A STUDY ON SMART PARKING SYSTEM USING IOT TECHNOLOGY IN SHOPPING MALL

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BY

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DECEMBER 2023

DECLARATION

We hereby declare that:

(1) This undergraduate research project is the end result of our own work and that due acknowledgement has been given in the references to ALL sources of information be they printed, electronic, or personal.

(2) No portion of this research project has been submitted in support of any application for any other degree or qualification of this or any other university, or other institutes of learning.

(3) The word count of this research report is 18128.

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LIST OF ABBREVIATIONS

IoT	Internet of Things
IPM	Inverse Perspective Mapping
NAPIC	National Property Information Centre
PIR	Passive Infrared
GPS	Global Positioning System
RFID	Radio Frequency Identification
CCTV	Closed-Circuit Television
AVI	Automated Vehicle Identification
LPR	License Plate Recognition
ITS	Intelligent Transportation Systems
PRS	Parking Reservation System
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
SOR	Stimulus-Organism-Response
RII	Relative Important Index
SPSS	Statistical Package for Social Sciences

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Preface

This research explores the integration of IoT technology in developing a smart parking system within shopping malls in Kuala Lumpur. Investigating the implementation of sensor system, navigation system, security system, smart payment system, parking reservation system and electric vehicle charging system, this research aims to enhance parking management efficiency, reduce congestion, and provide real-time information to optimize parking space utilization. In addition, this research also will conduct to identify the components of smart parking system that will affect the level of customer's satisfaction. The research aims to analyze the feasibility, effectiveness, and convenience inherent in introducing IoT-based smart parking system tailored for urban shopping environments in Kuala Lumpur.

Abstract

Smart parking system with IoT technology is important in shopping mall parking because it enhances convenient and efficiency to the shoppers and visitors. The system can assist to reduce several problems that impacted to the users, such as wasting time in finding parking and paying parking fees at auto-pay machine. Thus, this research was conducted to study on the components of smart parking system that will affect the level of customer's satisfaction. The components include smart payment system, sensor system, navigation system, security system, parking reservation system and electric vehicle charging system. Questionnaires were used to collect data with total respondents of 100 who are above 16 years old and has experience driving vehicles to shopping mall in Kuala Lumpur. The results obtained from Relative Important Index analysis shown the most affecting component of smart parking system was smart payment system. Therefore, the shopping operator, developer and property manager can emphasize the most important elements of the smart parking system to enhance the management and increase the customer's satisfaction. In addition, the smart parking system should be implemented in Malaysia to ensure that the parking system has advanced and comprehensive facilities to the visitors.

Chapter 1: Research Overview

1.0 Introduction

This research is carried out to study the effectiveness of smart parking system in shopping mall which using Internet of Things (IoT). In this chapter, brief of introduction of this research will be discussed with supportive research subject globally and internationally. Next, issues arise will be explained in the problem statement's part and follow with outline of research questions based on the gap that come out in this part. Afterward is developing of research objectives and continue with significances of study and chapter layout. Conclusion are made at the end of this chapter.

1.1 Research Background

The number of vehicles in Malaysia is increasing day by day and it has increased by at least a million, surpassing the number of people since 2019 (Chan, 2022). Based on the yearly statistics of transport by Ministry of Transport Malaysia, it stated that the newly registered vehicles in 2021 was 1,192,592 and it was increase 2% compared to 2020. However, the accumulated registered vehicles in 2021 was 33,570,214, it was increase 3.7 compared to 2020. The highest percentage of the vehicles was car and followed by motorcycle (Ministry of Transport, 2023). Hence, the increasing number of vehicles provided a lot of impact, such as air pollution and it affected the health of the human. It is because Malaysian automobiles on the road often consume more fuel, which accounts for a large portion of the country's overall carbon dioxide (CO2) emissions, which is the principal greenhouse gas (theSundaily, 2021).

In addition, due to the increasing vehicles in the road it causes the problem of traffic congestion become more serious (Gautam, 2021). According to the information of the news of BusinessToday claimed that, at least in the Klang Valley Area, the typical Malaysian spends roughly 44 hours per month stuck in traffic. It means the people who live in Klang almost two whole days in traffic every month (BusinessToday, 2023).

The traffic congestion especially will occur during festival due to improper parking system to assist the customers find the parking and complete the payment, so it will take a longer time to stuck in the shopping mall (Victor, 2022). In addition, improper parking system in shopping mall will cause reduce repeat business as they think that finding a parking in the mall is difficult, so they will be persuaded to visit another mall or even do the shopping online. The converse of this is when the customers spend hours driving around the same patch of tarmac. Even if they do locate a location and interact with the mall, there's a good probability that this encounter will make them very unlikely to return. Hence, it's critical that the parking in mall should be enough and efficient enough to let the business speak for itself (Fick, 2022).

In Malaysia, the current condition of the car parking is some of the shopping mall still apply manual ticket system which is time-consuming. This kind of the system will cause the challenging nature of information management. The administration should be ready to quickly offer information about any car parked in their spot in the event of any unfavourable circumstances. Electronic automated systems enable this (Prasanth Aby Thomas, Consultant Editor, 2023). Besides, the issue of tough to find parking also occur in Dubai and one of the systems that used in shopping mall is the Mall of the Emirates app. Therefore, the customers can add their licence plate to the parking pre-booking area of the Mall of the Emirates app by downloading it. Customers will reserve parking in a particular zone and an arrival time. Hence, the customers do not need to spend too much time to find the available parking when they enter the shopping mall (Abbas, 2022).

As a result, development and implementation of a smart parking system is important in shopping mall in order to resolve the traffic congestion, reducing pollution and reducing the detrimental effects on the environment and landscape. It is because the system can help to locate and reserve the parking space before the customers arriving the destination (Balfaqih et al., 2021). A smart parking system an IoT (Internet of Things) solution that notifies users about open parking spaces in a certain location by using sensors, cameras, and/or software. Most of the time, individuals can also reserve the space directly before they reach at the shopping mall and pay for it via an app (Rosenkranz, 2023). The structure of smart parking is made up of several tools and procedures that serve as parking space detectors. On the one hand, the installation of cameras and/or sensors that capture, analyse, and present data and images to deliver real-time traffic occupancy statistics for the location we are going. On the other hand,

an IoT cloud-based system enables the connection of various devices and the centralization of the data. The availability of on-street parking spaces or spaces in public and private parking facilities is then determined using big data analysis of the data (Burbano, 2021). In shopping mall, it helps the customers easier to find the available parking slot by using camera and sensor. The camera can identify multiple cars at once. By having this image, the specific parking lots that are vacant may be identified which will be indicated on the screen with green circles, so the processed information was used to direct a driver to a space instead of wasting time looking for it (Ahad et al., 2016). As smart parking system is important to shopping mall, there has a lot of the shopping mall Malaysia apply the system to increase efficiency and easier to control and manage the car parking, such as Sunway Pyramid, CityOne MegaMall(Camelia, 2020).

Compared to traditional parking, traditional parking has a lot of disadvantages which will cause inconvenient to the people. The traditional parking system is completely manual and requires a guard to open and close whenever a vehicle enters or exits the car parking lot. The major challenge of traditional parking system is the visitors required to wait for a long time to enter the parking lot when there are number of the vehicles enter at the same time (Woo & Muslim, 2022). In addition, the traditional car parking is difficult to go through such a vast volume of data because manual parking systems still use paper records and data collection, and input are done manually by parking workers. Hence, it will cause the long-term profitability of the shopping mall is at stake because customers who use manual parking management systems lose time waiting in lines to enter and exit the parking lot due to outdated or manual methods (Karunarathna & Rathnayake, 2023). Therefore, traditional car parking system is not suitable for today's malls because it is outdated and also reduce efficiency.

In conclude, smart parking system will benefit to the shopping mall, especially the function of pre-reservation. It indicates the state of parking availability to car owners. After paying online, customers can reserve parking if it is available, or else they can find another parking space. It will help the customers save the time and efforts for finding a space to park the vehicle when they are shopping, especially during weekend and holidays.

1.2 Problem Statement

The number of vehicles in Malaysia is increasing year by year. The main reason is that previously, the government's implementation of the car sales and services tax exemption in June 2020 and it was extended until 30 June 2022. (Zulkaflee, 2022b). Hence, the ratio of the number of cars to the number of parking spaces is out of balance, for example, Sunway Pyramid, which has more than 10,000 parking spaces and an average daily traffic volume of 50,000 vehicles, has grown to be one of Malaysia's largest retail malls (Lee, 2021). Hence, implementation of smart parking system will make the parking management ease because it can provide current parking availability status for vehicle owners in order to help them save time to find the parking lot (Aravinthkumar et al., 2020).

A traditional parking system is that the customers must roll down the window, depress the button, and wait for the ticket to be processed and issued in order to use the conventional ticket parking system. This may cause traffic congestion in the future (Louis, 2021). In addition, there has limited parking information provided by traditional parking system which is do not provide real-time information on parking spaces (Estheralu, 2023a). Compared to the traditional ticket parking system, it is outdated and unsatisfactory due to limited parking information, which is do not offer real-time parking information, which may lead to inefficient use of parking spaces and irate customers who are unable to find a spot. Moreover, it will cause inconvenient to customers because it requires to pay the cash before they leave the shopping mall and most of the people did not bring the cash when they out (Estheralu, 2023e). Figure 1.0 depicts the phases of a typical traditional parking system.

Figure 1.0: Traditional Parking Stages

Source: Mufaqih et al. (2020). *Applying smart parking system with internet of thing(IoT) design.* IOP Conference Series.

According to Mufaqih et al. (2020), some malls in Jakarta have implemented smart management systems by employing sensors to locate open slots and guide customers there. Despite having sensors, the information may not reflect real-time events, leading to frequent delays in reporting to drivers. Other issues include the potential for users to lose their tickets and the challenge of locating the car. The car users frequently take longer to resolve ticket issues, which is seen as time wasted.

Hence, there has a lot of advantages of implementation smart parking system to the customers and the system can help to increase the satisfaction of the customers during shopping. One of the major factors in smart parking system that can increase the level of user satisfaction is they can quickly check the parking garage's availability and reserve a space using a mobile device (Nehra, 2022). Furthermore, the major benefit of smart parking system compared to traditional parking system will be real-time tracking, it can help the customers save time to reach the desired destination because it can give them access to real-time parking space tracking. By tracking parking use and spotting trends, they can assist businesses in making the most of their parking operations (Estheralub, 2023). However, it is not all the smart parking system can provide real time and accurate information to customers. Hence, it will cause the drivers may proceed to locations other than the specified parking spots due to inaccuracy or delays in getting the data, which can cause chaos and confusion on the roads (Pratik R, 2022). Thus, research about smart parking in shopping mall is required to carry out in order to enhance the effectiveness of parking lot beside it is a main point to attract the customer's satisfaction.

1.3 Research Questions

i. What are the components of IoT that can assist on the implementation of smart parking system in shopping mall?
ii. How does the components affect the level of customer satisfaction?

1.4 Research Objectives

1.4.1 General Objectives

i. To assess the impact of implementing IoT smart parking system in shopping mall.

1.4.2 Specific Objectives

i. To identify the components of IoT that can assist on the implementation of smart parking system in shopping mall.
ii. To analyse the level of customer satisfaction towards IoT smart parking in shopping mall.

1.5 Significance of the Study

In recent years, customers to shopping malls have faced considerable parking issues as a result of the rapid rise of urbanization and the rising number of vehicles. Modern consumers' demands have shown traditional parking systems to be unable to accommodate them, which causes annoyance, lost time, and poor shopping experiences. This research on installing a smart parking system in the shopping mall deals with this urgent problem. This research's importance stems from its ability to improve the customers' shopping experiences. By adopting the smart

parking system can decrease the amount of time customers spend looking for parking spaces by using real-time sensors, data analytics, and mobile applications, thereby increasing their shopping experience.

Moreover, implementation of smart parking system also benefits to seller on the shopping mall. It is because customers spend more time shopping in the mall due to it is more convenient to find the available parking, and small businesses have more opportunities to interact with a wide range of customers. By enhancing the experience of the customers, they are more inclined to return and check out the mall's other offerings, this can result in increased sales and better customer retention rates. Therefore, the smart parking system not only increases convenience but also acts as a driver of economic growth for the mall.

In addition, this research will be beneficial to shopping mall manager because the system produces priceless insights on client behaviour, peak times, and parking habits. With this knowledge, shopping mall managers can tweak the performance of the shopping mall and increase profits by optimising pricing policies, business hours, and facility upgrades. Furthermore, some smart parking systems increase parking facility security by including surveillance functions. By keeping an eye on activities, responding quickly to issues, and ensuring the safety of patrons and their vehicles, the shopping mall managers may promote a safe and welcome environment.

In brief, this research highlights the several advantages of smart parking systems for shopping malls, emphasising how they may improve consumer satisfaction, stimulate business growth for retailers, and facilitate effective mall administration. It is an essential element in ensuring that malls are appealing, competitive, and sustainable in a city that is always changing.

1.6 Chapter Layout

This thesis will be layout with five (5) chapters.

Chapter 1: Research Overview

The first chapter delineated an overview of the concept of the research. It covered the introduction, research background, problem statement, research questions and research objectives. The significance of the study is then described in the chapter before the layout of the chapter.

Chapter 2: Literature Review

In Chapter 2, the literature review highlights the insights of previous researchers, drawing from their journal articles. This section offers a comprehensive review of data from secondary sources relevant to the research topic. This chapter aims to aid both the researcher and readers by providing a clear and concise description of the relevant research conducted in the field of interest. It offers a logical and informative overview of the existing body of work, contributing to a better understanding of our study.

Chapter 3: Methodology

Chapter 3 describe the methodology of the research project. It covers the research design and identify the suitable method to collect the research data. In this chapter, it includes the data collection methods, sampling design, research instrument, constructs measurement, data processing, data analysis and conclusion of the chapter.

Chapter 4: Data Analysis

In Chapter 4 describe the data analysis of research. The pattern of the results and analyses of the results which are relevant to the research questionnaire will be discussed. The result of the questionnaire was collected from 100 respondents. The result of the questionnaire will be conducted by content analysis, frequency analysis, descriptive analysis, reliability test and inferential analysis.

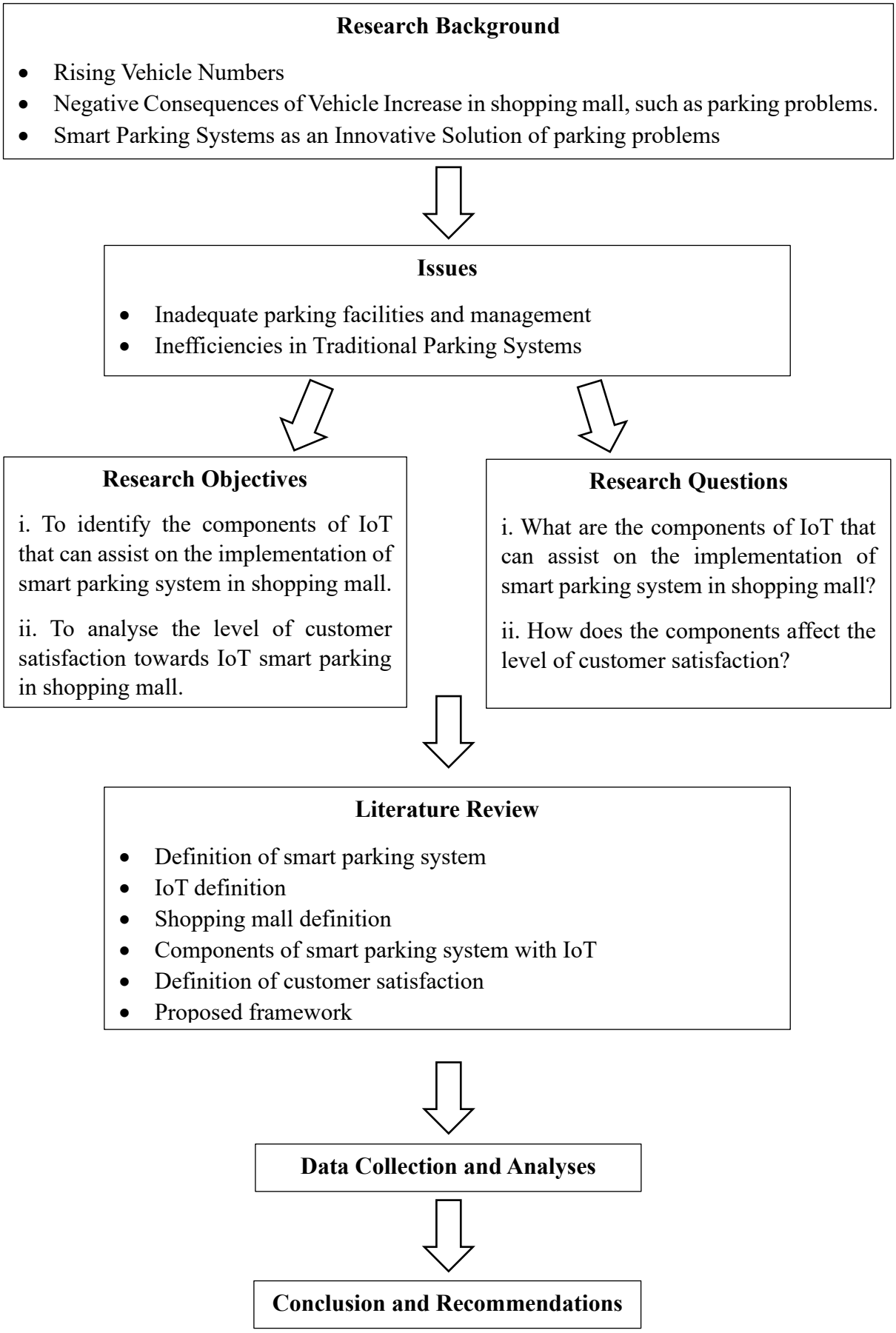
Chapter 5: Discussion, Conclusion and Implications

The last chapter of the research is discussion, conclusion and implications. The chapter include summary on statistical analysis and discussion on the major findings. Furthermore, the chapter

also discuss the implications of study and provide the recommendations for future researcher on the limitations of the study. Lastly, the chapter will provide an overall conclusion of the research.

The chapter layout will be illustrated into a diagram that shown in Figure 1.1.

Figure 1.1: Chapter Layout



1.7 Conclusion

In conclusion, the increasing number of vehicles in Malaysia has led to numerous challenges, including traffic congestion and parking shortages, particularly in shopping malls. The traditional parking systems used in many malls have proven inadequate and inconvenient for customers. This research is crucial in addressing these issues by introducing a smart parking system powered by the IoT technology. In the following chapter will delve into a detailed description of the types of smart parking system and its functions and the wide-ranging benefits it brings to customers. By exploring the technical aspects and practical advantages of this innovative system, this research aims to demonstrate its potential to revolutionize the shopping experience and improve the efficiency of parking facilities in shopping malls.

Chapter 2: Literature Review

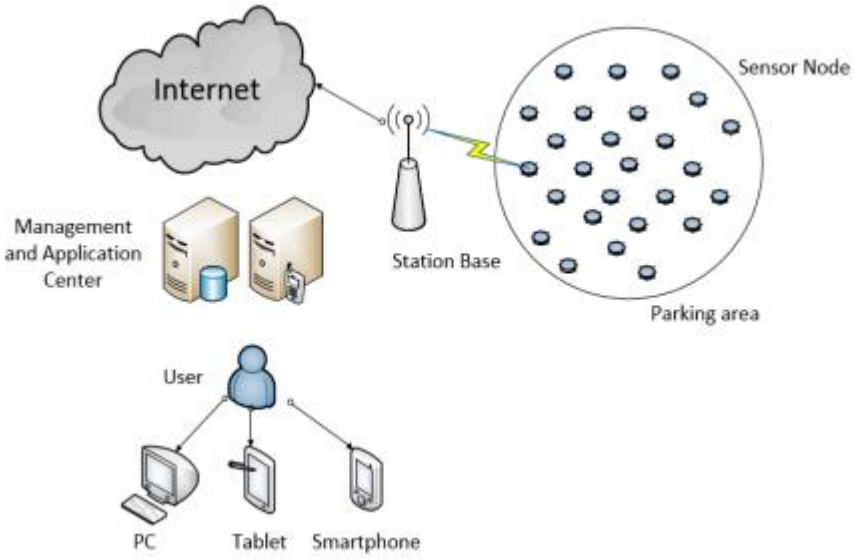
2.0 Introduction

In this chapter, it will contain the study of the field of smart parking system which include the types and its crucial role in shopping mall. This chapter also includes the definition and various parking system uses of the IoT. Definitions of shopping malls are discussed, highlighting their need on effective parking options. Guided by conceptual framework, it will discuss the components that capture customer satisfaction on the parking system in shopping mall. The next section of the chapter discusses implementation IoT in smart parking systems that will improve consumer satisfaction. Finally, a proposed framework will be provided in order to summarise the essence of optimised parking experience in shopping malls.

2.1 Smart Parking System

Smart parking system is a parking solution that may comprise counting sensors, cameras, or in-ground sensors. In order to determine if parking spaces are empty or occupied, these devices are typically placed adjacent to or implanted into parking spaces. Real-time data collection enables this by the sensor nodes scattered in the parking area. The information is subsequently sent to a smart parking mobile application or website, which informs its users of the availability (Karsten, 2019). It means that the smart parking system is an architectural framework made up of many embedded systems and application platforms. For instance, users can request reserved parking spaces at the application layer, and this request will immediately be handled at the network layer (Biyik et al., 2021). Figure 2.0 shows the overall design of a smart parking system (Hilmani et al., 2018). There are three common types of the smart parking system which are camara-based technology, overhead radars/lidars technology and ground sensor technology (Birchenko, 2023).

Figure 2.0: Smart Parking System



Source: Hilmani et al. (2018). *Designing and Managing a Smart Parking System Using Wireless Sensor Networks.* Journal of Sensor and Actuator Networks.

2.1.1 Camera-based Technology

This kind of the smart parking system is the parking lot aerial view image is provided by the system using inverse perspective mapping (IPM), which is then processed to extract parking spot information. A navigation system is also part of the system to help cars locate open parking places (Liu et al., 2023). In this technology, a camera serves as a sensor to take pictures that depict how full parking lots are. A camera is utilised because it can detect the presence of numerous cars simultaneously using an image. Additionally, the camera is easily movable to detect various car parking lots. By having this image, it is possible to determine which parking lots are empty, and the processed information was then utilised to direct a driver to an available parking lot rather than wasting time looking for one (Al-Kharusi & Al-Bahadly, 2014).

2.1.2 Overhead radars/lidars Technology

Utilising radio transmissions and laser light reflections, overhead radars and lidars can identify the presence of a vehicle. A mains-powered sensor mounted on a lamp pole can reliably cover only 4-5 parking spaces because the device is accurate up to a distance of 7 metres but loses accuracy at larger distances and sharper reflection angles (Cto & Cto, 2022).

2.1.3 Ground Sensors Technology

According to Shah et al. (2021), this technology is to keep track of the occupancy of parking spaces, sensors are installed on each one. The detecting approach does not depend on supporting systems like pillars, walls, or other similar structural elements, and it is not impacted by line-of-sight interference. high precision, which results from the proximity to identified objects being the guiding factor. a 1-1 detection strategy, or one sensor per vehicle. The smart parking market, system requirements, and available IoT solutions are all in their nascent stages. The ground-mounted vehicle detection sensors, which incorporate the most recent sensing, wireless communication, and cloud computing technologies, show the greatest promise for bridging that gap. The most popular sensing technology for ground sensors are magnetometers and radar.

2.2 Internet of Things (IoT)

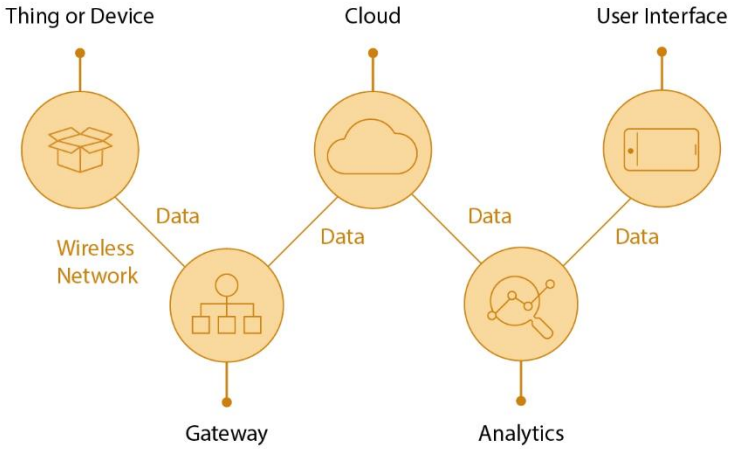
The internet of things (IoT) is a term that broadly refers to anything that can be connected to, controlled, or observed online. IoT is a network of sensors, intelligent gadgets, and actuators that improves the efficiency of our daily tasks. Over the internet, activities and processes can be remotely traced, observed, and managed. By building a network of "Things" that can communicate with one another, IoT expands the use of the internet. It offers a future in which objects (home appliances, wearables, and sensors) develop intelligence; with cloud computing, IoT becomes highly scalable and intelligent. The network can have any number of nodes added

or removed, and data can be retrieved, examined, and monitored in real-time with minimal need for human intervention (Agarwal et al., 2021).

According to Trivedi (2022), it provides five (5) major components of IoT. There are thing or device, user interface, cloud, analytics and gateway. IoT depends on intelligent sensors that are affixed to actual physical items, or "Things," and which transmit data to a centralised hub, the portal or gateway. The commonly used sensor are RFID tracking, proximity, light, humidity, temperature, and pressure. These sensors can be linked to low-power wireless networks, such as WiFi, ZigBee, Bluetooth, Z-wave and LoRAWAN (Rajiv, 2023). Besides, based on Trivedi (2022), user interface serves as the user-facing component of an IoT device, enabling users to monitor and control data. It constitutes the visible and tangible aspect of the device, facilitating interactions between people and technology. Cloud storage is crucial for storing data from IoT devices. Cloud computing involves continuous server networks. IoT clouds manage vast data for remote access and decision-making, prioritizing high-speed data processing and analysis, often with distributed databases. In the cloud, received data undergoes processing and analysis, often employing algorithms like machine learning. Analytics is the conversion of analogy data from sensors and devices into actionable insights, crucial for IoT monitoring and improvement. Lastly, IoT Gateways manage data traffic between networks, ensure device interoperability, and provide security with encryption. They can locally preprocess data and act as a protective layer against malicious attacks. Figure 2.1 show the component of IoT.

IoT has been applied wide aspect of life, which involved in private as well as public sectors. There are some top applications of IoT across industries which are agriculture, healthcare, retail, transportation and so forth (Terra, 2023). IoT also used into smart parking system, and it will be the main focus in this research.

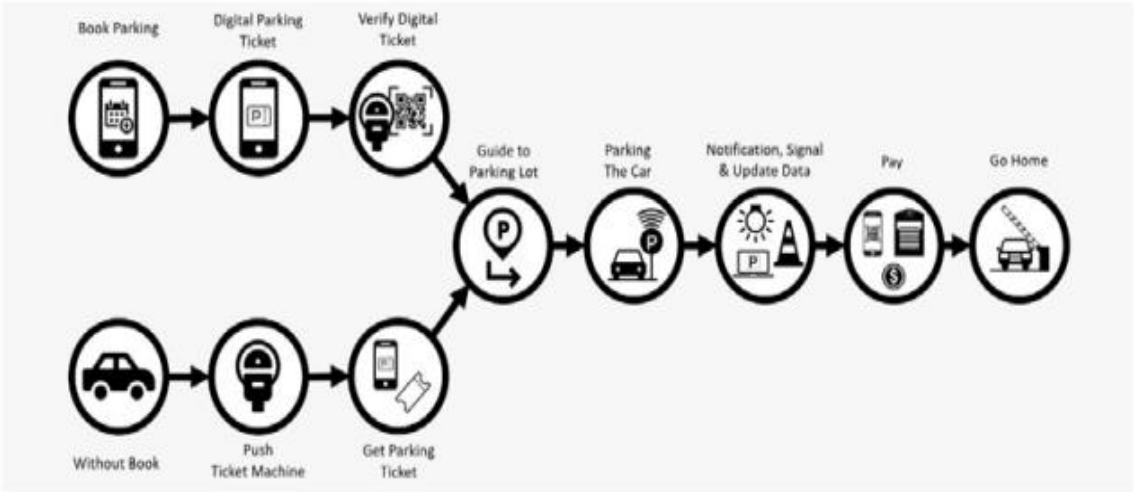
Figure 2.1: Major Components of IoT



Source: Trivedi. (2022). *Components of IOT*. Scaler Topics

More of the parking lot of shopping mall adopt IoT smart parking system to enhance the efficiency and convenience to the visitors. The implementation of IoT in shopping mall parking will use sensor, mobile and web-based application and cloud system. Hence, the parking system incorporates an in-ground vehicle detection sensor that uses infrared technology to communicate with signal light notifications above parking spaces. The sensor signals whether a parking space is vacant (green light) or occupied (red light). A mobile and web-based application allows customers to interact with the system, checking parking lot availability, booking spaces, and making payments. The cloud system serves as the database, recording all activities in the parking system, including booking times, parking duration, fees, and payment methods, along with user information (Mufaqih et al., 2020b). Figure 2.2 show the implementation of smart parking system.

Figure 2.2: Smart Parking System Implementation



Source: Mufaqih et al. (2020). *Applying smart parking system with internet of things (IoT) design*. IOP Conference Series.

2.3 Shopping Mall

Shopping mall also known as shopping centre or shopping arcade which is a building or collection of buildings that houses retail stores, with interconnecting walkways allowing customers to conveniently walk from store to store (Shopping Mall - New World Encyclopedia, 2023). Shopping malls are characterised by a sizable enclosed, designated area, provide a variety of retail shops, dining establishments, lodging options, and entertainment venues serving as "a premier habitat for consumers"(Krey et al., 2022). Shopping malls do more than only provide a wide variety of goods and services. They offer the neighbourhood where they are located a variety of benefits. The growth of work opportunities is one of the largest benefits. People of all ages and backgrounds can find employment at shopping centres as security guards or sales workers. By giving the workers a source of income, these occupations support the local economy and lower unemployment rates in the area (Pat, 2023). As shopping mall is important to drive the growth of economic and bring benefits to the social, there had a total of 1,060 shopping complexes with 17.25 million square meter of space in Malaysia, according to National Property Information Centre (NAPIC) in 2022. Selangor (3.74 million square metres; 153 malls) is the largest contributor, and it is followed by Kuala Lumpur (3.29 million square metres; 111 malls), Johor (2.44 million square metres; 157 malls), and Penang (1.82 million

square metres; 108 malls) (Yee, 2022). The examples of shopping malls in Malaysia are Pavillion KL, Sunway Pyramid, 1-Utama Shopping Centre and so forth. Based on Musil (2023), there are eight (8) types of the shopping mall, and it will be shown in Table 1.0 in order to differences between the types of malls.

Table 1.0: Differences between Types of Malls

Types	Concept	Gross Leasable Area (GLA)	No. of Anchors	Types of Anchors	Trade Area Size
1. Regional Mall	Enclosed malls. Offer general merchandise and fashion.	400,000 – 1,000,000 square feet	2 - 3	Discount department store Fashion apparel Full-line department store	5 – 25 miles
2. Lifestyle Centers	Open-are retail centers. Upscale stores with dining and entertainment.	150,000 – 500,000 square feet	0 - 2	Large format upscale specialty	8 – 12 miles
3. Factory Outlets	Open-air shopping centers. Sell brand-name products, often from previous seasons or overstock. Offer a wide range of discounted products.	50,000 – 400,000 square feet	N/A	N/A	25 -75 miles
4. Power Centers	Category-dominant anchors. Leased to large-format retailers.	250,000 – 600,000 square feet	3 or more	Category Killer Home improvement Hypermarket	5 – 10 miles
5. Theme/Festival Centers	Leisure, tourist, retail and service-oriented offerings.	80,000 - 250,000 square feet	N/A	N/A	25 -75 miles

6. Community Centers	Offer general merchandise and a wider range of apparel and other soft goods. Convenience	125,000 – 400,000 square feet	3 or more	Discount department store Supermarket Drug Apparel	3 – 6 miles
7. Neighborhood Centers	Convenience, cater to day-to-day needs of community. Most common type	30,000 – 125,00 square feet	1	Supermarket	3 miles
8. Covenience Centers	Smaller properties. Primarily serve the immediate neighbourhood or local community	< 30,000 square feet	N/A	N/A	< 1 mile

Source: Musil. (2023). *7 Types of retail shopping centers*. TriLand.

Since the mid-1950s, customer reasons to visit malls have changed from just shopping to seeking out extra experiences, consistent with other retail outlets, as a result, a positive holistic (Krey et al., 2022). Hence, one of the factors that will enhance the customer experience is provide convenience in term of easy to find the stores, parking spaces, ATMs and so forth, but the important is provide plentiful parking places which can directly enhance their shopping experience and makes it simple (Azam, 2023). In addition, parking lot is a major factor that will affect the business of shopping mall because it can ensure a positive branding by providing a safety and efficient parking system to make them easier find a parking lot and no worry about the safety of vehicles (Editorial, 2022). Besides, an efficient parking system which ensures the smooth flow or traffic that also will increase the satisfaction of the customers. Efficient parking allows quick entry for shoppers and swift exits, leaving ample space for others. Without proper maintenance and management of the parking lot, congestion can impede business profitability (Ten-X Commercial, 2022).

2.4 Components of Smart Parking System with IoT

Based on several journal and article, this research will cover the components of smart parking system with IoT in shopping mall parking. These components will play the role that can enhance the service of IoT based smart parking system to the visitors.

2.4.1 Sensor System

The sensor system that commonly used in parking system in shopping mall are Infrared, Passive Infrared (PIR) and Ultrasonic Sensors. These sensors can determine whether a parking space is available by scanning the parking lot (Khanna & Anand, 2016). The IR sensors sense the output, which is red if a vehicle is detected at that moment and show green when there isn't a vehicle there. The data is then transmitted wirelessly to the middle-wear microcontroller IoT device (Alsafery et al., 2018). According to Ashok et al. (2020), the lights are left on as a result of continuous motion detection by the Dual

Technology sensors which is Passive Infrared and Ultrasonic technology. Sensors give information to the controller showing that no one is in the parking area when no human presence is detected. After a predetermined amount of time, the controller dims the lighting of the parking and aisle lights, reducing energy use. When a user reaches the sensor zone while returning to their car in the parking lot, the controller turns on the aisle and parking light as usual. If a parking system has multiple stories, the parking occupancy data is kept in levels. Each entry has a display that the user can use to choose which level to park on. The display provides precise information regarding the number and quantity of available slots. This user convenience helps users from having to waste time looking for a parking space each time they need to park. Hence, these sensors can provide real-time availability data and energy-efficient lighting control that can enhance shopping mall parking. The sensors also user-friendly that displays for multi-storey parking that the customers can easily detect the available parking lot, so it can enhance their satisfaction during shopping.

2.4.2 Navigation system

Many people use automated mapping software to assist with directions. A navigation system is a computer program that provides graphical maps, coordinates, and directions on a screen. These mapping systems are available on computers, car stereos, and many smart phones (Holmes, 2023). One of the technologies that used in navigation system is Global Positioning System (GPS). GPS-based navigational directions are provided to the driver for occupying a vacant parking space. GPS will facilitate in finding the shortest/optimal route from the current location. A GPS is also perceptible to errors when the signal is blocked due to tall towers, walls within a building or under the ground. Therefore, navigational directions using GPS will be prone to errors in a closed indoor parking lot. Usage of GPS is suited for outdoor open parking lots where there is less chance for signal blocking (Paidi et al., 2018).

According to Kim et al. (2017), there has a system that can address the limitations of GPS technology in these environments by utilizing Bluetooth Beacon communication, NFC card reading, ultrasonic sensors in parking spaces, and advanced algorithms. The system determines the driver's position by combining NFC card reading and Beacon triangulation, with distance measurements between the driver and Beacons. To improve accuracy, a Kalman filter is applied for location recognition. Additionally, it offers Shortest Path Route Navigation, guiding drivers to the nearest available parking spaces using the A Star algorithm and preventing conflicts. Therefore, it can enhance the customer satisfaction by providing real-time information and guidance in challenging indoor parking environments.

2.4.3 Security System

Up to 80% of crimes committed in or around public spaces take place in the parking lot. Vehicle thefts, vandalism, and muggings are some of the most frequent crimes committed in parking lots. Customers are more likely to take their business elsewhere that has proper parking lot security if they do not feel secure parking and strolling to the location (Cyberoptik, 2021). To enhance the security of the shopping mall parking, the application of IoT will play a important role in the parking system. Firstly, the elements of IoT that can enhance the safety of customers are car parking locator, supervision, information services and driver face recognition model. For embedded parking solutions, a variety of sensing technologies could be used at the sensor layer, such as Radio Frequency Identification (RFID) for car parking access control, Closed-Circuit Television (CCTV) with video image processing for determining the condition of the car parking lots, and licence plates with an embedded 3G/4G communication module for tracking and tracing vehicles (RAJYALAKSHMI & LAKSHMANNA, 2023).

According to Rajalakshmi and Lakshmana (2023), the facial recognition model system is the system that utilizes IoT, facial recognition, and optical character recognition to enhance parking management and security. It involves a central parking allocation center, allows access to relevant authorities, and employs sensors to monitor parking space occupancy. The system captures driver faces during entry and exit, compares them with a

database, and allows only authenticated users to exit, ensuring vehicle security. Overall, it proposes an Intelligent Face Recognition-based Multi-Location Linked IoT-based Car Parking System to improve parking efficiency and security.

2.4.4 Smart Payment System

In traditional parking system, the payment system is one of the challenges because the customers need to wait in queues to complete the payment by machine before they leave the mall, so it will consume a lot of time. Sometimes, the customers need to consume time to find the machine which is auto-pay machine and due to the cost of the machine, so it does not been located anywhere in shopping mall. However, apply IoT in payment system will be an effective payment method to customers (Agarwal et al., 2021a). The smart parking system uses contact, contactless, and mobile modes to complete the payment. Smart cards and RFID systems like Automated Vehicle Identification (AVI) tags are employed in contactless mode. Credit and debit cards are used in touch mode. When using mobile mode, payment is collected using mobile phone services (Al-Turjman & Malekloo, 2019a). By utilizing RFID and mobile phone services, the method of parking payment will become easier.

According to Tiew & Kamsin (2021), the system uses RFID technology to record the entry date and time of vehicles into a parking facility. When a vehicle exits, an RFID reader verifies it and records the exit date and time. The system calculates the parking duration by subtracting the entry time from the exit time. The parking fee is determined based on this duration. RFID tags are linked to a mobile payment app, allowing the parking fee to be automatically deducted from the app. Vehicle owners can easily reload their mobile payment apps using their bank cards. This RFID-based parking payment system, combined with financial technology, eliminates the need for physical cash and offers a fully automated parking experience.

One of the examples shopping mall that applied ticketless and cashless in Malaysia is Sunway Pyramid. It uses License Plate Recognition (LPR) technology which is the system

that automatically read and convert car plate numbers into text and numbers. It eliminates the need for physical tickets or cards. When a vehicle enters the parking lot, a camera captures the plate, and parking time is calculated from that moment (Wah et al., 2022). The parking fees can be paid by drivers using a variety of cashless payment methods, including credit cards, debit cards, Touch N Go cards, e-wallets, and online banking or Sunway Pyramid Mobile Application (Tiew & Kamsin, 2021).

2.4.5 Parking Reservation System

A newly developed concept in Intelligent Transportation Systems (ITS) called Parking Reservation System (PRS) enables vehicles to reserve a parking space, especially during rush hours before or while travelling. Either increasing parking revenue or decreasing parking fees are PRS's two main goals (Al-Turjman & Malekloo, 2019b). Based on Quadri et al. (2023), this system contains a host parking database management that gathers and saves information on the identity of the driver and the location of the parking space. An administrator-provided web service sends a warning to the user when the parking reservation time is about to expire. This system can help to overcome the challenge of limited availability because it allows the customers to reserve a parking space in advance. It operates on a first-come, first-served basis, prioritizing users who make reservations earliest (Tu et al., 2023).

2.4.6 Electric Vehicle (EV) Charging Station

The process of recharging an electric vehicle's battery is referred to as electric vehicle (EV) charging. The EV is connected to a charging station or charger to accomplish this. Electricity is supplied to charge electric vehicles (EVs) using a charging station, commonly referred to as an EV charging station or Electric Vehicle Supply Equipment (EVSE). There are three main types of EV chargers exist: Level 1, Level 2, and DC fast chargers. Level 1 is slow charging and usually used at home or workplace, Level 2 is

medium-speed charging and usually provided in parking lots or shopping mall, and DC fast chargers are the fastest for quick charges. (Martinez, 2023).

The integration of IoT technology into EV charging stations offers several advantages. Firstly, it enables remote monitoring and management of charging station operations, including tracking charger availability, controlling user access, and providing real-time status updates. Secondly, IoT data can be used to enhance the efficiency of charging stations, identify problem areas, and track long-term trends. Overall, IoT integration improves the effectiveness, usability, and reliability of EV charging stations (Deepika, 2022).

According to S. Team (2023), the market for electric vehicles (EVs) is rapidly growing, with a 186% increase in sales of electric passenger cars in 2020 and a record year in 2021. Currently, there are over 12 million EVs on the road, and this number is expected to continue rising. Therefore, if the mall does not already have EV charging stations, it is highly advisable to consider installing them, as the demand for electric vehicles is steadily increasing, making them a significant part of the future of transportation. There are few benefits of installing EV charging system in shopping mall. There are attract more customers and boost profits, elevate the shopping experience, address driver range concerns.

2.5 Customer Satisfaction

Customer satisfaction is a metric for gauging how well a company's goods, services, and general customer experience live up to expectations. By demonstrating how well the goods or services are received by customers, it represents the health of the business (Franklin, 2023). Besides, Megha (2023), The Customer Satisfaction Model (Figure 2.4) is a system of causal relations that connects customer satisfaction to perceived quality, perceived value, and customer expectations. The customer satisfaction model is related to the results in terms of client loyalty and complaints.

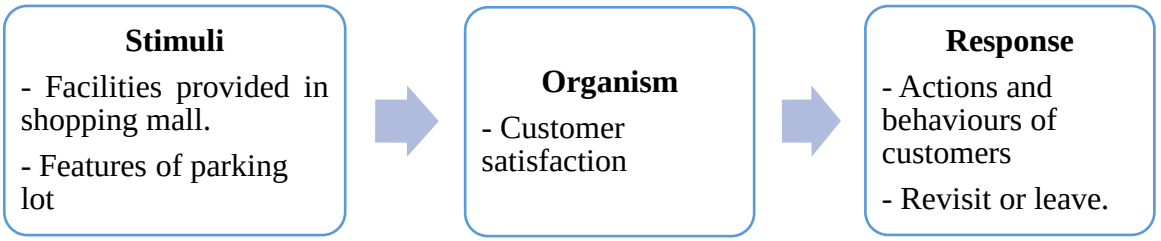
Figure 2.4: Model of Customer Satisfaction

Source: Megha. (2023). *What is Customer Satisfaction?* Zonka.

However, customer satisfaction models often incorporate the Stimulus-Organism-Response (SOR) framework to understand and analyse the components that influence customer satisfaction. According to Juhari et al. (2015), it shows that S-O-R Model, also referred to as the Stimuli Organ Response Model. The Mehrabian and Russell (1974) model adapts to environmental stimuli that directly influence whether customers approach or avoid a situation following their experience there. The model consists of three components which are Stimuli(S), Organism (O) and Response (R). The (S) component will specify the precise stimuli that will determine whether a consumer is satisfied or dissatisfied. Physical traits influence the (O) component, which in turn influences the (R) component, the behaviour of approach and avoidance. This model is frequently employed, especially in the retail industry, to investigate how retailing affects consumer behaviour. Hence, the facilities that provided in shopping mall, such as toilet, banks, customer services and parking lot will be the components affect the level of satisfaction of customers, especially parking lot. The customers are mainly focus on the parking lot that can bring convenient and safety to them, so it can enhance they repeat purchase and retain in the same shopping mall (Saber et al., 2017). Regards to this research, customer satisfaction has a relationship with the shopping mall, if the parking lot is not sufficient, it will decrease the opportunity of the customer revisit to the shopping mall due to inconvenient to find an available parking lot. Hence, the facilities of the shopping mall will affect the customer satisfaction and the level of satisfaction will also affect their

response that is to decide whether to visit the shopping centre again in the future. Here, the facilities of shopping mall will focus on the features of the parking lot in shopping mall. Figure 2.5 show the S-O-R model that relate to the satisfaction of the customers in shopping mall.

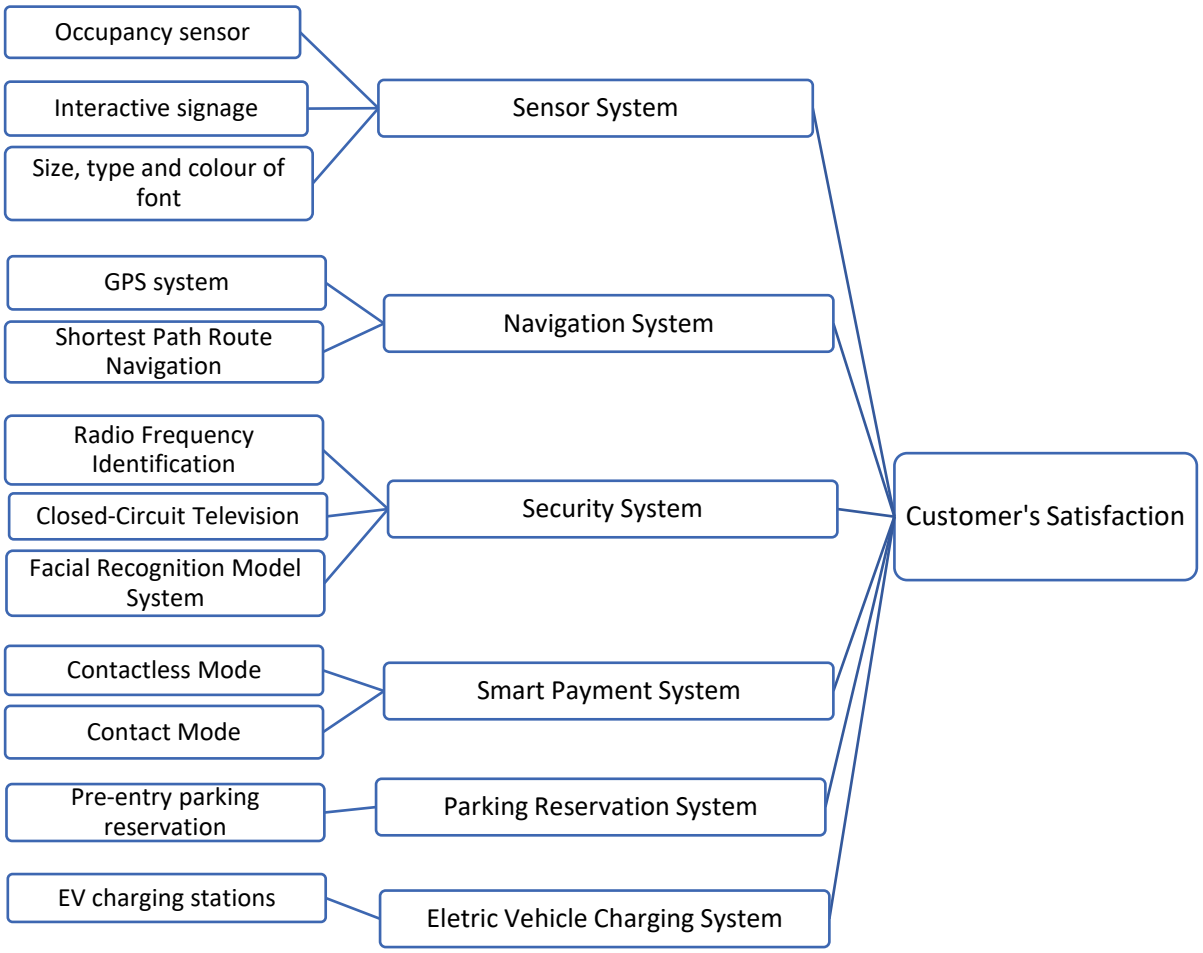
Figure 2.5: S-O-R Model



Source: Juhari et al. (2015). *Key indicator for measurement shopping mall's services capes*. CRC Press eBooks.

2.6 Proposed Framework

Figure 2.6: Proposed Framework



Source: Developed for research. (2023)

Figure 2.6 is the proposed framework of the research that show the components of the smart parking system affect the level of customer's satisfaction. It includes six components of smart parking system with IoT which are sensor system, navigation system, security system, smart payment, parking reservation system and electric vehicle charging system. Each of the elements has the sub-elements that related to the implementation of the main elements. Furthermore, these elements and sub elements will affect the level of customers 'satisfaction.

2.7 Conclusion

In conclude, Chapter 2 which is literature review provide the definition of smart parking system, Internet of Things (IoT), shopping mall. The components of IoT that implemented in smart parking system in shopping mall also has been discussed. Besides, the conceptual framework and the declarations of the hypotheses were developed with assistance from additional research. The following chapter which is Chapter 3 will conduct the methodology part.

Chapter 3: Methodology

3.0 Introduction

This chapter will describe the methodology that used to analyse the data from the collection of questionnaires to achieve the objective of the research. The details of the procedure include research design, data collection methods, sampling design, research instruments, constructs measurement, data processing and data analysis. At the end of the chapter, it will cover a conclusion to provide a short summary of this chapter.

3.1 Research Design

A plan to respond to a series of questions is a research design, often known as a research strategy. It is a framework that contains the techniques and steps for gathering, analysing, and interpreting data. In other words, the study design, which is a component of the research proposal, outlines how the researcher would approach the major research question (Bouchrika, 2023). There are three types of the research design which is qualitative, quantitative and mixed research. Before choosing the method of the research, it needs to consider a variety of factors, such as data types, research objectives, time constraints and so forth. It's crucial to manage risks and avoid reliance on hard-to-obtain elements. A well-executed simple methodology is often more effective than a complex one executed poorly (Jansen, 2023).

According to the definition of qualitative research provided by the American Psychological Association (APA), it is "the study of the nature of phenomena," which includes "their quality, different manifestations, the context in which they appear, or the perspectives from which they can be perceived," but excludes "their range, frequency, and place in an objectively determined chain of cause and effect". A more common-sense guideline can be used in conjunction with this official definition: Data for qualitative research is typically presented as words rather than statistics (Busetto et al., 2020). Hence, the qualitative research is done via observations, interviews, surveys, it cannot be done by sets of numbers or quantifiable information.

However, quantitative research gathers numerical data and uses statistical techniques to analyse it. The goal is to generate factual, empirical data that can be measured and quantified. Making forecasts, seeing trends, and testing hypotheses are common uses for quantitative research (McLeod, 2023a). The common way to collect the data from the research is through observations or questionnaires.

Mixed method is research that involves gathering and analysing both quantitative and qualitative data for the same research (Shorten & Smith, 2017). The purpose of using this method to have a better understanding rather than using one method to obtain the result of the research. When researchers select this method to collect the data, it should be based on two factors to design which are priority and implementation of data collection (Molina-Azorín, 2016). A more thorough understanding of a research subject can be obtained through mixed-method research, which also improves the validity and dependability of research findings by utilising complementary strengths, triangulation, flexibility, greater response rates, and a wider audience (Kuhn, 2023).

Hence, it is important to understand the objectives and issues of the research before choosing a suitable research method to collect the data and analyse the result. Therefore, the suitable research method of this research is quantitative research method due to its ability to measure efficiency, effectiveness, and user satisfaction with numerical data. Quantitative research effectively collects data from a sizable sample size given the potentially enormous user base and parking spaces associated in a shopping mall, improving the generalizability of findings. As a result, the data collection from the quantitative research method can provide more accurate and valuable insight for the research.

3.2 Data Collection Methods

The process of data collection involves obtaining information from all relevant source in order to identify a solution to the research topic. The researcher might get to a conclusion about the result to the relevant question using the data collection techniques. The majority of organisations employ data collection techniques to predict probability and trends in the future. After the data has been gathered, the procedure of organising the data must be done. There are two types of the

data will be collected in order to analyse the outcome of the research, which are primary data and secondary data.

3.2.1 Primary Data

The process of collecting primary data entails getting information directly from a first-hand source. In other words, it's information that the organisation intends to use has obtained. Surveys, questionnaires, interviews, observation, and focus groups are some of the techniques (Simelane, 2023). According to Busayo.Longe (2020a), the primary data offers several advantages, such as tailored data specific to your business or research needs, accuracy, and real-time updates. This data is valuable for addressing unique issues and supporting current organizational or research objectives. In contrast, secondary data can be less reliable due to the risk of encountering false information online and may become outdated. However, primary data collection is time-consuming and may not always be feasible, especially for extensive or unrealistic demands, where existing secondary data, such as census records, can provide valuable insights.

In this research, questionnaires will be used to collect the primary data. The method to distribute questionnaire can be online or offline and the method to collect the data of this research will be distribute via online because it is the easiest and effective way. The reason that uses questionnaire to collect the data is to cost-effectiveness and enable collect the primary data in a short period. In addition, it is easier for the researcher analyse the outcome of the data because using questionnaire is to convert the responses into number, so it can identify the trends and patterns in the data. By using the numerical representation of the data, this technique aids researchers in discovering insights, seeing trends, and coming to wise conclusions (Lindemann, 2023).

3.2.2 Secondary Data

According to (Busayo.Longe, 2020b), data that has previously been gathered from primary sources and made easily accessible for academics to use for their own research is known as secondary data. It is a category of information that has previously been gathered. The sources of secondary data are books, journals, newspapers, government records, websites and so forth. The benefit of secondary research is that it allows for insight and conclusion-drawing without the need for new data collecting, saving time and resources. However, it necessitates a methodical and thorough approach, comprising the identification of trustworthy and pertinent sources. In secondary research analysis, it is crucial to be critical and aware of any biases or data constraints (Bhat, 2023).

The sources of secondary data in this research involve article, government statistic, journal, news to support and enhance the quality and accuracy of the result of this research. The secondary data as a tool for validation for the research and it enhances the validity and dependability of the research if the findings of this research are consistent with those of previous studies or published data. In addition, secondary can help to reduce time to obtain the result from primary data and enables the researcher to perform important research without the requirement for time-consuming data collection efforts, especially involves global or national scale. In short, the combination of primary data and secondary data will provide comprehensive and accurate insight and data for the research to enhance the quality of the research.

3.3 Sampling Design

A sampling design is a detailed strategy for selecting a sample from a certain population. It alludes to the method or practises the researcher would use while choosing the items for the sample. The sample's size, or the number of objects that will be included in the sample, may also be specified in the sample design. Before data are gathered, the sample design is decided (Rashid, 2022). Before establishing a sampling design, it should define the target population, sampling frame and location, sampling elements, sampling technique and sampling size.

3.3.1 Target Population

The targeted population of this research will focus on the customers who from sixteen years old onwards. The reason choosing the age more than sixteen years old onwards is because they have ability to drive vehicles, such as motorcycles or cars to shopping mall. Hence, the targeted population will be the customers who are more than sixteen years old and has experience driving car to the shopping mall. The research will focus on the customers in the Kuala Lumpur. Based on Department of Statistics Malaysia Official Report Second Quarter 2023 there are 1.99 million of population in Kuala Lumpur. Hence, the population in KL is quite huge, it can ensure that this research has a substantial pool of potential participants, allowing for a robust and representative sample.

3.3.2 Sampling Frame and Sampling Location

The sampling location will be chosen in Kuala Lumpur because it is the capital and largest city of Malaysia, making it a significant urban hub with a multicultural and vibrant population. In addition, due to KL's relatively high population density, a great number of eligible research subjects can be found within a condensed geographic area. This can make it easier to gather data and guarantee a big enough sample for statistical analysis. The most important is KL offers a wide range of shopping malls, so it will help the researcher easier to collect the data on this research. There has more than fifty shopping centers in Kuala Lumpur, such as Pavilion Bukit Jalil, Mid Valley Megamall, Sunway Velocity and so forth (VisitSelangor.com, 2021).

Besides, the reason that chooses the targeted population is more than sixteen years old is driving eligibility means that they are eligible to drive their own transport which are motorcycle or car to shopping mall, so they have experience on facing issue of parking system in shopping mall. In addition, choosing this criterion is to enhance the data quality because this age group of adults is more likely to disclose truthful information about their preferences and behaviour, which increases the analytical validity of the data.

3.3.3 Sampling Elements

The main respondents on this research will be the customers who are more than sixteen years old and have experience go to the shopping mall in Kuala Lumpur by their own transportation. Hence, the example of the respondents that will involve in the questionnaire will be undergraduate, office worker, housewife and so forth. It will mainly focus on the residents or visitors that have been go to shopping mall in Kuala Lumpur. Therefore, the respondent involved in the questionnaire will be wiling and available to participate, so they can provide more accurate and valuable data for the research.

3.3.4 Sampling Technique

Sampling technique is a process to obtain samples and data form a target population. There are two types of sampling technique can be used in the research which are probability sampling and non-probability sampling. Probability sampling is a random selection which is a type of sample selection that substitutes randomization for conscious decision. However, non-probability sampling entails non-random selection which based on practicality or other factors (McCombes, 2023). The types of probability sampling include simple random sampling, cluster sampling, systematic sampling and stratified random sampling while non-probability sampling include convenience sampling, quota sampling, purposive sampling and snowball sampling (Mcleod, 2023b).

In this research, the sampling technique that will be used in questionnaire is purposive sampling. Purposive sampling also known as subjective or judgement sampling. This sampling technique is the researcher chooses only study participants who, in their opinion, meet the study's objectives. Using this sampling strategy, the researcher selects study participants at random from the study population. In addition, purposive sampling, based on the researcher's expertise, selectively chooses participants that suit the study, saving time by excluding irrelevant individuals. By collecting data from the best-fit participants, it reduces sampling errors, ensuring highly relevant results for the research context (Obilor,

2023). As a result, the target population is the respondents that above 16 years old and has experience driving to shopping mall in Kuala Lumpur, so it has a specific requirement of the respondent. Thus, using purposive sampling will more relevant to the research objectives and ensures that the sample comprises individuals who possess the necessary experiences and characteristics related to driving and parking at these malls. It allows the researcher gains provide in-depth insights and perspectives from a targeted group that is directly connected to the research questions.

3.3.5 Sampling Size

The phrase "sample size" in research refers to the number of people who are included in a study to adequately reflect the population. In order to ensure that the overall sample accurately represents the entire population, the sample size refers to the total number of respondents included in a study. This number is frequently divided into subgroups based on variables like age, gender, and region (Kibuacha, 2022). The total number of the respondent can be based on Taro Yamene Formula to obtain the number of the respondents that need to participate in the questionnaire (Drew & Drew, 2023).

The formula is as below:

$$n = \frac{N}{1 + N(e)^2}$$

Where,

n = The sample size in the questionnaire

N = Population size

e = The acceptable margin of error,

90% confidence level, therefore e = 0.1

$$n = \frac{1{,}990{,}000}{1 + 1{,}990{,}000(0.1)^2}$$

$$= 99.95$$

$$\approx 100$$

Based on Department of Statistics Malaysia Official Report Second Quarter 2023 there are 1.99 million of population in Kuala Lumpur. The confidence level is 90%, so margin of error (e) is 0.1, therefore from the formula, it obtains this research require 100 respondents to complete the questionnaire.

In addition, based on (Memon et al., 2020), simple regression analysis requires at least 50 samples, and usually 100 samples for most research scenarios, whereas exploratory factor analysis cannot be performed if the sample contains fewer than 50 observations (which is still subject to other factors). Hence, this research should be collected 100 samples to analysis the result of the research.

3.4 Research Instrument

According to (Collins, 2021), any device a scientist uses to collect, measure, and analyse data is referred to as a "research instrument". The subject-specific data comes from participants in the study investigation. Hence, the research instrument of this research will be distribution of questionnaire to obtain the data. The purpose of distribution of questionnaire is to collect the data about the satisfaction of customers on the components of IoT that implementation in smart parking system in shopping mall. The reason using questionnaire as the research instrument because it can enhance the standardization of the data and it can reduce the potential bias and ensures that data collection is consistent. In addition, it is more flexible and tailor, so the researcher can design the questionnaire relate to the topic of the research.

Therefore, there has three sections in this questionnaire, which are Section A, B and C. Section A is about the demographic, Section B is regarding the components of IoT that can assist on the implementation of parking system in shopping mall, Section C is about the level of customer satisfaction towards smart parking in shopping mall. The section A is close-ended question, which include gender, age, marital status, highest education level, living area, frequency visit shopping mall, types of transportation used to go shopping mall, opinion of the parking system and opinion of implementation IoT smart parking system in shopping mall. Section B is multiple-choice question which consists of the types of smart parking system should be implemented in shopping

mall, types of facilities should be adopted with IoT and factors to consider for smart parking system in shopping mall. Section C is Likert scale question, it divided into six part to rate the level of satisfaction on components of IoT implemented in smart parking system. The components are sensor system, navigation system, security system, smart payment system, parking reservation system and electric vehicle charging system. Below is the design of the questionnaire.

Section	Description
A	The section consists of 9 questions of the demographics. It includes gender, age, marital status, highest education level, living area, frequency of visiting shopping mall in Kuala Lumpur, types of transportation used to go shopping mall, opinion of parking in shopping mall and opinion of the importance of implementation IoT smart parking system in shopping mall.
B	This section has 3 multiple-choice questions on the components of IoT should be implemented in smart parking system in shopping mall. This section can understand the visitors or customers that more focus on which components of IoT smart parking system.
C	This section includes 21 questions of the level of customer satisfaction towards smart parking in shopping mall. The questions divided into six components of IoT which is sensor system, navigation system, security system, smart payment system, parking reservation system and electric vehicle charging system.

Source: Developed for the research. (2023)

3.4.1 Pilot Studies

A feasibility study or pilot study is a small-scale preliminary research project carried out before the primary research to assess feasibility or enhance the research concept. The pilot study can assist the researcher in identifying any ambiguities, confusion in the participant instructions, or issues with the developed task (Simkus, 2023). Hence, the main goal of a pilot study is not to provide answers to specific research questions, but rather to stop

researchers from beginning a large-scale study without sufficient understanding of the suggested methods; in other words, a pilot study is carried out to avoid the occurrence of a fatal flaw in a study that would be expensive in terms of both time and money (Lowe, 2019). According to Bullen (2022), the number of data collectors that required and the size of the actual sample will determine the size of the pilot sample. A sample of between 30 and 50 people is usually sufficient for quantitative survey to detect any significant system flaws. Hence, the size of the pilot test for my research requires 30 people is enough to evaluate feasibility and identify the potential problems, challenges or unexpected issues of my research.

The process of the research instrument can be divided into 3 steps. Firstly, it needs to develop the suitable and relevant questionnaire which consists of three sections, Section A, B and C. After developing the questionnaire, it requires 30 people to conduct the pilot test to enhance the quality of the data. After collecting the result of the polit test and ensure the questionnaire is related to the research, then can proceed to next step which is distribute the questionnaire to 100 respondents and obtain the result from them. The whole process is estimated 2 weeks will be completed.

3.5 Constructs Measurements (Scale and Operational Definitions)

Operational constructs, also known as operationalizations, are the practical tools or methods used in research to turn abstract concepts into measurable and observable variables. They encompass questionnaires, surveys, tests, observations, or any approach used to collect data related to the concepts being studied. These tools are designed and validated to accurately capture the essence of the theoretical ideas in a concrete, quantifiable manner. Researchers select these constructs based on their research goals, available measurement techniques, and theoretical frameworks to create reliable and valid measures aligned with their study objectives (Pedada, 2023). According to Busayo.Longe (2019c), measurement scales in statistics classify data variables into four types: nominal, ordinal, interval, and ratio. Nominal and ordinal scales measure qualitative data, while interval and ratio scales measure quantitative data, guiding the choice of statistical analysis

methods based on the nature of the data being analysed. Hence, this research will use nominal and ordinal scales in Section A while Likert scale, one of type of ordinal scale will be used in Section B.

3.5.1 Nominal Scale

The simplest and first level of measurement is called the nominal level. Variables are categorised and labelled qualitatively. Put differently, it assigns them to designated groups devoid of any quantitative significance. It's crucial to remember that numerals have no numerical value, even when they are employed to designate different groups. There is no hierarchy among the groups that employ to categorise the variable when using the nominal scale. There is no category that is superior to, better than, or higher than another (Stevens, 2023). Example of nominal scales include gender, marital status, blood type and so forth. This research includes 4 questions in Section A will use nominal scale to analyse the data.

3.5.2 Ordinal Scale

Using a sequence of ordered responses, an ordinal scale allows researcher to evaluate a respondent's attitude towards a subject. Quantitative data having a naturally occurring order is represented by the ordinal scale. Ordinal scales can be assigned names, ranks, or classifications. The second level of measurement, the ordinal scale, presents the data in a ranked and ordered manner without assessing the degree of variance among them. When variables are measured and ranked or ordered in some order but there is no degree of group distinction, the ordinal scale is employed in statistical data (Akman, 2023). The examples of ordinal variables include education level (certificate, diploma, degree), satisfaction level (dislike, neutral, like). This research will use ordinal scale in Section A which cover 4 questions and all the questions in Section B will also use ordinal scale.

3.5.3 Likert Scale

The Likert scale is one of the types of ordinal scale and this research will use Likert Scale in Section B to analyse the data. Likert scale is a rating system which is employed to gauge beliefs, dispositions, or actions. It starts with a query or statement and ends with five or seven answer statements. The choice that most closely matches the respondent's attitude towards the statement or question is selected. Likert scales are excellent for more nuancedly expressing respondents' sentiments or degree of agreement with an issue since they provide a variety of alternative responses. However, due to weariness, social desirability, a propensity for extreme responding, or other demand characteristics, respondents may reply to Likert scales by agreeing or disagreeing with every sentence (Bhandari, 2023). In Likert scale, it has two of the most popular scales which are 5-point and 7-point Likert scales, and this research will use 5-point scales which is agreement (strongly disagree, disagree, slightly agree, agree and strongly agree). The reasons that choose 5-point Likert scale are easy to use and comprehend for both researcher and respondents. In addition, it requires less time and effort than higher point scales, it also permits a smaller error margin. It can provide a deeper understanding of respondents' thoughts and emotions generates dependable quantitative data that is somewhat easy to analyse (WorkTango, 2023).

3.6 Data Processing

The process of transforming, analysing, and organising data into a format that is valuable for future use is known as data processing. To help corporate processes like forecasting and decision-making, data processing aims to extract pertinent information from raw data (Khandelwal, 2023). The data processing cycle encompasses distinct stages: collection involves gathering raw data from reliable sources such as financial records or user behaviour. Next, preparation filters and organizes this data, eliminating errors and incomplete information. Input converts refined data into a machine-readable format for processing. In the data processing stage, diverse methods and algorithms are used to transform raw data into desired outputs. The output phase presents processed data in readable forms like graphs or tables for user understanding. Finally, in storage,

both data and metadata are stored for quick retrieval and future use, ensuring efficient utilization in subsequent data processing cycles. This systematic flow underlines the importance of refining, processing, and storing data for meaningful applications (Duggal, 2023). Hence, it is important to collect the accurate data to avoid the result of the research has large errors and having the researcher analyse the wrong results.

3.7 Data Analysis

The process of cleansing, converting, and modelling data in order to find relevant information for commercial decision-making is known as data analysis. Extracting valuable information from data and making decisions based on that information is the aim of data analysis. The has several steps in data analysis which are data requirement gathering, data collection, data cleaning, data analysis, data interpretation, data visualization (Johnson, 2023). In this research, it will use, reliability test, descriptive analysis and Relative Important Index (RII) to analyse and interrupt the data collected.

3.7.1 Reliability Test

According to Owa (2023), reliability is the extent to which a measurement method consistently produces the same results when applied under consistent conditions. It ensures stability and consistency in measurements over time. When a measurement method is reliable, it yields consistent outcomes upon repetition. For instance, in a survey, consistent responses from participants over time indicate the reliability of the research method, demonstrating its effectiveness in accurately measuring the targeted concept. Reliability is crucial for obtaining accurate and dependable data that truthfully represents the subject of study. There are several types of reliability which is test-retest, internal consistency and inter-rater reliability.

In this research, it will use internal consistency to test the reliability of the data and the main application of Cronbach's coefficient alpha is to characterise the dependability of multiitem scales. Similar to how it is used with objects, alpha can also be applied to raters. This method of using alpha enables researcher to ascertain inter-rater agreement in cases where the ratings involve noncategorical data (e.g., the degree of emotionality, measured on a range of 1 to 10 across different textual units) (Miller, 2010).

According to Chong et al. (2017), reliability testing often requires a pilot study, which involves administering a questionnaire to approximately 30 individuals not included in the main sample. The data collected from this trial run are then analysed using software like SPSS (Statistical Package for Social Sciences). SPSS offers tools to assess the reliability of items designed to measure a specific construct. The reliability coefficient, often measured through Cronbach's alpha, ranges between 0 and 1. A score of 0 signifies an instrument riddled with errors, while a score of 1 indicates the complete absence of error. In research contexts, a Cronbach's alpha score of 0.70 and above is generally considered to indicate acceptable reliability. Figure 3.0 shows the level of Cronbach 'Alpha indicates the level of internal consistency.

Figure 3.0: Cronbach's Alpha Rule of Thumb

Cronbach's Alpha	Internal Consistency
$\alpha \geq 0.9$	Excellent
$0.8 \leq \alpha < 0.9$	Good
$0.7 \leq \alpha < 0.8$	Acceptable
$0.6 \leq \alpha < 0.7$	Questionable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Source: Habidin et al. (2015) *Sustainable Performance Measures for Malaysian Automotive Industry*. ResearhGate.

3.7.2 Descriptive Analysis

The kind of data analysis known as descriptive analysis aids in the constructive description, display, or summarization of data points so that patterns that satisfy all of the data's requirements may show up. It is among the most crucial procedures for analysing statistical data. It provides researcher with a conclusion regarding the distribution of the data, aids in the detection of typos and outliers, and helps to recognise patterns among variables, so preparing for carrying out additional statistical analysis (Rawat, 2021).

According to Bush (2020), descriptive analysis falls into one of four categories. They are frequency, position, dispersion or variation, and central tendency measures. In this research, frequency analysis will be used in Section A and B to analyse and display how often certain values or ranges of values occur within the data.
A descriptive statistical technique called frequency analysis displays the frequency of each response that the respondents selected. In order to assist users in analysing the data and formulating conclusions, SPSS Statistics has the ability to compute the mean, median, and mode when utilising frequency analysis (myCSULA, 2017). Hence, this analysis will use in Section A, demographic questions and Section B, components of IoT that can assist on the implementation of parking system in shopping mall. Frequency analysis can help to create a clear picture of the characteristics of the group under the research and serves as foundational step for more in-depth analysis and decision making.

3.7.3 Inferential Analysis

Inferential statistical analysis is the technique that will be applied to derive the conclusions. It enables users to draw conclusions or infer trends regarding a broader population from the examined samples. In essence, it uses information from a sample to draw inferences about the population or group as a whole (Calvello, 2020). Based on (Simplilearn, 2023), the major types of inferential analysis are regression analysis, hypothesis tests, confidence intervals. By this technique, it can help researchers to make forecasts, test theories, assess

relationships, extrapolate results to a broader population, and assist in decision-making. In this research, RII will be used in Section C to analyse the level of customer satisfaction towards smart parking in shopping mall.

According to (Sakhare & Patil, 2019), it should be noted that feedback for the study was given on a Likert scale from 1 to 5. Consequently, applying parametric approaches is not useful and appropriate for determining the preferences of the respondents, the method of the relative importance index was utilised to assess the relative significance of sustainable parameters. The non-parametric RII is method that's widely employed in facilities and building management scientists to examine organised replies to questionnaires for ordinal data the evaluation of attitudes.

For the part of the questionnaire of the research, the five-point Likert scale of 1 to 5
(1) = Strongly Dissatisfied,
(2) = Dissatisfied,
(3) = Slightly Satisfied,
(4) = Satisfied,
(5) = Strongly Satisfied

Based on the (Mésároš et al., 2021), the formula of RII as below:

$$RII = \frac{\sum_{i=1}^{5} w\ Xi}{A \times N} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5 \times N}$$

Where,

RII = relative importance index

w = weighting given to each benefit by respondents, and it ranges from 1 to 5

x = frequency of the i-th response given for each cause

A = highest weight (i.e., 5 in this case)

N = total number of participants

n_5= number of respondents for Completely Satisfied

n_4= number of respondents for Satisfied

n_3= number of respondents for Slightly Satisfied

n_2= number of respondents for Dissatisfied

n_1= number of respondents for Strongly Dissatisfied

Based on (Sakhare & Patil, 2019), the RII value has a range of 0 to 1, where 0 is not included. It demonstrates that the sustainable requirements were more significant the higher the RII rating and vice versa. The five critical levels are transformed from RII values are explained in the Table 3.0 (Akadiri et al., 2013).

Table 3.0: Importance Level of RII

High (H)	$0.8 \leq RII \leq 1$
High-Medium (HM)	$0.6 \leq RII \leq 0.8$
Medium (M)	$0.4 \leq RII \leq 0.6$
Medium-Low (ML)	$0.2 \leq RII \leq 0.4$
Low (L)	$0 \leq RII \leq 0.2$

Source: Akadiri et al. (2013), *Multi-criteria evaluation model for the selection of sustainable materials for building projects*. Automation in Construction

3.8 Conclusion

In conclusion, the chapter covers the data research design, data collection method, sampling design, research instrument, construct measurement, data processing and data analysis. The result of the questionnaire will be discussed in Chapter 4 which is data analysis.

Chapter 4: Data Analysis

4.0 Introduction

In this chapter will discuss the result of the questionnaire that collected from 100 respondents. Three analyses are using to analyse the data which are descriptive analysis, scale measurement and inferential analysis. The chapter will encounter with the analysis from Section A, Section B and Section C. Few analyses were using which are Reliability test, Frequency analysis, and RII to provide the result and insight of the questionnaire. Lastly, it will provide a summary of the analysis at the end of the chapter.

4.1 Result for Reliability Test

The reliability test evaluates the stability and consistency of a measurement tool over a given period of time or under various circumstances. Its goal is to guarantee that the scale continuously measures the things it is supposed to measure. Therefore, in this section, it provides the result of the reliability test which is the pilot study. The result is collected from 30 respondents which shows in Table 4.0 while Table 4.1 shows the result of the reliability test.

Table 4.0: Case Processing Summary

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded[a]	0	0
	Total	30	100.0

a. Listwise deletion based on all variables in the procedure.

Source: Developed for research. (2023)

Based on Table 4.1, the result shows six variables which are sensor system, navigation system, security system, smart payment system, parking reservation system and electric vehicle charging

system in the shopping mall. The result of all the variable is acceptable or even good because the Cronbach's Alpha value is more than 0.7. It is explained from Chapter 3.7.1, the Cronbach's Alpha value is between 0.7 to 0.8 consider acceptable while between 0.8 to 0.9 consider good, so the pilot study of the research is reliability. The statement stated by Habidin et al., 2015.

Table 4.1: Reliability Statistics

Reliability Statistics

Variable	Cronbach's Alpha	N of Items
Sensor System	0.838	4
Navigation System	0.822	3
Security System	0.819	4
Smart Payment System	0.866	4
Parking Reservation System	0.776	3
Electric Vehicle Charging System	0.855	3

Source: Developed for research. (2023)

From the Table 4.1, the highest Cronbach's Alpha value is 0.866 which is smart payment system followed by electric vehicle charging system which is 0.855. Next, the Cronbach' Alpha value of sensor system is 0.838 and navigation system is 0.8222. The Cronbach' Alpha value of security system is 0.819. The lowest Cronbach's Alpha value is parking reservation system which is 0.776. Hence, it can conclude that the variables for this research are accurate.

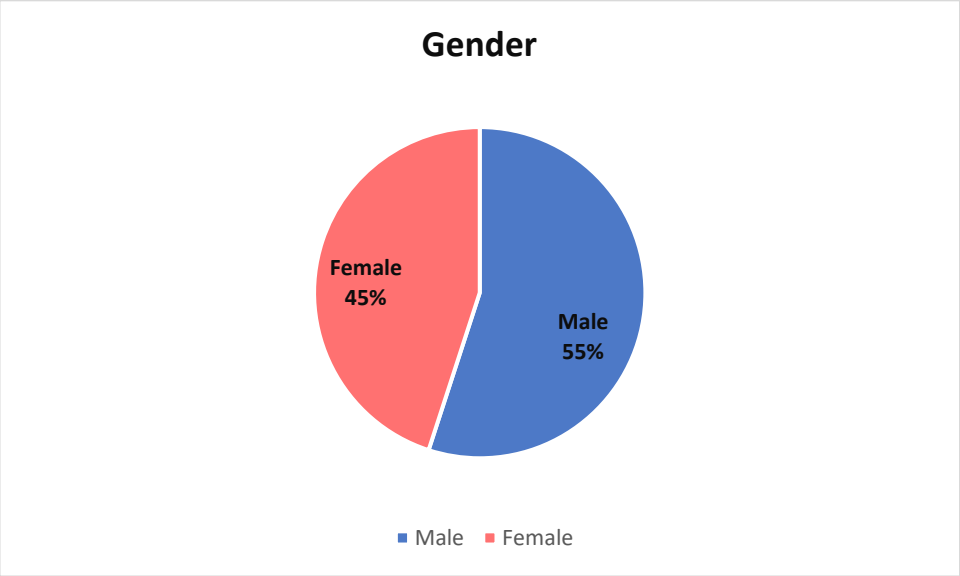
4.2 Demographic of the respondents

The respondent demographic profile is collected from 100 respondents. The profile is distributed to 9 questions. The questions include gender, age, marital status, education level, whether is resident of Kuala Lumpur, frequency of visiting shopping mall in Kuala Lumpur, types of transport that used to shopping mall, experience rate of the shopping mall's parking lot in Kuala Lumpur, importance of IoT smart parking system in shopping mall. These questions will be used frequency analysis to understand the response from the respondent. In addition, the question of

the types of smart parking system should be implemented at shopping mall also use frequency analysis.

4.2.1 Gender

Figure 4.0: Gender

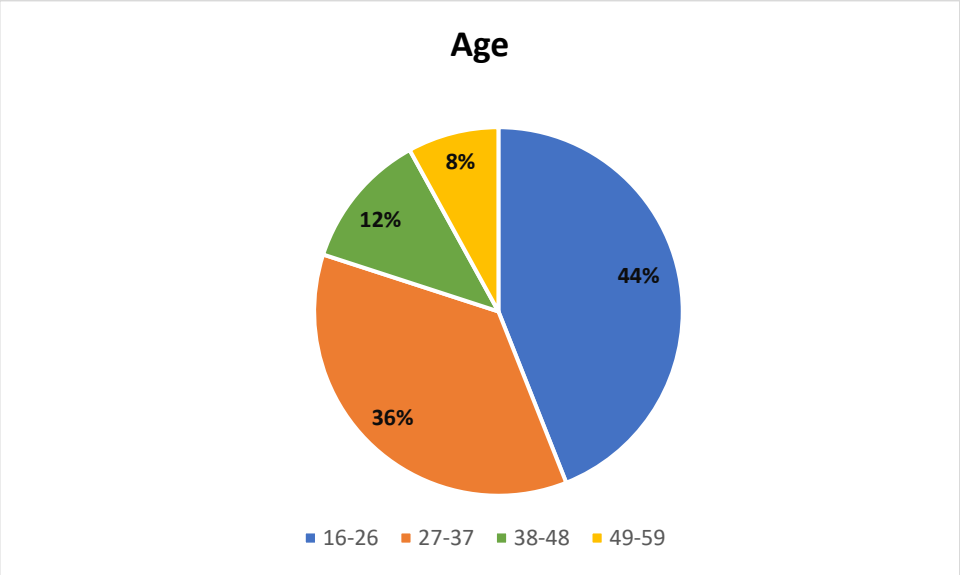


Source: Developed for research. (2023)

Figure 4.0 shows the gender for the total of 100 respondents that participate in this questionnaire of the research. From the pie chart, there has 45% of the female which is 45 female and 55% of the male which is 55 males complete the questionnaire.

4.2.2 Age

Figure 4.1: Age

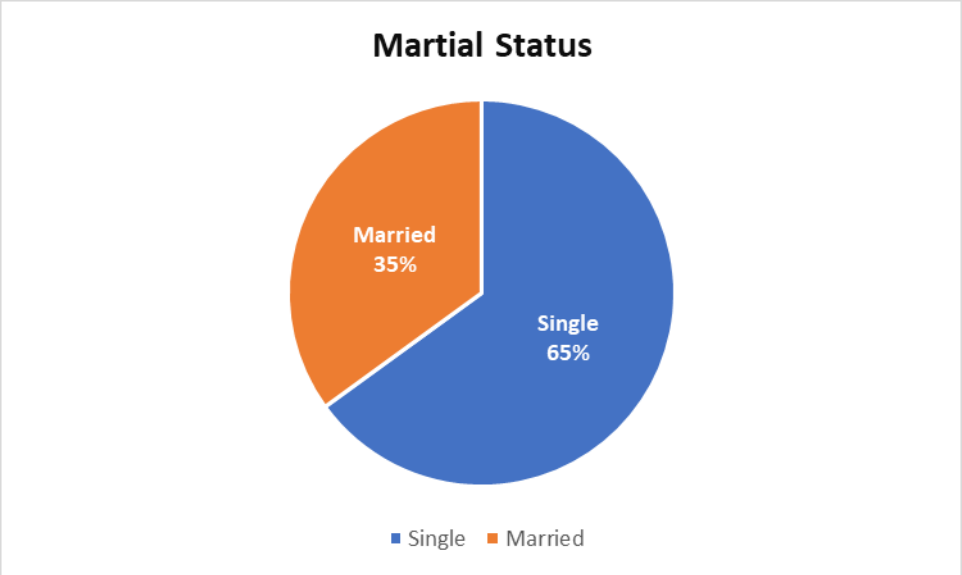


Source: Developed for research. (2023)

Figure 4.1 illustrate the age group of the respondent. It categorized into 4 groups which are 16-26, 27-37, 38-48 and 49-59 years old. The highest frequency in age is 16-26 years old which has 44% of the respondents while the least frequency in age is 49-59 years old which has only 8% of the respondents. Furthermore, there has 36% of the respondents aged from 27-37 years old while in the group of 38-48 years old total has 12% of the respondents.

4.2.3 Marital Status

Figure 4.2: Marital Status

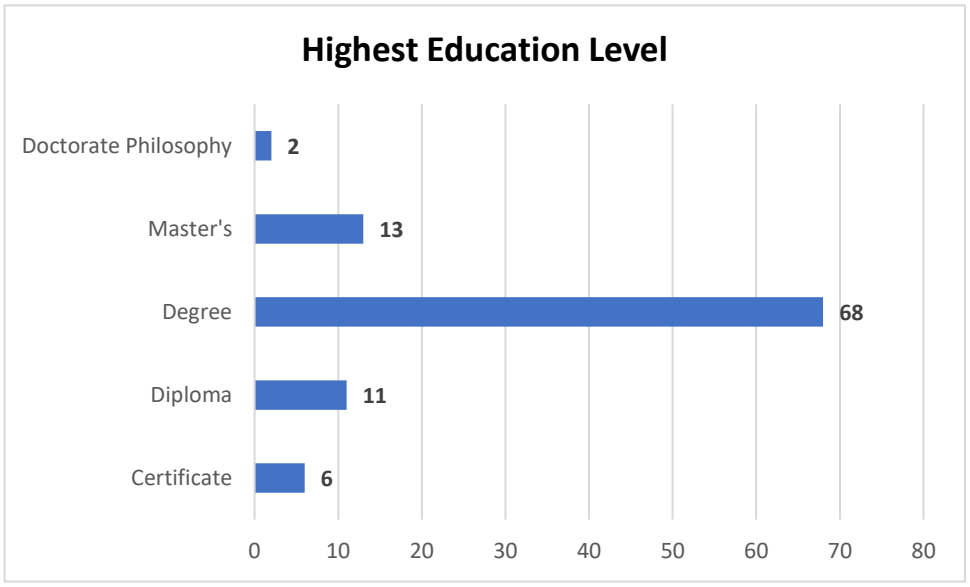


Source: Developed for research. (2023)

The pie chart which is Figure 4.2 showcases the marital status of a group comprising 100 individuals. One segment depicts the 35% married individuals, comprising 35 people of the total, while the other segment signifies the 65% single individuals, constituting 65 of the respondents.

4.2.4 Highest Education Level

Figure 4.3: Highest Education Level

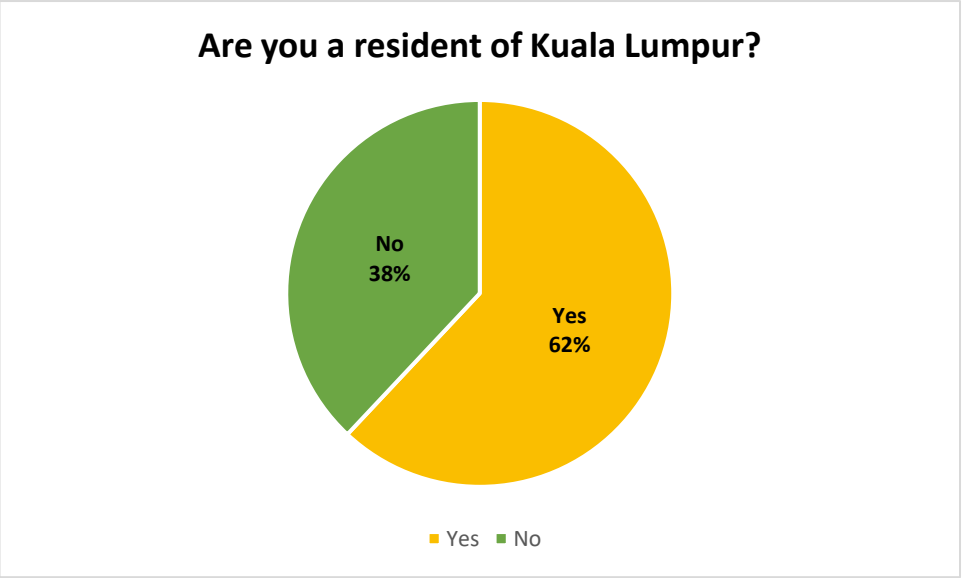


Source: Developed for research. (2023)

Figure 4.3 is the bar chart that shows the distribution of the highest education level of the respondents. From the bar chart, the largest segment represents the 68 individuals with a degree, constituting 68% of the total. Following this, the segment for individuals holding a master's degree include 13 people (13%). In addition, there are 11 respondents holding a diploma, representing 11% of the group and 6 respondents which is total 6% of the group holding certificate. Lastly, the smallest segment represents 2 individuals with the highest education level that is doctorate philosophy, making up 2% of the total respondents.

4.2.5 Resident of Kuala Lumpur

Figure 4.4: Resident of Kuala Lumpur

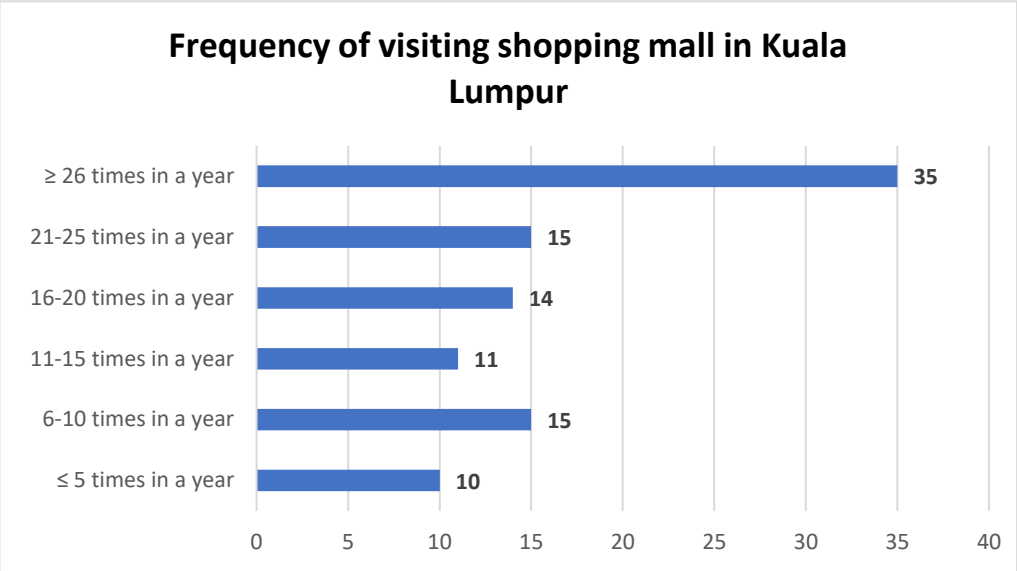


Source: Developed for research. (2023)

The result of the residents of Kuala Lumpur is represented in Figure 4.4. From the pie chart, there are 38 individuals reside in Kuala Lumpur. Conversely, the remaining 62 individuals, do not reside in Kuala Lumpur which is come from other state.

4.2.6 Frequency of Visiting Shopping Mall in Kuala Lumpur

Figure 4.5: Frequency of Visiting Shopping Mall in Kuala Lumpur

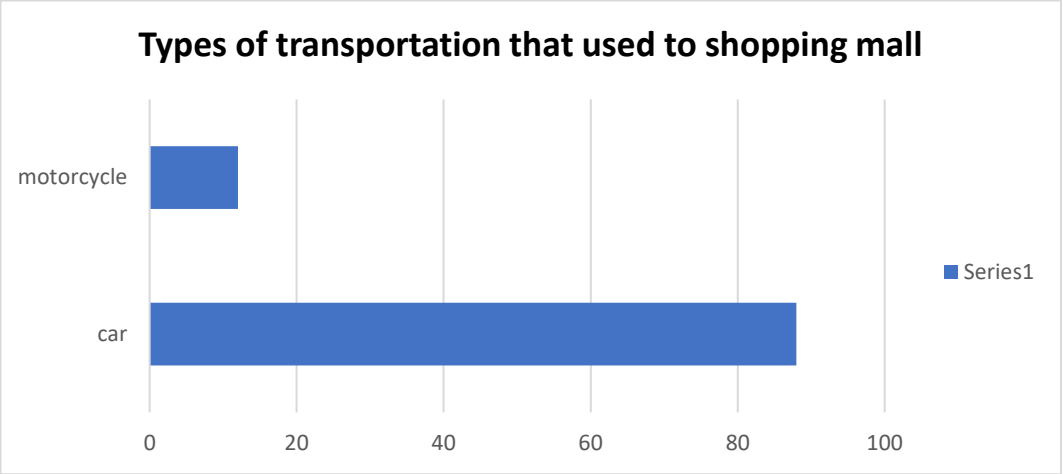


Source: Developed for research. (2023)

The bar chart which is Figure 4.5 illustrates the frequency of visiting shopping malls in Kuala Lumpur by respondents within a year. The vertical axis categorizes the frequency into distinct ranges: "⩽ 5 times," "6-10 times," "11-15 times," "16-20 times," "21-25 times," and "⩾ 26 times." The horizontal axis of the chart represents the number of respondents falling within each frequency range. The highest frequency of visits to shopping malls is more than 26 times in a year which has 35 respondents while the least of the frequency of visits to shopping malls is less than 5 times in a year which has 10 respondents. Besides, there are 15 respondents visit malls 21-25 times in a year and followed by 14 respondents who go 16-20 times annually. Additionally, 11 respondents visit malls 11-15 times annually. The respondents that visit malls 6-10 times in a year has 15 respondents.

4.2.7 Types of Transportation that Used to Shopping Mall

Figure 4.6: Types of transportation that used to shopping mall

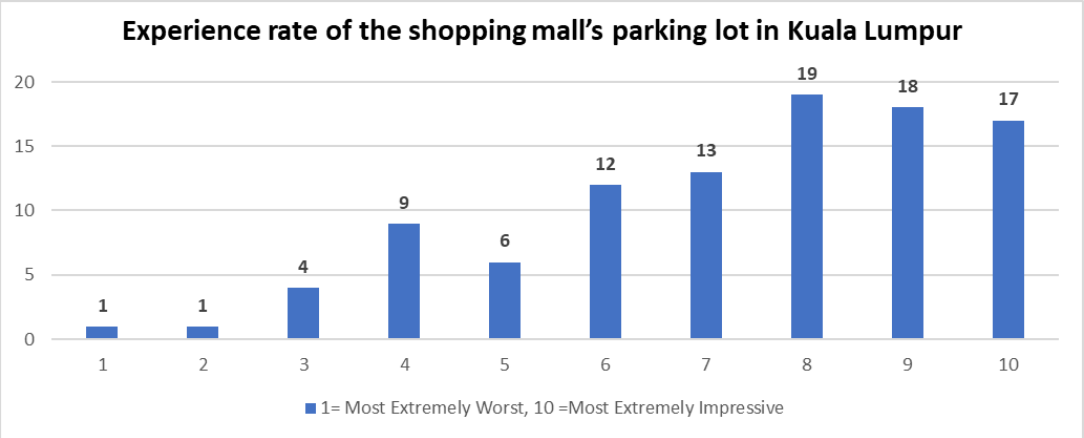


Source: Developed for research. (2023)

The transportation that the respondents used to shopping mall can be categorized into two types which are motorcycle and car. The result shows in Figure 4.6 which illustrate in bar chart. From the bar chart, most of the respondents visiting the shopping mall by car, total 88 of the respondents. However, the rest of the respondents which is 12 people using motorcycle go to the shopping mall.

4.2.8 Experience Rate of the Shopping Mall's Parking Lot in Kuala Lumpur

Figure 4.7: Experience Rate of the Shopping Mall's Parking Lot in Kuala Lumpur

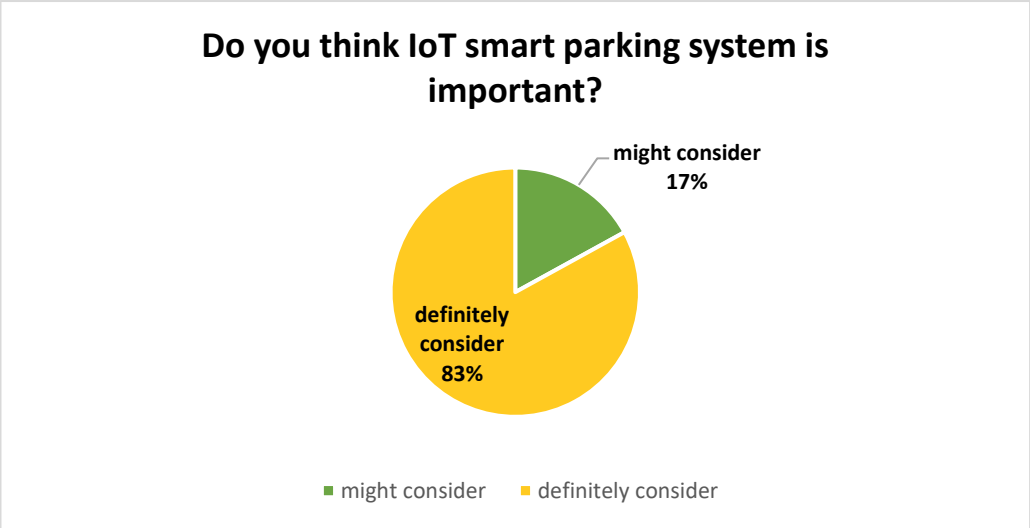


Source: Developed for research. (2023)

The above bar chart illustrates the experiences of respondents regarding the parking lot facilities at a shopping mall in Kuala Lumpur. The horizontal axis displays the ratings from 1 to 10, where 1 indicates a "most extremely worst" experience, and 10 represents a "most extremely impressive" experience. The vertical axis indicates the number of individuals who provided each rating. Majority of the respondents, 19 people rate parking facilities with rating as "8" that stand as an impressive. The least of the respondent, each has 1 respondent give the ranking "1" stand as most extremely worst and ranking "2" stand as extremely worst. Besides, 4 respondents rated their experience as "3," indicating has worst experience for parking facilities in shopping mall. 9 people provided a rating of "4,"slightly worst experience. 6 of respondents gave a "5," reflecting an average view. 12 people rated it as a "6," implying a slightly impressive experience. 13 respondents rated their experience as a "7," which is a moderately impressive experience. 18 people give a ranking "9," which is extremely impressive experience. Lastly, there are 17 respondents rate it with rating "10" that stand for most extremely impressive.

4.2.9 Importance of IoT Smart Parking System in Shopping Mall

Figure 4.8: Importance of IoT Smart Parking System in Shopping Mall

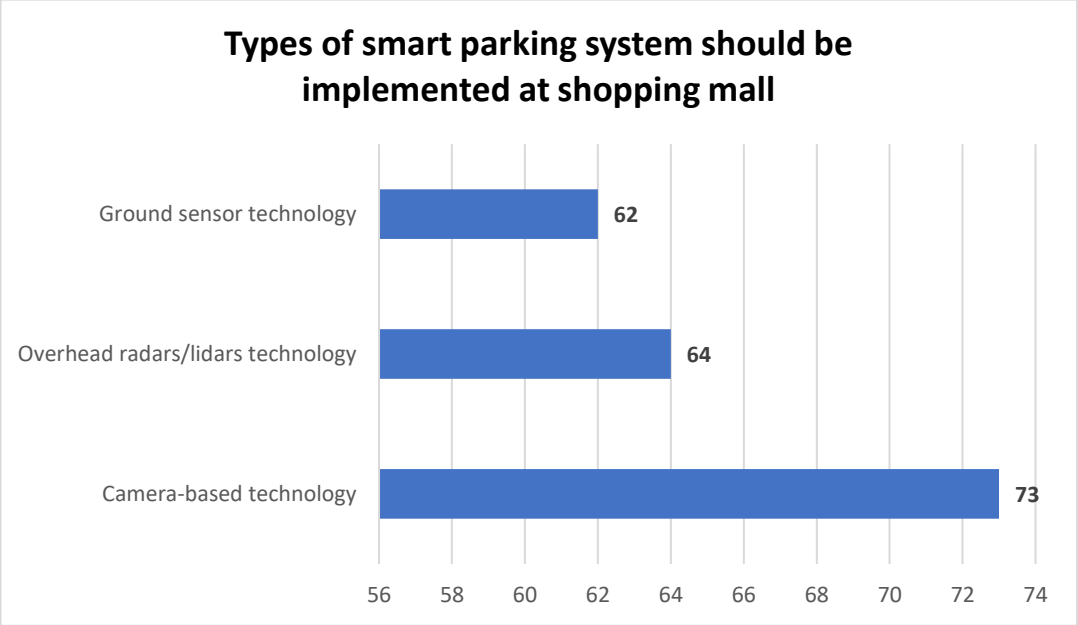


Source: Developed for research. (2023)

The pie chart in Figure 4.8 visualizes the opinions of respondents regarding the significance of implementing IoT smart parking systems in shopping mall. The larger group which is 83%, total 83 respondents definitely consider implementation of IoT smart parking system is important to shopping mall. In contrast, there has 17% of the respondents might consider on it.

4.2.10 Types of Smart Parking System Should be Implemented at Shopping Mall

Figure 4.9: Types of Smart Parking System Should be Implemented at Shopping Mall



Source: Developed for research. (2023)

Figure 4.9 indicates the result of each type of smart parking system should be implemented at shopping mall. There have three types which are ground sensor technology, overhead radars or lidars technology and camera-based technology. Most of the respondents which is 73 people choose camera-based technology while the least types that been choose is ground sensor technology which has 62 people. Moreover, there has 64 people choose overhead radars or lidars technology and camera-based technology.

4.3 Results for Objective I

The objective I for this research is to identify the components of IoT that can assist on the implementation of smart parking system in shopping mall. The result of objective I will be tabled in Chapter 4.3.1 and supported with the discussion in Chapter 4.3.2 and 4.3.3. The questions are

related to the types of the facilities of parking system should adopt with IoT and the factors to be considered for smart parking system in shopping mall.

4.3.1 Content Analysis

Table 4.2 shows the list of components of smart parking system with IoT in shopping mall. The result gathered from few authors that discussed in Chapter 2. There are 6 components which separate into few elements. There is sensor system, navigation system, security system, smart payment system, parking reservation system and electric vehicle system.

Table 4.2: Content Analysis

Components of smart parking system with IoT	Authors
Sensor System	
- Scanning available parking lot	- Khanna & Anand (2016)
- Occupancy sensor	- Alsafery, Alturki, Reiff-Marganiec, & Jambi, (2018)
- Real-time parking available data	- Ashok, Tiwari & Jirge (2020)
Navigation System	
- Definition of navigation system	- Holmes (2023)
- GPS provide to indoor and outdoor parking	- Paidi, Eleyeh, Håkansson, Nyberg (2018)
- Guide to the Shortest Path Route Navigation.	- Kim, Park, Lee, Roh (2017)
Security System	
- Important of security in shopping mall towards customers	- Cyberoptik (2021)
- RFID, CCTV, facial recognition system to enhance security	- Rajyalakshmi & Lakshmanna (2023)
Smart Payment System	
- Smart payment system is more effective than traditional parking system.	- Agarwal, Ratnani, Shah & Jain (2021)
- Contact and contactless payment mode	- Al-Turjman & Malekloo (2019)

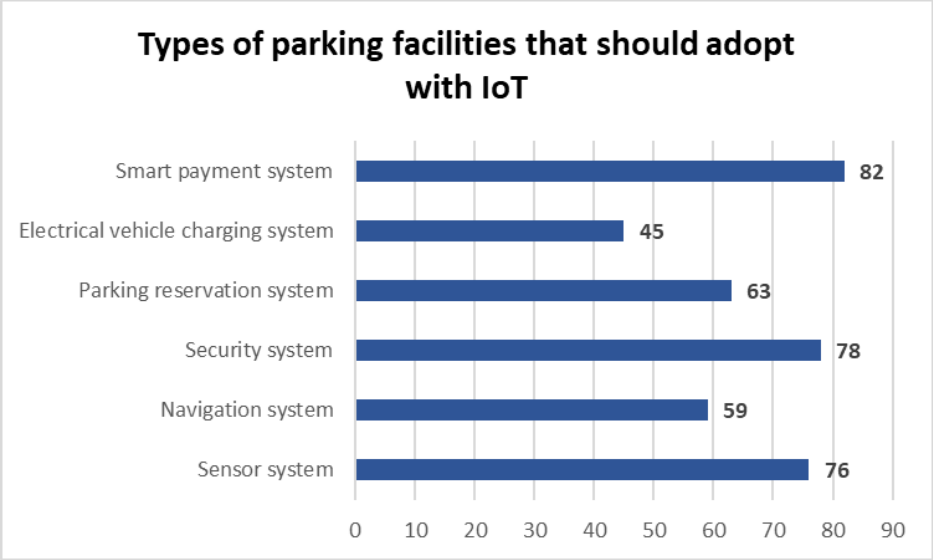
- RFID payment mode	- Tiew & Kamsin (2021)
- Example of shopping mall using smart payment system	
- License Plate Recognition technology	- Wah, Ramiah, Kamsin (2022)
Parking Reservation System	
- Definition and purpose of parking reservation system	- Al-Turjman & Malekloo (2019)
- Process of parking reservation system	- Quadri, Kumar, Sahu, Kumar & Rakesh (2023)
- Overcome the challenge of limited availability.	- Tu, Ayaz, Arshad, Iftikhar, Harrath & Waqas
Electric Vehicle Charging System	
- Definition and types of electric vehicle charging system.	- Martinez (2023)
- Advantages of electric vehicle charging system	- Deepika (2022)
- Market trends of electric vehicle charging system	- S. Team (2023)

Source: Developed for research. (2023)

4.3.2 Types of Parking Facilities that Should Adopt with IoT

In order to support the above result, frequency analysis have carried out using a question regard to parking facilities. Figure 4.10 show types of parking facilities that should adopt with IoT in shopping mall.

Figure 4.10: Types of Parking Facilities that Should Adopt with IoT



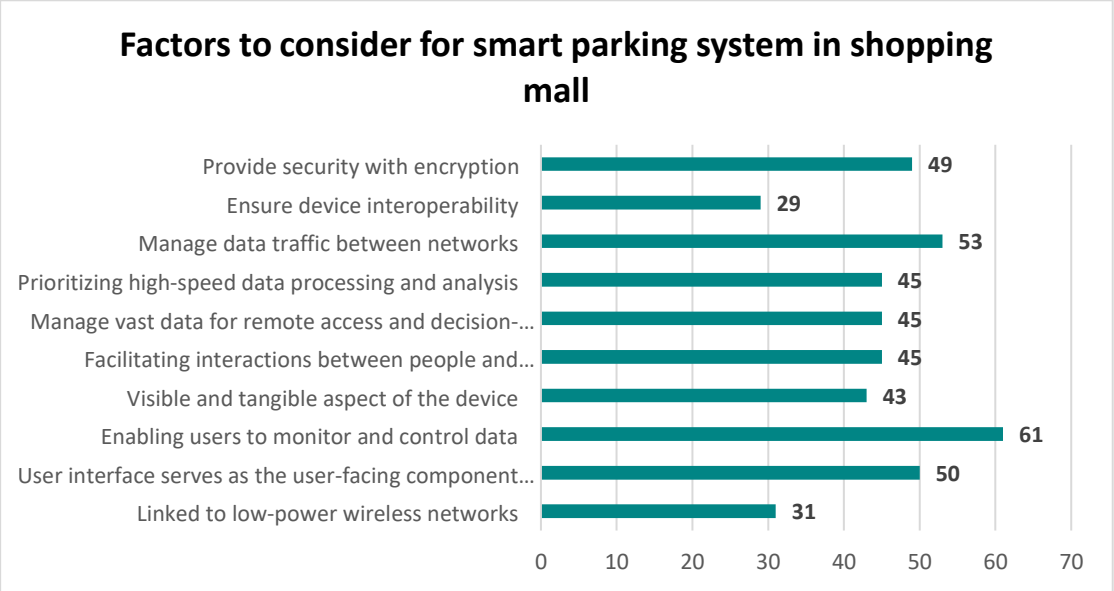
Source: Developed for research. (2023)

Figure 4.10 illustrate the six types of parking facilities that should adopt with IoT. Most of the respondents, 82 people choose smart payment system should be adopt with IoT to shopping mall. However, the least component that the respondents think should adopt with IoT which is electrical vehicle charging system, total 45 people. In addition, total 78 of respondents choose security system should adopt IoT, followed by the sensor system which is chosen by 76 respondents. Furthermore, total 63 of respondents choose parking reservation should adopt IoT and 59 respondents choose navigation system should adopt IoT.

4.3.2 Factors to Consider for Smart Parking System in Shopping Mall

A few factors must be taken into account before implementing an IoT system for the parking system at a shopping centre. There are 10 factors as stated in Figure 4.11.

Figure 4.11: Factors to Consider for Smart Parking System in Shopping Mall



Source: Developed for research. (2023)

According to Figure 4.11, the result illustrates the factors that the respondents consider essential for implementing a smart parking system in a shopping mall. The highest response in 61 people emphasize the factors of enable user to monitor and control data should be considered. Next, 53 people choose the factor of manage data traffic between networks. The factor of user interface serving as the user-facing component of IoT device received 50 responses. Moreover, the factor of provide security with encryption and visible and tangible aspect of the device received 49 and 43 respondents. Facilitating interactions between people and technology, manage vast data for remote access and decision-making and prioritizing high-speed data processing and analysis, each received 45 responses. There are 29 respondents choose the factor of linked to low-power wireless networks while the least factor that chose by respondents is ensure device interoperability, total 29 respondents.

4.4 Result for Objective II

The objective II for this research is to analyse the level of customer satisfaction towards IoT smart parking in shopping mall. To achieve this objective, RII is used to analyse the Section C in questionnaire.

Table 4.3: Result of Relative Important Index (RII) for Objective II

Components of smart parking system with IoT	RII	Ranking by category	Overall ranking
Sensor system			
1. Occupancy sensor	0.8280	2	
2. Scanning available parking lot	0.8340	1	
3. Interactive signage shows slot availability details.	0.8000	4	
4. The size, type and colour of font is clear	0.8160	3	
Average RII	**0.8195**		**2**
Navigation system			
1. GPS provide to the indoor vacant parking.	0.8060	1	
2. GPS provide to the outdoor vacant parking.	0.7920	3	
3. Guide to the Shortest Path Route Navigation.	0.7980	2	
Average RII	**0.7987**		**3**
Security system			
1. RFID is fully functional.	0.7960	3	
2. CCTV covers all corners and hidden spots	0.8100	1	
3. CCTV is fully functional.	0.8060	2	
4. Facial recognition system for driver safety	0.7640	4	
Average RII	**0.7940**		**4**
Smart payment system			
1. Contactless Mode (ex: RFID) system is use.	0.8300	2	
2. Contact Mode: credit card is very useful.	0.7960	4	
3. Contact Mode: debit card is very useful.	0.8020	3	
4. Contact Mode: touch N go is very useful.	0.8740	1	
Average RII	**0.8255**		**1**

Parking reservation system			
1. Pre-entry parking reservations available.	0.7580	3	
2. The system easier and friendly user.	0.7780	2	
3. All information in the system is clear and fast respond.	0.7880	1	
Average RII	**0.7747**		**6**
Electric vehicle charging system			
1. Adequate EV charging stations available	0.7740	2	
2. Fast charging	0.7700	3	
3. Easy guidance to charge car	0.8080	1	
Average RII	**0.7840**		**5**

Source: Developed for research. (2023)

Table 4.3 is the result of Relative Important Index (RII) analysis. There are six components; sensor system, navigation system, security system, smart payment system, parking reservation system, electric vehicle charging system will affect the level of customer satisfaction. Hence, from the table, the highest average RII is component smart payment system, 0.8255 followed by the sensor system, 0.8195. The third average RII is navigation system which is 0.7987. The security system' average RII is 0.7940 and electric vehicle charging system's average RII is 0.784. However, the least average RII is 0.7747 which is parking reservation system.

4.5 Conclusion

In this chapter, it analyses the result of the questionnaire that collected from 100 respondents. The data analysed by frequency analysis, content analysis and Relative Important Index. Besides, the result of the research is conducted and showed with pie chart, bar chart, table by using SPSS Software and Excel software. The next chapter will discuss further on major findings and recommendation of research.

Chapter 5: Discussion, Conclusion and Implication

5.0 Introduction

In this chapter, it will discuss the results and findings of the research objectives. In addi0tion, it will provide the summary of statistical analyses, implications of study. The limitation of the study also will be discussed and the recommendation for future research will be provided. Lastly, the chapter will cover the overall conclusion of the entire research.

5.1 Summary of Statistical Analyses

The summary of statistical analyses which is Section A, demographic profile. The demographic profile of this research is involved 100 respondents. Most of the respondents are male which is 55 people while there have 45 female respondents. The age of the respondents mostly is around 16-26 years old which has 44 respondents and there only has 8 respondents from the elder age group, 49-59 years old. In addition, the marital status of the respondents mostly is single, total 65 people while only 35 respondents are married. For the education level of the respondents, most of them hold a degree which has 68 respondents and only 2 of them hold Doctorate Philosophy, so it can indicate the respondents all have a certain level of education. It can help to reduce inaccuracies in their completion of the survey questionnaire.

The majority of the respondents live in Kuala Lumpur, total 62 people while the rest of the people which is 38 are not the resident of Kuala Lumpur. There are 35 respondents frequently visit to shopping mall that is more than 26 times annually. The respondents that visit to shopping mall mostly are by car, accounted for a total of 88 people. Moreover, more than half of the people gave a rating of 8 or above, indicating that they consider parking facilities as one of the factors influencing people's decision to visit the shopping mall. Hence, the vast majority of respondents, total 83 respondents think that implementation of IoT smart parking system is important.

5.2 Discussion of Major Findings

5.2.1 Objective I

Objective I of the research is to identify the components of IoT that can assist on the implementation of smart parking system in shopping mall. Hence, there are 6 components identified which are listed in Table 5.0. Majority of the respondents state that smart payment system should be adopted with IoT to the shopping mall parking, followed with security system, sensor system, parking reservation system and navigation system. The component of electrical vehicle charging system is the least respondents think should be adopt IoT to the shopping mall parking.

Table 5.0: Components of Smart Parking System with IoT and Number of Respondents

Ranking	Components of smart parking system with IoT	Number of respondents
1	Smart payment system	82
2	Security system	78
3	Sensor system	76
4	Parking reservation system	63
5	Navigation system	59
6	Electrical vehicle charging system	45

Source: Developed for research. (2023)

In addition, there has some factors need to consider before implementing smart parking system in shopping mall. In Chapter 4.3.2 mentioned the ranking of the factors that need to be considered in implementation smart parking system from the view of 100 respondents. Among the highlighted aspects, enabling users to monitor and control data emerged as one of the most valued factors. Additionally, factors like providing security with encryption, serving as the user-facing component through the interface, managing data traffic between networks, and facilitating interactions between people and technology

were identified as crucial functionalities. Other aspects such as linking to low-power wireless networks, managing vast data for remote access, ensuring device interoperability, visible and tangible aspect of the device and prioritizing high-speed data processing and analysis also drew attention, indicating diverse yet interconnected priorities and concerns among respondents regarding fundamental functionalities and features expected from IoT devices.

5.2.2 Objective II

Table 5.1: Components of smart parking system with IoT and Average RII

Ranking	Components of smart parking system with IoT	Average RII
1.	**Smart Payment System** a. Contactless Mode (ex: RFID) system is use. b. Contact Mode: credit card is very useful. c. Contact Mode: debit card is very useful. d. Contact Mode: touch N go is very useful.	0.8255
2.	**Sensor System** a. Occupancy sensor b. Scanning available parking lot c. Interactive signage shows slot availability details. d. The size, type and colour of font is clear	0.8195
3.	**Navigation System** a. GPS provide to the indoor vacant parking. b. GPS provide to the outdoor vacant parking. c. Guide to the Shortest Path Route Navigation.	0.7987

4.	**Security System** a. RFID is fully functional. b. CCTV covers all corners and hidden spots. c. CCTV is fully functional. d. Facial recognition system for driver safety	0.7940
5.	**Electric Vehicle Charging System** a. Adequate EV charging stations available b. Fast charging c. Easy guidance to charge car	0.7840
6.	**Parking Reservation System** a. Pre-entry parking reservations available. b. The system easier and friendly user. c. All information in the system is clear and fast respond.	0.7747

Source: Developed for research. (2023)

Objective II of this research is to analyse the level of customer satisfaction towards IoT smart parking in shopping mall. The ranking of the component of smart parking system with IoT is determined by Average RII which show in Table 5.1. Hence, the most components that will affect the customer's satisfaction is smart payment system because its RII is the highest means that this element has stronger impact on the customers' satisfaction. The following component that will affect the customers' satisfaction are sensor system, navigation system, security system, electric vehicle system and parking reservation system. Therefore, this research will emphasize to provide the insight of customers on the components of smart payment system, sensor system, electric vehicle charging system and parking reservation system.

First at all, smart payment system is the component that most affecting the customer satisfaction. It is because based on Agarwal et al. (2021a), the payment by machine is not convenient to the customers, the customers need to queue in long line to complete the payment. Therefore, an efficient and user-friendly parking payment will increase the customers' satisfaction and attract them revisit the shopping mall. One of the factors of

the user-friendly parking payment is the payment method. The common payment methods that used in the smart payment system are RFID, credit card, debit card and touch N go. In these four methods, touch N go is the payment that the respondents most satisfied. It is because touch N go is convenient to people, such as it can easily top up the money by smartphone that provided function of NFC. Therefore, people can easily use touch N go card to pay tolls, parking fees, retail purchases and so forth (Lee, 2022). In addition, Touch 'n Go wallet's Scan QR feature in Malaysia enables hassle-free parking payments at selected locations via the app. Users scan QR codes for entry and exit, automatically deducting fees without extra charges, even without an immediate internet connection. In case of a dead battery, users can still obtain a ticket by providing their linked phone number, enhancing convenience at up to 70 supported parking sites nationwide, such as One Shamelin Mall (Saw, 2023).

Next is the sensor system. The respondents think that sensor system is the element that can enhance the satisfaction because the system, such as Infrared, Passive Infrared and Ultrasonic sensors can detect the available parking spaces. This real-time data transmission helps the drivers quickly identify empty spots without needing to search extensively, so it can save time and reduce frustration (Alsafery et al., 2018). By these sensor systems, it can guide the driver simplicity and easy orientation in the car park, which means minimize the time to find available parking space, increase safety and environmental friendliness of traffic (Stopka et al., 2019). According to Hanzl (2020), Unlike static assistance, dynamic guidance notifies drivers of their occupancy in addition to directing them to parking lots. From the driver's perspective, the primary benefit of this system is the ability to select from a variety of parking options based on the quantity of available spots as well as the safety and flow of traffic on the roads leading to the parking lots. Hence, the clarity of font size, type and colour used in dynamic guidance or displays is crucial for effective communication. Clear and easily readable fonts ensure that drivers can quickly comprehend parking availability details displayed on interactive signage.

However, there has two components that the respondents think that has less affecting on the customer's satisfaction in the shopping mall parking, which are electric vehicle charging system and parking reservation system. Although the shopping mall parking that

provided electric vehicle charging system will enhance the value of the customers' satisfaction, but the trend of electric vehicle in Malaysia is not common. Based on Mba (2023), in contrast to the 1,642 EVs sold in 2020, the Malaysian Automotive Association (MAA) reports that 2,717 EVs were sold in 2021. With just 0.4% of all vehicle sales in Malaysia, the EV market share is currently quite small. The reason that majority of Malaysian did not choose electric vehicle is the higher price and there is not enough number of public EV charging system to ensure that they can drive it for long distance. The majority of the EV charging system are available at interstate highway stop, shopping malls and hotels, the rural areas is not developed well for the EV charging system (Bernama, 2023). According to Chapree (2023), the data provided at the National EV Steering Committee's inaugural meeting, there would only be 1,063 public EV chargers in Malaysia by June 2023. Hence, the infrastructure in Malaysia for EV charging could not be prepared to handle a rapid surge in the number of EVs on the road. Moreover, the price of EV in Malaysia must exceeds RM 100,000 due to the limitations imposed by the Ministry of Trade, Industry and Investment (MITI). These reasons affect the decision of the people purchase electric vehicles, so they did not think that the electric vehicle charging system is the most elements that can enhance their satisfaction in the shopping mall parking.

Last but not least, RII of the parking reservation system is the least means that this element is the smallest that can affect customers' satisfaction on the shopping mall parking. It is because the parking reservation system is useful during rush hours or peak hour which the drive is very hard to find the available parking space, so they will use the system to reserve the parking space before they arrive in the shopping mall parking (Al-Turjman & Malekloo, 2019b). Therefore, the system will less use during the common day, so the respondents think that this is not the main elements will affect their satisfaction. Moreover, the development of parking reservation system is not comprehensive in Malaysia. One of the apps that can use to reserve the parking is ParkEasy, but the apps only available for few shopping malls. Besides, most of the mall that provided this system only availability for the EV charger parking, so the normal parking space is not allowed to reserve. As a result, the respondents think that this system will not help them a lot in searching available parking system.

5.3 Implications of the Study

The implications so the study is beneficial to different sectors of people, such as property manager, shopping operator, policy maker, developer and future researcher. By understanding the implications of implementing smart parking system with IoT in shopping mall can provides valuable and insights for these stakeholders, influencing decision-making, improving operations and festering future advancements in the field.

Firstly, property manager is benefitted from this research. It is because implementation smart parking system with IoT in shopping mall can increase the efficiency of operation. The smart parking system can assist property manager in streamlining operations, optimizing parking spaces and managing traffic flow within the shopping mall premises. In addition, the property manager also can evaluate the scalability of smart parking system to determine which elements should be adapt or strengthen in the shopping mall parking. It is to enhance the overall value of the property. Property manager can take use of this enhancement to draw in more renters, boost demand for their properties, and possibly even increase leasing costs because of the better amenities.

Secondly, shopping operators benefit greatly from the installation of a smart parking system in a mall, which has several advantages. As more people visit the mall due to the improved parking experience, it immediately affects the rise in foot traffic. This increase in foot traffic means that retailers have more opportunity to display their goods and services, which could result in higher revenue and sales. Additionally, a more efficient parking procedure enhances client satisfaction and motivates return business. Additionally, by integrating technology and catering to modern consumer demands, this approach positions the mall as a cutting-edge destination for shopping. Ultimately, shopping operators may strengthen their competitive edge, improve brand loyalty, and cultivate a vibrant retail environment within the mall by improving the whole shopping experience through optimised parking.

Furthermore, the research's insights into the importance of smart parking systems in malls and the policy maker can more understand the important of implementation smart parking system and take attention of this topic. Therefore, the policy maker can take action to support and enhance the system to benefit the people. Encouraging the adoption of these systems through providing

incentives and eliminating fees for cashless payments aligns with several key findings. Enhancing customer experiences stands at the forefront, as smart parking streamlines the parking process, offering convenience and ease to mall visitors. Moreover, these systems aid in mitigating traffic congestion, contributing to smoother traffic flows in urban areas. Policymakers can leverage these findings to encourage technological advancements by supporting the integration of innovative parking solutions. Additionally, the research emphasizes the environmental benefits, as smart parking systems reduce emissions by optimizing parking and reducing idle time. Aligning policies with these implications promises a customer-centric, technologically progressive, and environmentally conscious approach to parking infrastructure, benefitting both visitors and urban ecosystems alike.

Next, this research benefits for developer in designing and planning the future shopping mall parking. From this research, the developer can more understand the future trend or the preference of the customers of the facilities of the smart parking system, so the developer can focus on the important elements. Hence, the research can ensure the adequate space allocation for efficient parking systems and improve the overall functionality of the shopping mall. Moreover, implementation of smart parking systems can be a unique selling proposition for developer and attract high-profile tenants who value and seek locations with modern amenities and advanced infrastructure. In order to draw in potential tenants looking for high visibility and enhanced customer flow, developer can market the smart parking system as a way to increase foot traffic to the mall.

Lastly, there are advantages for future researcher from this research. Future researcher can conduct comparative studies across different malls or countries to analyse the effectiveness of various smart parking system and highlight best practice in smart parking implementation. Besides, researcher can conduct investigations into the sustainability of smart parking systems could look at the technology's environmental impact, upkeep needs, and long-term sustainability strategies.

5.4 Limitations of the Study

There are few limitations of this research which are respondents' size, location of the shopping mall and the elements of the smart parking system. This research only focuses on 100 respondents which is not sufficient to provide an overall and completely response of all people. The small sample size might cause an inadequate understanding of diverse perspectives because it cannot represent individuals that from different cultural backgrounds, age groups and preferences. It will potentially overlooking crucial insights or preference specific to certain demographic segments.

In addition, this research has limited geographic focuses which is focusing exclusively on shopping mall within Kuala Lumpur might restrict the research's applicability to a broader context. This research strictly concentrating on shopping mall in Kuala Lumpur could ignore possible variations in suburban against rural parking preferences and system effectiveness. These locations may have unique parking requirements or usage patterns that aren't fully reflected in urban shopping malls.

Furthermore, this research only emphasizes six elements of smart parking system which are sensor system, navigation system, security system, smart payment system, parking reservation system and electric vehicle charging system. Hence, it will restrict the view of the entire smart parking system because the overall performance or user experience of the system may be greatly impacted by some essential features or components that go beyond the six components that were selected. The limited elements of smart parking system will affect gain an inadequate coverage of user experience, such as ease of use, adoptability to diverse user needs.

5.5 Recommendations for Future Research

There have few recommendations for future researcher to overcome the limitation of this research to obtain a comprehensive evaluation on implementing smart parking system in shopping mall. Firstly, the future researcher can increase the size and diversity of the sample size by include a wider range of customers at shopping malls in terms of age, gender and cultural background. This

more inclusive depiction improves the research's capacity to be applied broadly and encompasses a wider variety of viewpoints.

The future researcher can include multiple cities and regions to extend the research beyond Kuala Lumpur to encompass shopping malls in different cities or regions within Malaysia. The researcher can include the shopping mall in Selangor or Johor Bahru because the malls in these two areas are booming, it is worthwhile to include them in the study to obtain a more comprehensive assessment.

Moreover, the future researcher can consider broadening the scope of the research to encompass a more extensive range of smart parking elements. This methodology guarantees a more comprehensive assessment of the system, encompassing interrelated functionalities and novel technical developments. The future research can focus on the system maintenance and upkeep to ensure the smart parking system can be functional in a good condition. The future researcher also can investigate the smart parking system's environmental sustainability, energy usage to ensure the system is friendly to environment as well as increase efficiency to the people.

5.6 Conclusion

In a nutshell, this research identifies the most important elements of the smart parking system in shopping malls. In addition, the research also collected responses from the market to identify the ranking among six elements of the smart parking system with IoT. Hence, as a result, the most important element that can affect customers' satisfaction is the smart payment system. Moreover, it is important to implement the smart parking system with IoT in the shopping mall because the traditional parking system is not convenient and inefficient for people. The future trend will focus on the development of technology and IoT. As a result, the shopping mall in Malaysia should implement and develop a smart parking system to attract more customers and benefit property management by managing parking efficiently. In short, this research will help to identify the trend of implementation of smart parking systems in shopping malls and substantiate the elements of smart parking systems that will affect the level of customers' satisfaction.

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Appendix

FACULTY OF ACCOUNTANCY AND MANAGEMENT
BACHELOR OF BUILDING AND PROPERTY MANAGEMENT (HONOURS)

FINAL YEAR PROJECT
SURVEY QUESTIONNAIRE
A STUDY ON SMART PARKING SYSTEM USING IOT TECHNOLOGY IN SHOPPING MALL

Dear Sir/ Madam,

I am a final year undergraduate student from Universiti Tunku Abdul Rahman (UTAR), Goh Yuki, who is currently pursuing in Bachelor of Building and Property Management (Honours). The aim of this questionnaire is to assess the impacts of IoT (Internet of Things) smart parking system in shopping mall.

A set of questionnaires will require 10 minutes to be completed. This questionnaire consists of **THREE SECTIONS**, which are **Section A**, **Section B** and **Section C**. Section A is about demographic profile while Section B is regarding on the factors of IoT smart parking system in shopping mall and Section C is focusing on the level of customer satisfaction towards smart parking in shopping mall.

Information obtained is strictly confidential and will be used for statical and mathematical analysis for the purpose of study only. Your kind participation in this study is highly valued and appreciated. Should you have any enquiry regarding this study, kindly contact me through this email: yukigoh24@1utar.my

Thank you for your time and your input in this research.

Please tick ☑ in the box below to proceed with the survey.

I hereby consent you on my voluntary participant in this survey which will be conducted anonymously. (As proposed accordingly by Personal Data Protection Statement – UTAR)

- ☐ Yes: proceed to the questionnaire
- ☐ No: thank you for your time

Section A: Demographic

INSTRUCTION: Please tick ☑ in the box next to your answer of your choice or write in the space provided.

1. Gender
   - ☐ Male
   - ☐ Female

2. Age
   - ☐ 16-26
   - ☐ 27-37
   - ☐ 38-48
   - ☐ 49-59
   - ☐ 60-70
   - ☐ 71-81

3. Marital Status
   - ☐ Single
   - ☐ Married

4. Highest education Level
   - ☐ Certificate
   - ☐ Diploma
   - ☐ Degree
   - ☐ Master's
   - ☐ Doctorate Philosophy

5. Are you resident of Kuala Lumpur?
   - ☐ Yes
   - ☐ No

6. Frequency of visiting shopping mall in Kuala Lumpur?
   - ☐ ≤ 5 times in a year
   - ☐ 6-10 times in a year
   - ☐ 11-15 times in a year
   - ☐ 16-20 times in a year
   - ☐ 21-25 times in a year
   - ☐ ≥ 26 times in a year

7. Types of transportation usually use to shopping mall?
   - ☐ Bicycle
   - ☐ Motorcycle
   - ☐ Car

8. Parking is one of the important elements that can attract people to visit the shopping mall. Based on your experiences, how much you can rate the shopping mall's parking lot in Kuala Lumpur? The consideration should consist of facilities and the friendly use of parking area.

   Hence, in your opinion, on a scale of 1 to 10 (1 being "extremely worst" and 10 being "extremely impressive"), please rate the parking lot.

   1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10

9. Do you think IoT smart parking system is important in shopping mall? (ex: cashless payment, vehicle detection sensor)
   - ☐ Less consider
   - ☐ Might consider
   - ☐ Definitely consider

Section B: Factors of IoT that can assist on the implementation of parking system in shopping mall.

1. Which type of smart parking system should be implemented at shopping mall. (You may choose more than 1 answer)
   - ☐ Camera-based Technology
   - ☐ Overhead radars/lidars technology
   - ☐ Ground sensor technology

2. Which parking facilities that should adopt with IoT? (You may choose more than 1 answer)
   - ☐ Sensor system
   - ☐ Navigation system
   - ☐ Smart payment system
   - ☐ Security system
   - ☐ Parking reservation
   - ☐ Electrical vehicle charging system

3. Factors to consider for smart parking system in shopping mall. (Please choose more than 1 answer)
   - ☐ Linked to low-power wireless networks
   - ☐ User interface serves as the user-facing component of an IoT device
   - ☐ Enabling users to monitor and control data.
   - ☐ Visible and tangible aspect of the device
   - ☐ Facilitating interactions between people and technology
   - ☐ Manage vast data for remote access and decision-making
   - ☐ Prioritizing high-speed data processing and analysis
   - ☐ Manage data traffic between networks
   - ☐ Ensure device interoperability
   - ☐ Provide security with encryption

Section C: Level of customer satisfaction towards smart parking in shopping mall.

For this section, please circle your answer to each statement using five (5) Likert scales to indicate to what extent your satisfaction or unsatisfaction with each statement.

(1) = Strongly Dissatisfied (SD), (2) = Dissatisfied (D), (3) = Slightly Satisfied (SS), (4) = Satisfied (S), (5) = Completely Satisfied (CS)

No.	Factors	SD	D	SS	D	CS
Sensor System shopping mall parking lot.						
1.	Occupancy sensor					
2.	Scanning Available Parking Lot					
3.	Interactive signage displays precise information regarding the number and quantity of available slots.					
4.	The size, type and color of font is clear.					
Navigation System that provides direction to the available parking lot.						
1.	GPS provide to the indoor vacant parking.					
2.	GPS provide to the outdoor vacant parking.					
3.	Guide to the Shortest Path Route Navigation					
Security System in shopping mall parking lot.						
1.	Radio Frequency Identification (RFID) is fully functional.					

2.	Closed-Circuit Television (CCTV) is installed at every corner and hidden area.					
3	Closed-Circuit Television (CCTV) fully functional.					
3.	Facial recognition Model System is applied for captures driver faces during entry and exit, decrease the risk of stolen car.					
Smart Payment System in shopping mall parking lot.						
1.	Contactless Mode (ex: RFID) system is use.					
2.	Contact Mode: credit card is very useful.					
3.	Contact Mod: debit card is very useful.					
4.	Contact Mode: touch N go is very useful.					
Parking Reservation System in shopping mall parking lot.						
1.	Reservation parking can do it before enter shopping mall.					
2.	The system easier and friendly user.					
3.	All information in the system is clear and fast respond.					
Electric Vehicle Charging System provided in shopping mall parking lot.						
1.	Sufficient number of EV charging station provided for electric car.					
2.	Fast charging.					
3.	Easy guidance to charge car.					

Thank you