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ENHANCING CUSTOMER SATISFACTION THROUGH IOT-BASED SMART PARKING SYSTEMS IN SHOPPING MALLS

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ABSTRACT: An intelligent parking system with IoT technology is vital in shopping mall parking because it enhances convenience and efficiency for shoppers and visitors. The system can assist in reducing several problems that impact the users, such as wasting time finding parking and paying parking fees at the auto-pay machines. Thus, this study examines the components of smart parking systems that affect customer satisfaction levels. The smart payment system, sensor system, navigation system, security system, parking reservation system, and electric vehicle charging system are among the components. Data was gathered via questionnaires from 100 respondents who were at least 16 years old and had experience driving vehicles to shopping malls in Kuala Lumpur. The results from the Relative Important Index indicate that the smart payment system is the most influential component of IoT-based smart parking systems in affecting customer satisfaction at shopping malls. Therefore, the shopping operator, developer, property manager, and future researcher can emphasise the most important elements of the intelligent parking system to enhance management and increase customer satisfaction. In addition, the smart parking system should be implemented in Malaysia to ensure that the parking system has advanced and comprehensive facilities for visitors.

Keywords: IoT, Parking System, Shopping Mall, Customer Satisfaction

1. Introduction

In Malaysia, the current condition of car parking is that some shopping malls still apply a manual ticket system, which is time-consuming. This kind of system will cause a challenging nature in 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 [1]. Besides, the issue of tricky-to-find parking also occurs in Dubai, and one of the systems used in shopping malls is the Mall of the Emirates app. Therefore, the customers can download their license plates to the parking pre-booking area of the Mall of the Emirates app. Customers will reserve parking in a particular zone and an arrival time. Hence, customers only need to spend a little time finding available parking when they enter the shopping mall [2].

As a result, developing and implementing a smart parking system is important in shopping malls to resolve traffic congestion, reduce pollution, and reduce the detrimental effects on the environment and landscape. This is because the system can help to locate and reserve parking spaces before the customers arriving their destination [3]. An intelligent parking system is an IoT (Internet of Things) solution that notifies users about open parking spaces in a specific location using sensors, cameras, and software. Most of the time, individuals can reserve the space directly before they reach the shopping mall and pay for it via an app [4]. The structure of intelligent parking is made up of several tools and procedures that serve as parking space detectors. On the one hand, cameras and sensors that capture, analyse, and present data and images are installed to deliver real-time traffic occupancy statistics for the location where we are going. On the other hand, an IoT cloud-based system enables the connection of various devices and the centralisation 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. In shopping malls, it helps customers find available parking slots by using cameras and sensors. The camera can identify multiple cars at once. By having this image, the vacant parking lots may be determined, 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 [5]. As a smart parking system is essential to shopping malls, many in Malaysia

apply it to increase efficiency and make it easier to control and manage car parking, such as Sunway Pyramid and City One Mega Mall [6].

The primary benefit of a smart parking system compared to a traditional one will be real-time tracking; it can help customers save time in reaching their desired destination by giving 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 [7]. However, only some smart parking systems can provide customers with real-time and accurate information. Hence, it will cause the drivers to 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 [8].

Thus, examining customer satisfaction levels for various IoT-based smart parking system components is essential to develop more efficient, user-centred solutions that improve convenience, effectiveness, and overall satisfaction with the parking experience. Developers and operators can optimise the user experience by identifying the components that significantly impact satisfaction. Prioritising essential components ensures better design and implementation. Moreover, understanding the components that drive satisfaction enhances operational efficiency and contributes to business success through increased customer attraction and retention.

2. Literature Review

This section will study smart parking systems, including their components and crucial role in shopping malls. This chapter also includes the definition of IoT and various parking system uses. Guided by a conceptual framework, it will discuss the components that capture customer satisfaction in parking systems in shopping malls.

2.1 Smart Parking System

A smart parking system is a parking solution that may comprise counting sensors, cameras, or in-ground sensors. These devices are typically placed adjacent to or implanted into parking spaces to determine if parking spaces are empty or occupied. 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 [9]. The smart parking system is an architectural framework comprising 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 [10]. There are three common types of smart parking systems: camera-based technology, overhead radars/lidars technology, and ground sensor technology [11]. The components of the smart parking system are shown in Table 1.

Table 1 The components of the smart parking system

Components of Smart Parking System with IoT
Sensor System
- Scanning available parking lot
- Occupancy sensor
- Real-time parking available data
Navigation System
- GPS provides indoor and outdoor parking
- Guide to the Shortest Path Route Navigation.
Security System
- RFID, CCTV, and facial recognition systems to enhance security
Smart Payment System
- Smart payment system is more effective than traditional parking system.
- Contact and contactless payment mode
- RFID payment mode
Parking Reservation System
- Process of parking reservation system
- Overcome the challenge of limited availability.
Electric Vehicle Charging System
- Advantages of electric vehicle charging system

2.2 Internet of Things (IoT) in Shopping Mall

More shopping mall parking lots adopt an IoT smart parking system to enhance the efficiency and convenience of the visitors. The implementation of IoT in shopping mall parking will use sensors, mobile and web-based applications, and cloud systems. Hence, the parking system incorporates an in-ground vehicle detection sensor that uses infrared technology to communicate with signal light notifications above parking spaces [12]. 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,

check parking lot availability, book spaces, and make payments. The cloud system serves as the database, recording all activities in the parking system, including booking times, parking duration, fees, payment methods, and user information [13].

3. Methodology

A plan to respond to a series of questions is a research design, often known as a research strategy. The framework contains the techniques and steps for gathering, analysing, and interpreting data. In other words, the study design, a component of the research proposal, outlines how the researcher would approach the central research question [14]. A suitable research method for this research is quantitative 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 with a shopping mall, improving the generalizability of findings. As a result, data collected using the quantitative research method can provide more accurate and valuable insight for the research.

In this research, questionnaires were used to collect the data. A Descriptive statistical technique such as frequency analysis and Relative Importance Index (RII) are used to display each respondent's response. To assist users in analysing the data and formulating conclusions, SPSS Statistics can compute the mean, median, and mode when utilising frequency analysis. Hence, this analysis was used in Section A, demographic questions, and Section B, factors of IoT that can assist in implementing parking systems in shopping malls. Frequency analysis can help to create a clear picture of the characteristics of the group under the research and serves as a foundational step for more in-depth analysis and decision-making. Meanwhile, RII, which is used in Section C, provides a clear indication of the relative importance of different factors, making it easier to focus on the significant elements.

4. Results and Discussion

The respondents' demographic profiles were collected from 100 respondents. The profile is distributed to 9 questions. The questions include gender, age, marital status, education level, whether the respondent is a resident of Kuala Lumpur, frequency of visiting shopping malls in Kuala Lumpur, types of transport used to shopping malls, experience rate of the shopping mall's parking lot in Kuala Lumpur, and the importance of IoT smart parking system in the shopping mall. These questions will be used for frequency analysis to understand the responses from the respondents. The same method applies to the data gathered from Section B. Three questions are covered in this section which will be further discussed below based on Figure 1, Figure 2, and Figure 3. Next, the discussion will follow with the customer satisfaction level towards the IoT smart parking components in shopping malls. It refers to Table 2, which was analysed using RII.

Figure 1 indicates the result of each type of smart parking system that should be implemented at a shopping mall. There are three types of technology: ground sensor, overhead radar or lidar, and camera-based. Most respondents, 73 people, chose camera-based technology, while the minor type chose ground sensor technology, which has 62 people. Moreover, 64 people chose overhead radar or lidar technology and camera-based technology.

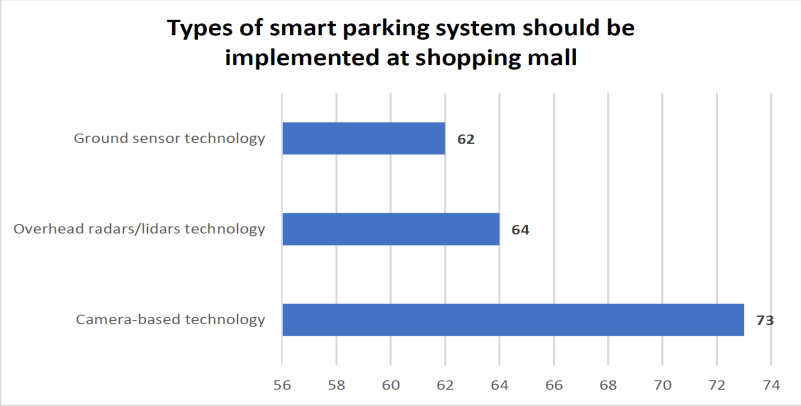

Figure 1 Types of Smart Parking Systems Should be Implemented at Shopping Mall

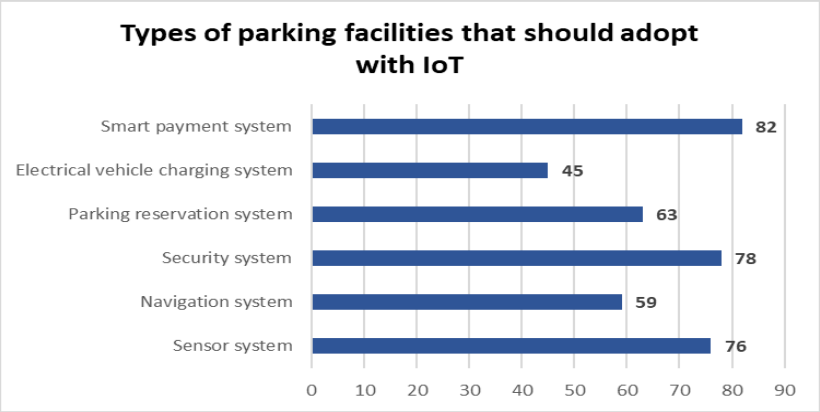

Figure 2 Types of Parking Facilities that Should Adopt with IoT

To investigate the requirements of the parking facilities with IoT, thus the data is presented in Figure 2. Figure 2 shows the types of parking facilities that should be adopted with IoT in shopping malls. The result illustrates the six types of parking facilities that should be adopted with IoT. Most respondents, 82 people, chose smart payment systems that should be adopted with IoT in shopping malls. However, the last component that the respondents think should be adopted IoT is the electrical vehicle charging system, a total of 45 people. In addition, 78 respondents chose a security system that should adopt IoT, followed by the sensor system, which 76 respondents chose. Furthermore, 63 respondents chose parking reservations to adopt IoT, and 59 respondents chose navigation systems to adopt IoT.

A few factors must be considered before implementing an IoT system for the parking system at shopping malls. There are ten factors, as stated in Figure 3. According to Figure 3, the result illustrates the factors that the respondents consider essential for implementing a smart parking system in a shopping mall. The highest response from 61 people emphasises that the factors enabling the users to monitor and control data should be considered. Next, 53 people choose the factor of managing data traffic between networks. The user interface factor serving as the user-facing component of the IoT device received 50 responses. Moreover, the factor of providing security with encryption and visible and tangible aspects of the device received 49 and 43 respondents. Facilitating interactions between people and technology, managing vast data for remote access and decision-making, and prioritising high-speed data processing and analysis, each received 45 responses. A total of 31 respondents chose the factor linked to low-power wireless networks, while the least chosen factor ensured device interoperability by 29 respondents.

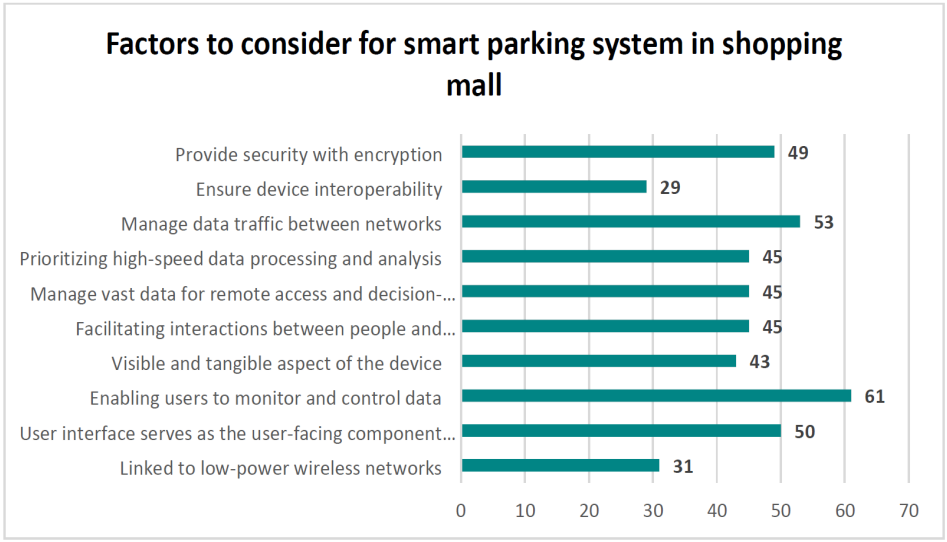

Figure 3 Factors to Consider for Smart Parking System in Shopping Mall

Table 2 The Ranking of The Components in The Smart Parking System

Components of Smart Parking System with IoT	RII	Average RII	Rank
A. Smart payment system		**0.8255**	**1**
1. Contactless Mode (ex: RFID) system is used.	0.8300		
2. Contact Mode: A credit card is very useful.	0.7960		
3. Contact Mode: A debit card is very useful.	0.8020		
4. Contact Mode: touch N Go is very useful.	0.8740		
B. Sensor system		**0.8195**	**2**
1. Occupancy sensor.	0.8280		
2. Scanning available parking lot.	0.8340		
3. Interactive signage shows slot availability details.	0.8000		
4. The fonts' size, type, and colour are apparent.	0.8160		
C. Navigation system		**0.7987**	**3**
1. GPS is provided for indoor vacant parking.	0.8060		
2. GPS provides the outdoor vacant parking.	0.7920		
3. Guide to the Shortest Path Route Navigation.	0.7980		
D. Security system		**0.7940**	**4**
1. RFID is fully functional.	0.7960		
2. CCTV covers all corners and hidden spots.	0.8100		
3. CCTV is fully functional.	0.8060		
4. Facial recognition system for driver safety.	0.7640		
E. Electric vehicle charging system		**0.7840**	**5**
1. Adequate EV charging stations available.	0.7740		
2. Fast charging.	0.7700		
3. Easy guidance to charge the car.	0.8080		
F. Parking reservation system		**0.7747**	**6**
1. Pre-entry parking reservations available.	0.7580		
2. The system is easier and more friendly.	0.7780		
3. All information in the system is clear and fast respond.	0.7880		

Table 2 presents the ranking of components within the IoT-based smart parking system based on customer satisfaction levels. The smart payment system ranks highest, with an average RII of 0.8255, followed by the sensor system with an RII of 0.8195. The navigation system ranks third with an RII of 0.7987. The security and electric vehicle charging systems follow, ranking fourth and fifth with RIIs of 0.7940 and 0.7840, respectively. The component with the lowest level of customer satisfaction is the parking reservation system, which has an RII of 0.7747.

The smart payment system is the component that most significantly impacts customer satisfaction. According to Agarwal et al. [15], traditional payment methods, such as machine payments, are inconvenient and lead to long wait times. An efficient and user-friendly payment system can enhance customer satisfaction and encourage repeat visits to the shopping mall.

The parking reservation system has the lowest RII, which shows less influence on customer satisfaction. This system is more helpful during peak hours when finding a parking space is challenging and costly. However, this system is not as often used on typical days when parking is more easily accessible. Malaysia's restricted access to parking reservation systems also influences reduced interest. For example, few malls offer the ParkEasy app, which allows you to reserve parking, mostly for EV charging stations.

To summarise, camera-based is the most preferred technology that should be implemented in shopping malls. Besides, the highest ranking of parking facility components that should be adopted with IoT is the smart payment system. In addition, enabling users to monitor and control data emerged as the most valued factor that needs to be considered for smart parking systems in

shopping malls. Moreover, the smart payment system is the most significant component of IoT-based smart parking systems in influencing customer satisfaction and encouraging visits to shopping malls. Nevertheless, other aspects also drew attention, indicating diverse yet interconnected priorities and concerns among respondents regarding fundamental functionalities and features expected from IoT devices.

5. Conclusion

This research identifies the most critical elements of the smart parking system in shopping malls. Moreover, it is essential to implement a smart parking system with IoT in shopping malls because the traditional parking system could be more convenient and efficient for people. Future trends 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

References

[1] Prasanth Aby Thomas, Consultant Editor. (2023, April 14). Major challenges in managing parking lots. Messe Frankfurt (HK) Limited, Taiwan Branch. Taipei, Taiwan. https://www.asmag.com/showpost/28445.aspx

[2] Abbas, W. (2022, May 27). Dubai: Now, pre-book a parking spot at a mall - News | Khaleej Times. Khaleej Times. https://www.khaleejtimes.com/transport/dubai-now-pre-book-parkingspot-at-a-mall

[3] Balfaqih, M., Jabbar, W. A., Khayyat, M., & Hassan, R. (2021). Design and Development of a Smart Parking System Based on Fog Computing and the Internet of Things. Electronics, 10(24), 3184. https://doi.org/10.3390/electronics10243184

[4] Rosenkranz, E. (2023). Smart Parking: How it Works & Successful Examples. Smart CRE. https://smart-cre.com/smart-parking-definition-indexamples/#:~:text=Smart%20parking%20is%20an%20IoT,for%20it%20with%20an%2 0app

[5] Ahad, A., Khan, Z. R., & Ahmad, S. S. (2016). Intelligent Parking System. World Journal of Engineering and Technology, 04(02), 160–167. https://doi.org/10.4236/wjet.2016.42014

[6] Camelia. (2020). New smart parking is in the new normal with the LPR launch. Borneo Post Online. https://www.theborneopost.com/2020/07/02/new-smart-parking-in-the-new-normalwith-lpr-launch/

[7] Estheralu. (2023, April 6). Ticketless Parking vs. Traditional Parking: Which is Better for Your Business? Sensor Dynamics. https://sensordynamics.com.au/ticketless-parking-vs-traditional-parking/

[8] Pratik R. (2022, December 21). IoT In Smart Parking Management: Benefits, Challenges & Potential. Intuz. Retrieved July 16, 2023, from https://www.intuz.com/blog/iot-in-smartparking-management-benefits-challenges#:~:text=Availability%20of%20standard%20IoT%20tools,-The%20service%20providers&text=Another%20problem%20with%20installing%20a,for%20a%20single%20booking%20window

[9] Karsten, J. (2019, March 20). What is Smart Parking? - Parkeagle - Smart Parking Solutions. Parkeagle. https://www.parkeagle.com/2018/05/12/what-is-smart-parking/

[10] Biyik, C., Allam, Z., Pieri, G., Moroni, D., Fraifer, M., O'Connell, E., Olariu, S., & Khalid, M. (2021). Smart Parking Systems: Reviewing the literature, architecture and Ways forward. Smart Cities, 4(2), 623–642. https://doi.org/10.3390/smartcities4020032

[11] Wahab, Izudinshah Abd., Bakar, Noor Athirah Abu, Amin, Noor Dina M., Hamberi, Mohd. Jamil (2023). Ventilation Shaft Design In Enhancing Indoor Air Movement For Public Buildings. Journal of Sustainable Technology and Applied Science, 4 (1), 25-28. https://doi.org/10.36040/jstas.v4i1.8118

[12] Birchenko, Y. (2023). Smart Parking Solutions - IoT sensors space race | element14 Malaysia. https://my.element14.com/smart-parking-solutions-the-iot-sensors-space-race

[13] Mufaqih, M. S., Kaburuan, E. R., & Wang, G. (2020a). Applying smart parking system with Internet of Things (IoT) design. IOP Conference Series, 725(1), 012095. https://doi.org/10.1088/1757-899x/725/1/012095

[14] Bouchrika, I. (2023, May 15). Types of research design: perspective and methodological approaches. Research.com. https://research.com/research/types-of-research-design

[15] Agarwal, Y., Ratnani, P., Shah, U., & Jain, P. (2021a). IoT-based Smart Parking System. *2021 5th International Conference on Intelligent Computing and Control Systems (ICICCS)*. https://doi.org/10.1109/iciccs51141.2021.9432196