |
| 1:17 | | 4:15 |
| 4:07 | | 4:14 |
| 1:00 | | 4:13 |