

# SUITABILITY OF SMART CAR PARKING FOR SHOPPING MALLS IN SRI LANKA

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## ABSTRACT

*Smart parking is a technical advancement that makes use of sensors and information technology to assist users in finding available parking spaces. It is a management approach for parking lots in many facilities for users to find satisfactory parking places. Shopping malls are one of the facilities that face different parking management issues due to the large crowd. Smart car parking solution is one of the best solutions to mitigate the issues associated with parking management systems. Thus, this study aims to investigate the suitability of smart car parking as a solution to mitigate the current parking management issues faced by Sri Lankan shopping malls. A case study approach is employed using three shopping mall facilities located in Colombo metropolitan area to analyse the current parking management issues. Further, a questionnaire survey was carried out to identify the issues from the customers' perspective. The data collected from structured interviews and the questionnaire survey was analysed using manual content analysis and statistical analysis, respectively. The findings revealed that the choice of shopping at the facility is strongly affected by the availability of parking, and this has a significant impact on the facility. Further, this paper highlights the major issues associated with shopping mall parking management systems and the suitability of smart car parking to mitigate those issues. The findings of this study are useful in developing smart car parking solutions for shopping malls in Sri Lanka.*

**Keywords:** Car parking; Shopping malls; Smart car parking.

## 1. INTRODUCTION

Vehicle purchases are no longer considered a luxury and it is more like a need than a luxury to own a vehicle (Chandran et al., 2019). Further, ownership of vehicles is increasing with the improvement of the financial status of individuals and as a result, the complications, and tensions of parking increase. The functionality of classic parking systems may have been adequate in the past, however modern structures confront new issues that require fresh solutions (El-Din & Ahmed, 2017). Smart Parking is by far the most widely acquired and evolving smart solution for issues in classic parking systems with the use of sensing tools like cameras, sensors embedded in the pavement, and vehicle counting equipment (Chandran et al., 2019). Powerful sensing systems are developed to evaluate data in real-time and send it to a database further, smart parking could be used to make parking easier and faster in personal parking lots, hospitals, hotels, shopping malls, public parking garages, and workplaces, among other places (Gunasekara et al., 2015).

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Shopping malls or shopping complexes are large shopping centres with a variety of retailers, restaurants, and other businesses situated in a sequence of connected or neighbouring buildings or in a single enormous structure (Aravinthkumar et al., 2020). During peak hours (lunch, evening, weekends), and sales seasons, large crowds are common in shopping malls and the majority of customers arrive at the shopping centre in their own vehicles, which creates an indirect challenge for car drivers in terms of obtaining available parking spaces (Khang et al., 2010). Parking management at shopping malls can be made easier with the smart parking management system and this method would ensure that parking at shopping malls is easily accessible during operating hours and especially during rush hours (Aravinthkumar et al., 2020).

Though automated car parking is quite popular in Sri Lanka, smart car parking is not that popular among Sri Lankans. Radio frequency identification (RFID) systems and light emitting diode (LED) signalling are the commonly used smart access controlling and smart car parking solutions used in the Sri Lankan context (Maduranga et al., 2021). When considering car parking in shopping malls in Sri Lanka, people spend a lot of time searching for car parking slots inside the parking areas. As access control and payment handling for parking are controlled manually, results in customers wasting a considerable amount of time (Chaaminda, 2019). Further to the author, from the perspective of the facility, at least two guards have to be placed at the entrance and exit to perform the above task. The facility has to spend additional labour costs for maintaining the car parking facility. Considering those issues, a specifically designed smart car parking solution can help to mitigate the issues faced by the customers while parking their vehicles in shopping malls, and at the same time, it will be beneficial to the facility as well.

Thus, this paper presents the findings of a study that aimed at investigating the suitability of smart car parking as a solution to mitigate the current parking management issues faced by Sri Lankan shopping malls. The paper starts with a literature review on car parking. Then it presents the research methodology followed by data analysis and research findings. Finally, the conclusions of the study are presented.

## **2. LITERATURE REVIEW**

### **2.1 SMART PARKING SYSTEM**

Smart parking is a technological solution that uses sensors and information technology to help users to locate open parking places (Elsonbaty & Shams, 2020). According to Hassoune et al. (2016), utilising a variety of technologies, smart parking is a management strategy for parking lots in different types of facilities. Smart parking uses information and communication technology to make it quick and easy for users to find satisfying parking spaces, especially on-street parking (Hassoune et al., 2016). Another definition of smart parking is a parking system that aids vehicles in finding an open place by employing sensors to determine if a car is there or not before directing drivers to available spaces (Krishna Chaitanya et al., 2021).

Urban areas are getting more and more crowded and the amount of traffic in a city that is accounted for by people seeking parking is thought to be 30% of all traffic (Lin et al., 2017). By 2050, it is expected an increase in the world population from 55% to 68% in urban areas (Smart Parking Infrastructure, 2020). Smart parking will transform urban driving by making it easier for users to identify vacant spaces and giving authorities the ability to influence the driving habits of their citizens and by reducing travel time and fuel

consumption. Smart parking will also considerably aid in the reduction of greenhouse gases and pollution in the transportation sector (Smart Parking Infrastructure, 2020). If implemented suitably, smart parking can save 0.85 million litres of gasoline until 2030 and about 1.15 million litres of fuel by 2050, according to research, and smart parking maximises the use of existing parking spots, resulting in increased revenue for parking lot owners (Kalašová et al., 2021).

## **2.2 VEHICLE MANAGEMENT SYSTEMS**

This section explains the technologies, that make it easier for the motorists to find an open parking space.

**Global Positioning System:** To locate and monitor a vehicle's precise location, global positioning system (GPS) technology is employed. GPS allows for the determination of the quickest/best route from a given location. The data about parking place occupancy cannot, however, be obtained solely using GPS (Paidí et al., 2018).

**Machine Vision:** License plate recognition (LPR) and machine vision detection of parking lot occupancy may both be done with visual cameras. The camera ought to be situated close to the LPR parking lot's entrance (Enríquez et al., 2017; Paidí et al., 2018). Finding the number of vacant parking spots might be aided by knowing how many cars entered and departed the area. However, this technique cannot be used to determine if parking spots are occupied (Enríquez et al., 2017).

**RFID:** For the identification of the vehicle radiofrequency tags will be utilised and each car will be given a unique radiofrequency tag to specifically identify the vehicle. To identify the tag and allow the car to park there, a transceiver and antenna might be installed at the lot's entrance (Singh & Gupta, 2016).

**QR Code-based System:** In parking and access control applications, QR code-based solutions have shown potential. According to Jiang et al. (2020), a parking management system based on QR codes allows users to enter parking lots, make payments, and keep track of available spots. According to the study, QR codes are a practical and effective way to manage parking operations and improve customer satisfaction.

Compared to alternative methods for managing car parking, the QR code-based approach has a number of advantages including accessibility and user-friendliness, cost-effectiveness, easy implementation and integration, flexibility and scalability and integration with mobile applications (Jiang et al., 2020). Further to the author, the appropriateness of a QR code-based system or other system may rely on certain criteria, such as the size of the parking facility, the required level of security, and the available resources. Before making a choice, organisations should thoroughly assess their requirements and consider the benefits and limits of each system.

## **2.3 REQUIREMENT FOR SMART PARKING SYSTEM**

Classic or traditional car parking is the most available car parking type around the world which is handled and managed manually by security guards (Melsen, 2013). Traditional garages are open 24/7 and since there might not be enough space in certain typical parking lots, drivers must search for an empty place before parking (Krishna Chaitanya et al., 2021). Thomas (2019) stated that traditional parking will incur higher labour to manage and secure the parking facility. Since traditional parking systems are completely dependent on guards, the guards are in charge of manually entering data, processing

payments, updating the availability status, and overseeing the parking lot's overall operations (Melsen, 2013).

Given that manual parking systems still use paper records and data collection and input are manually carried out by parking staff, it is challenging to sort through such a large amount of data (El-Din & Ahmed, 2017). Customers with manual parking management systems waste time waiting in lines to access and depart the parking lot because of antiquated or manual processes; as a result, the long-term profitability of the business is put at risk (Melsen, 2013). However, with the number of cars surging and the shrinking amount of urban land, there is a need for an alternate, sustainable solution (Gautham, 2019).

Instead of adding additional parking spots, smart parking focuses on making it simpler for drivers to find available spaces right away, cutting down on the amount of time they spend driving (Khare, 2021). Drivers and parking lot managers receive information from smart parking technology, which combines the utilisation of detectors, street lighting, intelligent global positioning systems (GPS) technologies, and online payment platforms (Shah et al., 2021). Smart parking may minimise traffic by making it easier to locate vacant parking spaces and lowering the likelihood of distracted driving (Biyik et al., 2021). Sensors that can assess whether a spot is empty or filled, together with illumination that can indicate vacancy, are used by smart parking technology to help cars find parking places (Joshi et al., 2020).

Sensors and illuminated parking spots are just the beginning of smart parking technology (Orrie et al., 2015). According to the author, the most recent IoT innovations allow for the syncing of sensors to a cloud platform, which then feeds data into a mobile app. These applications may then send the car using a GPS to the next parking place that was open (Alharbi et al., 2021). The driver may avoid seeking parking places and retain their focus on the road as a result. Making payment simpler is another way that smart parking may reduce traffic (Hassoune et al., 2016).

## **2.4 CAR PARKING SYSTEMS IN SRI LANKAN SHOPPING MALLS**

Shopping malls or shopping complexes are large shopping centres with a variety of retailers, restaurants, and other businesses situated in a sequence of connected or neighbouring buildings or a single enormous structure (Aravinthkumar et al., 2020). A parking lot is a designated place on the mall grounds for parking automobiles and depending on the size and popularity of the vehicle, all malls offer specialised parking spaces with room for two and four-wheelers (Kumar, 2019). In order to ensure that customers have a hassle-free experience and to avoid resource and financial waste, malls may have a greater need for effective parking lot management systems due to the increased number of customers who prefer to arrive in their vehicles (Thomas, 2019).

It could be challenging to manage parking spaces in shopping mall parking lots without real-time information. If the parking structure has several levels, navigating it could be challenging, causing customers to waste time seeking a spot to park for nothing (Parklio.com, 2021). Even with technology, some people still misplace how they obtained a parking spot, while others become frustrated when they repeatedly fail to find a spot and this has been a major issue in shopping mall parking in Sri Lanka (Thomas, 2019). Over six million automobiles are registered under the fuel permit QR code on Sri Lankan roadways and with a near to 22 million projected population, the country has a car of

some type for every fourth person (Edirisinghe, 2022). According to the author, many people try to use private automobiles to fulfil their needs because of the current state of the public transportation system and concerns about social standing.

One of the biggest repercussions of the lack of suitable parking, especially in metropolitan areas, is the growth in city traffic, and due to this, looking for an empty parking space during peak hours takes a lot of time and wastes fuel (Lotlikar et al., 2016). However, many service providers, both private and public, have failed to grasp this fact and have neglected to give their clients or service seekers' convenience enough attention and therefore, in addition to the organisation's primary facility, service providers should pay appropriate attention to the fundamental needs like parking and convenience of their clients and service seekers (Edirisinghe, 2022).

## **2.5 ISSUES RELATED TO THE IMPLEMENTATION OF A SMART CAR PARKING SYSTEM**

For many of the parties concerned, using a smart parking system provides significant benefits. However, it also has certain drawbacks of implementation as this is a newer solution and required some amount of technological knowledge (Andriana et al., 2018).

Though a smart car parking system provides greater financial benefits to the facility by reducing the manpower associated with it, implementing a smart car parking system requires a significant initial cost as the components, sensors, and other technical features are higher in cost (Patil & Bhonge, 2013). Yahng et al. (2012) stated that the cost of data collection, analysing the most suitable system in the market, and customising the system according to the requirement of the facility will incur some amount of cost to the initial cost of implementation. Apart from that, a significant amount will incur in the operational and maintenance of the solution as it requires periodic maintenance, software updates, the labour cost of managing the software, and the maintenance cost of physical components (Andriana et al., 2018).

To address parking concerns, smart parking employs sensors, wireless communication technologies, data analytics, etc. (Aggarwal, 2011). Since the employed sensors are largely identical, greater emphasis will be placed on the various locations and any accompanying hardware used in combination with the sensors (Idris et al., 2009). In order to identify suitable locations for sensor placement, select the best type of sensor, and identify the other suitable associated equipment well technical knowledgeable personnel are required (Idris et al., 2009). Further to the authors, lack of resource personnel is the major technical issue faced by the facilities regarding implementing the smart car parking system. Apart from that, considering the Sri Lankan context, the availability of smart car parking solution providers is less compared to the global context (Maduranga et al., 2021). Further to the authors, Sri Lanka is a bit behind the other countries when it comes to technological advancements, and therefore, incorporating the latest technologies into the solution is quite hard and the availability of the latest technological equipment is less compared to the other countries.

The continuous flow of work is only possible with proper planning and management and administration ensures a skilled and efficient flow of work. For a smart car parking system, proper administration and management are highly required in order to manage the functions effectively and efficiently (Lotlikar et al., 2016). The main issue related to the administration is, management personnel does not have the required amount of

technical knowledge to manage the system and it requires providing proper training regarding the system before implementing it (Krishna Chaitanya et al., 2021). Further to the authors, a lack of confidence of the management personnel in managing a smart system is another issue faced by facilities when implementing a smart car parking system.

### **3. RESEARCH METHODOLOGY**

This study aims to investigate the suitability of smart car parking as a solution to mitigate the current parking management issues faced by Sri Lankan shopping malls. To identify the issues, in-depth expert knowledge from the facility’s perspective and opinions from the customers’ perspective is generally required. As customers are the centre of stakeholders, issues faced by the customers need to be carefully evaluated as it directly affects the growth of the facility. On the other hand, to provide a better customer experience facilities need to provide the best parking management services and to increase customer satisfaction, issues with current parking management systems need to be reviewed and solved.

The availability of expert knowledge in this area is limited due to the presence of limited number of shopping malls in the Colombo metropolitan area. As a result, it is difficult to draw a large sample of respondents for data collection. Additionally, the information extracted is mostly made up of opinion evidence, which requires descriptive evaluation. On the other hand, in order to identify the difficulties faced with current car parking designs, level of satisfaction with current designs and expected requirements, a questionnaire survey was done targeting motorists of Colombo metropolitan area who uses shopping malls. In addition, the information extracted is mostly made up of quantitative data, which requires statistical evaluation.

Three (03) shopping malls were selected as the cases for investigation and all the selected facilities are located in Colombo metropolitan area. Out of the three, two facilities are mixed developments that contain residential units, shopping malls and one includes a hotel. One respondent from the managerial level of each facility who is engaged in managing the property was interviewed. Matters identified in the literature review were the basis for the interviews and the issues of current parking management systems were identified.

The profile of the selected shopping malls and respondents are provided in table 1.

*Table 1: Details of the selected facilities and interviewees*

<b>Case Code</b>	<b>Description</b>	<b>Interviewee Code</b>	<b>Designation</b>	<b>Awareness of the smart car parking concept</b>
C1	Mixed development includes a shopping mall and residential units.	R1	Building Services Manager	Well- aware
C2	Shopping mall	R2	Property Manager	Unaware
C3	Mixed development includes a shopping mall, hotel, and residential units.	R3	Property Manager	Well- aware

The primary objective of the case studies was to identify the current parking management practices in shopping malls in Colombo metropolitan area and the current issues faced during the parking management process. The secondary objective was to identify the feasibility of implementing a smart car parking system, factors to be considered when implementing the system, required features and technologies and the feasibility of the smart car parking in the Sri Lankan context.

Apart from the case study, an internet-based questionnaire survey was done to identify the current issues faced by motorists when using the car parking area of a shopping mall. To gather information for the study, a sample of 40 people was chosen for the survey. The purposive sampling technique was used as the method of sampling and motorists who have used shopping mall facilities within two weeks of time were selected. This is a descriptive inquiry which aims to characterise the present state of a variable that has been discovered. To determine the motorists' experiences with the current parking systems, the questionnaire primarily consists of closed-ended questions with a few Likert scale questions.

The major objective of the survey was to evaluate how difficult it was for motorists to locate empty parking spaces inside the car park as well as the problems they encountered. Another goal was to calculate the typical amount of time required to locate an open slot. The survey was also conducted to identify how parking issues affect people's decisions to shop at the facility. Through this survey, the knowledge about smart car parking systems among motorists and their opinion about smart car parking system deployment to reduce parking-related problems were also identified.

## **4. RESEARCH FINDINGS AND DISCUSSION**

### **4.1 ISSUES IN THE CURRENT PARKING MANAGEMENT SYSTEM**

One of the most frequently discussed concerns among professionals and the general public alike is parking issues in shopping malls, which are growing more and more significant. The main cause of these parking issues has been attributed to an imbalance between parking supply and demand. To find a solution, identifying the most common challenges and issues faced is an essential part. The issues were analysed both from the facility's perspective as well as from the customers' perspective. Therefore, as the first step, respondents from each facility were asked to briefly describe the parking management issues that they are dealing with, as it was the primary goal of the case study to identify the difficulties and problems encountered during the management of the automobile parking space.

According to the critical analysis of the collected data regarding the common issues in the current parking management system, accidents, behavioural complaints, guidance system issues, inadequate parking facilities, management, and monitoring issues were highlighted as major issues. According to R1, accidents are one of the major issues they faced in managing the parking area. R1 further stated that "*Hit and run is a major problem in the parking area as people tend to escape from the place without negotiating the issue with the other party. Management has to always deal with the victims and have to examine CCTV footage to identify the wrongdoer but most of the time the wrongdoer cannot be identified*". Confirming that, R2 and R3 stated, negotiating with victims who faced accidents consume a lot of time for both the management and the security, and sometimes they had to deal with the legal parties as the accidents happened inside their facility.

R1 and R2 both stated that there are few complaints from the client’s side regarding the behaviours of the security guards. Unpleasant behaviours and rude actions were some common complaints. In addition, R3 indicated that the expense of maintaining the parking lot is high because they are currently practicing a smart car parking system. R2 added that management has had a few complaints about the insufficient parking spaces.

R1 and R2 both agreed that there are a few issues in managing the parking area as they have to manually control the payment process and the cost of management is high due to the employment of a high number of security guards. Further, R2 stated that they faced technical and monitoring issues regarding the car parking area. Further to the respondent, *“Parking lots will be in use most of the time because malls are frequently open late and almost every day of the week. In the event that an entry management system malfunctions in any way, there can be delays that annoy customers. This has happened quite a few times and it incurs a loss of parking charges to the company”*.

Additionally, R1 claimed that since they are lacking a guidance system, motorists spend a considerable time finding a free parking spot, and manually guiding them toward free parking slots is a significant challenge to them. Confirming R1’s statement, R3 further expressed that, though they have implemented a smart car parking system they still face the same issue when it comes to guiding motorists toward an empty parking slot.

The analysed responses from the questionnaire survey are demonstrated in Figure 1. The intention of this survey was to identify the current parking issues faced by the customers.

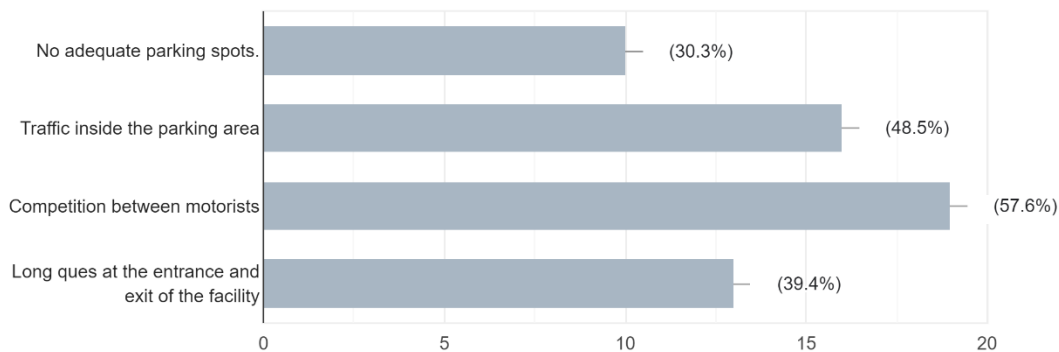


Figure 1: Difficulties faced in car parking

The competition between motorists to find an empty parking space was cited by 58% of respondents as the most challenging aspect of the existing parking arrangement. No sufficient parking spaces was cited by 30% of respondents as a challenge they encountered when parking in shopping mall facilities.

#### 4.2 LEVEL OF DIFFICULTY AND AVERAGE TIME SPENT ON FINDING A PARKING SPOT

According to the responses from the survey, 65% have stated that they spent around 5-10 minutes finding an empty parking spot inside the car parking area. When considering the level of difficulty, 60% stated that they face neither easy nor difficulty in finding a free parking slot.

The average time spent on finding an empty parking spot has a significant effect on the decision of shopping in the facility. Based on the responses received from the survey,



97.5% of the respondents stated that the time spent finding an empty parking spot affected their decision of shopping in the facility. Table 2 depicts the correlation between the average time to find a free parking spot and how it affects the decision of shopping in the facility.

Table 2: Correlation between time to find a parking spot and the decision to shopping

		Average time to find a free parking spot	Does this affect the decision of shopping in the facility?
Average time to find a free parking spot	Pearson Correlation	1	.685
	Sig. (2-tailed)		.008
	N	40	40
Does this affect the decision of shopping in the facility?	Pearson Correlation	.685	1
	Sig. (2-tailed)	.008	
	N	40	40

There is a strong positive correlation between the average time spent on finding a free parking spot and the decision to shopping in the facility. The Pearson correlation is 0.685, indicating a strong positive correlation, meaning that increasing the average time spent on finding a parking spot will highly affect the decision of shopping in the facility. If the time spent on finding an empty parking facility increases the decision of shopping at the facility will decrease. Further, as the Sig. (2-tailed) value is 0.008, it can be said that the relationship between the average time spent on finding a free parking spot and the decision of shopping in the facility is statistically significant.

### 4.3 IMPACT OF PARKING ISSUES TO THE FACILITY

As the shopping malls are commercial facilities, issues with parking will lead to a negative impact on the facility and on the public around the facility. According to the responses given by R1, *“issues with parking negatively impact the company’s reputation and sometimes it will decrease the customer’s future decision on shopping at the facility. This will have an impact on the sales of the facility”*. Confirming R1’s view, R2 and R3 stated that apart from that *“this will negatively affect the adjoining facilities and the public around the facility. Due to the parking issues, most of the time motorists tend to park on street and in front of adjoining buildings. It will affect the aesthetic of the building and most of the time it will be a burden to the public”*.

Further R3 expressed that, they receive lots of complaints from adjoining properties regarding the blocking of entranceways. Further to the respondent, it will affect the reputation of the facility badly and will have an impact on the revenue of car parking.

#### 4.3.1 Suitability of smart car parking to the Sri Lankan Context

The general view of the respondents was smart car parking is suitable for Sri Lanka. Further evaluating the views, R3 specifically mentioned that *“theoretically we can say this is suitable but when it comes to design and implementation sometime this will not be that much suitable. So as the first step, we have to conduct a pilot project collaborating with the government to identify the feasibility, cost, risks, and benefits associated with this concept”*. Further to the respondents, *“it is preferable to generate test data and test*

network performance before installing the system. Additionally, it is necessary to re-evaluate the initial considerations in order to confirm that they still apply”.

R1 expressed his opinion on the behaviours of the users. “If the facility wanted to implement the smart parking system, behaviours of the users need to be changed”. Further, he stated that “there is no guarantee that the users will use the allocated parking to them use the payment options correctly. In that point of view, smart parking will not be suitable for now but in the future, with behavioural changes, this concept will be highly advantageous and cost-effective to function”.

Moreover, R2 commented that “since Sri Lanka is a developing country, some technological advancements may not be suitable to the Sri Lankan context. Before planning to implement, those features or tools need to be tested to identify the suitability and operation conditions of those tools”. He further elaborated, “If we used such technology, it might be difficult to test it even here in Sri Lanka. Some of the causes behind them include a lack of funding and government involvement”.

Summarising the views presented by the respondents, smart parking is suitable to the Sri Lankan context with some technological and behavioural changes. All the respondents agreed that conducting a pilot project will be a more accurate way to identify the actual suitability of the system.

## 4.4 DISCUSSION

### 4.4.1 Facilities Perspective

The facility has to provide a better parking management system in order to increase customer satisfaction and mitigate the issues faced during the current parking management. To develop the most suitable solution, the issues faced by the facility, requirements of the facility, feasibility of the facility, and barriers from the facilities side need to be evaluated. Both traditional parking management and smart parking management system were evaluated, and the following are the summary of issues faced by the facilities.

Table 3: Traditional and smart parking management issues

Issues	Traditional Parking System	Smart Parking System
Accidents	X	X
Long queues at the entrance and exit gate	X	X
No proper mechanisms to guide motorists to the available slot	X	X
Issues of real-time space availability monitoring	X	X
Inadequate parking facility	X	
Behavioural issues of the guards	X	
Management issues	X	

## 4.5 CUSTOMERS PERSPECTIVE

Evaluation of the issues faced by the clients was discussed in the previous section. To provide a better solution for the issues, those identified issues need to be ranked and prioritised. The following shows the prioritisation of the identified issues:

1. Competition between motorists,
2. Traffic inside the parking area,
3. No adequate parking spots, and
4. Long queues at the entrance and exit of the facility.

When providing the solution, the issues need to be addressed in the above order.

#### **4.6 SMART PARKING AS A SOLUTION FOR CURRENT PARKING ISSUES**

After evaluating the awareness of the smart car parking concept, the respondents were asked about their opinion on implementing smart parking as a solution to the current issues in the parking management system. All the respondents stated that smart parking will provide a solution for the waiting time at the entrance and exit gates and it will reduce the waiting time of the customer. Further, it will increase customer satisfaction and cause minimum disturbance to the customer. R3 further explained smart parking will provide a solution to the management issues of the parking area, will generate revenue, and save unnecessary costs on parking management. R2 mentioned that it will indirectly increase business as smart parking solutions will increase customer attraction. Furthermore, smart parking lots provide many more benefits than traditional parking lots. *“Attracting and retaining clients is crucial to our business success, thus it must be done consistently. As a result, it must be met as soon as they arrive at our place, particularly if parking lot management is involved. Thus, it can achieve through implementing a smart parking system”*, is another idea expressed by R3.

In order to provide the solution, all the respondents were asked to select the most suitable option for smart parking type among the two options which are reservation-based parking and onsite parking selection. Reservation-based parking is a solution that allows motorists to reserve their parking spots prior to arrive the facility through a mobile app or through a website on the other hand onsite parking selection is an option that allows the motorists to select their parking location after arriving at the facility. All the respondents commented that onsite parking selection will be the best option for the Sri Lankan context as still the people are not familiar with advanced technologies.

Summarising the expressed views, all the respondents agreed that implementing smart parking is a practical solution to the current parking management issues and it will be more beneficial to the facility compared to the traditional or manual parking management systems. Further, all the respondents agreed that onsite parking selection is the most suitable option for the Sri Lankan context.

## **5. CONCLUSIONS**

Parking management concerns are one of the main difficulties that the management team of the shopping mall amenities must overcome. The number of people owning cars is rising along with their financial situation, which magnifies the difficulties and tensions associated with parking. A personalised parking management solution has to be offered in order to address the problems with the present parking management systems. According to the analysis, the facility's most frequent parking management problems include accidents, lengthy lines at the entrance and exit gates, a lack of proper mechanisms to direct drivers to available spaces, problems with real-time space availability monitoring, an inadequate parking facility, behavioural issues with the security personnel, and management problems. The challenges experienced by motorists

include traffic inside the parking lot, a lack of suitable parking spaces, and long lines at the facility's entry and departure.

Analysis of the findings revealed that there is a strong positive correlation between the average time spent on finding a free parking spot and how it affects the decision of shopping in the facility. Thus, the development and implementation of a smart parking solution is recommended in order to address the concerns indicated.

## 6. REFERENCES

- Aggarwal, C. C. (2011). An introduction to social network data analytics. In C. Aggarwal (Eds.), *Social Network Data Analytics*, (pp.1–15). Springer US. [https://doi.org/10.1007/978-1-4419-8462-3\\_1](https://doi.org/10.1007/978-1-4419-8462-3_1)
- Alharbi, A., Halikias, G., Yamin, M., & Abi Sen, A. A. (2021). Web-based framework for smart parking system. *International Journal of Information Technology*, 13(4), 1495–1502.
- Andriana, G. M., Agung, A. A. G., & Handayani, R. (2018). Implementation of smart parking system with real-time monitoring. *Far East Journal of Electronics and Communications*, 18(2), 277–290. <https://doi.org/10.17654/ec018020277>
- Aravinthkumar, S., Makkar, S., & Abdulhakim Al-Absi, A. (2020). Smart parking management system in shopping malls. In: P.K. Pattnaik, M. Sain, A.A. Al-Absi & P. Kumar (Eds.), *Proceedings of Strategic foresight, security challenges and innovation: Proceedings of international conference on smart computing and cyber security*, (pp.135–146).
- Biyik, C., Allam, Z., Pieri, G., Moroni, D., O'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>
- Chaaminda, M. D. J. (2019). A review on recreation management orientation of Sri Lankan shopping malls: An empirical study in Sri Lankan shopping malls focusing on developing the cinema sector in Sri Lanka. *International Journal of Scientific Research and Innovative Technology*, 6(5), 60–72. [www.ijrsrit.com](http://www.ijrsrit.com)
- Chandran, M., Fadila Mahrom, N., Sabapathy, T., Jusoh, M., Nasrun Osman, M., Najib Yasin, M., Hambali, N. A. M., Jamaluddin, R., Ali, N., & Abdul Wahab, Y. (2019). An IoT-based smart parking system. *Journal of Physics: Conference Series*, 1339(1), 012044. <https://doi.org/10.1088/1742-6596/1339/1/012044>
- Edirisinghe, J. (2022, September 6). Inadequate parking space, a key issue. *Daily News*. <https://www.dailynews.lk/2022/09/06/features/286580/inadequate-parking-space-key-issue>
- El-Din, H., & Ahmed, I. S. (2017, November 25). *Car parking problem in urban areas: Causes and solutions towards a better quality of life*. 1<sup>st</sup> International Conference Towards a Better Quality of Life <https://ssrn.com/abstract=3163473> Electronic copy available at: <https://ssrn.com/abstract=3163473>
- Elsonbaty, A., & Shams, M. (2020). The smart parking management system. *International Journal of Computer Science and Information Technology*, 12(4), 55–66. <https://doi.org/10.5121/ijcsit.2020.12405>
- Enríquez, F., Soria, L. M., Álvarez-García, J. A., Velasco, F., & Déniz, O. (2017). *Existing approaches to smart parking: An overview*. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 10268 LNCS, 63–74. [https://doi.org/10.1007/978-3-319-59513-9\\_7](https://doi.org/10.1007/978-3-319-59513-9_7)
- Gautham, S. (2019, July 9). *Traditional vs automated parking system*. Get My Parking. <https://blog.getmyparking.com/2019/07/09/traditional-vs-automated-parking-system/#:~:text=1.,increase%20organization%20and%20reduce%20traffic>.
- Gunasekara, G., Gunasekara, A., & Kathriarachchi, R. (2015). A smart vehicle parking management solution. *Proceedings of 8<sup>th</sup> international research conference KDU* (pp. 106-110).
- Hassoune, K., Dachry, W., Moutaouakkil, F., & Medromi, H. (2016, October 20). *Smart parking systems: A survey*. 2016 eleventh international conference on intelligent systems: Theories and applications. Mohammedia. Morocco.

- Idris, M. Y. I., Leng, Y. Y., Tamil, E. M., Noor, N. M., & Razak, Z. (2009). Car park system: A review of smart parking system and its technology. *Information Technology Journal*, 8(2), 101–113. <https://scialert.net/abstract/?doi=itj.2009.101.113>
- Jiang, L., Zhang, Y., & Wang, Z. (2020). QR Code-based parking management system for smart cities. *IEEE Transactions on Intelligent Transportation Systems*, 21(6), 2338-2349.
- Joshi, A., Hariram, A. T., Somaiya, V., & Hussain, M. (2020). Smart car parking system. *International Journal of Engineering Research and Technology*, 9(9), 484–487. [www.ijert.org](http://www.ijert.org)
- Kalašová, A., Čulík, K., Poliak, M., & Otahálová, Z. (2021). Smart parking applications and its efficiency. *Sustainability (Switzerland)*, 13(11), 6031. <https://doi.org/10.3390/su13116031>
- Khang, S. C., Hong, T. J., Chin, T. S., & Wang, S. (2010, December 6-10). *Wireless mobile-based shopping mall car parking system (WMCPS)*. 2010 IEEE Asia-Pacific Services Computing Conference. Hangzhou. China. (pp. 573–577). <https://doi.org/10.1109/APSCC.2010.116>
- Khare, P. (2021, December). *Smart, automated car parking system*. NBM&CW. <https://www.nbmcw.com/article-report/others/smart-automated-car-parking-system.html>
- Krishna Chaitanya, V., Sri Harsha, M., Maneesh Kumar, L., Rahul, V., Goutham Kumar Reddy, P., & Kumar, A. (2021). Smart parking management system. *IOP Conference Series: Earth and Environmental Science*, 796(1), 012014. <https://doi.org/10.1088/1755-1315/796/1/012014>
- Kumar, S. (2019). *Driving the change: Malls use technology for smart parking solutions*. India Retailing. <https://www.indiaretailing.com/2019/09/20/driving-the-change-malls-use-technology-for-smart-parking-solutions/>
- Lin, T., Rivano, H., & le Mouel, F. (2017). A Survey of smart parking solutions. *IEEE Transactions on Intelligent Transportation Systems*, 18(12), 3229–3253. <https://doi.org/10.1109/TITS.2017.2685143>
- Lotlikar, T., Chandrahasan, M., Oke, M., & Yeole, A. (2016). Smart parking application. *International Journal of Computer Applications*, 149(9), 32-37.
- Maduranga, D., Umayra, T., & Dewshan, R. (2021). Development of an Internet of Things (IoT) enable smart parking system for Sri Lanka. *Research Square*. <https://doi.org/10.21203/rs.3.rs-677449/v1>
- Melsen, N. van. (2013, March 21). *Conventional parking could soon be a thing of the past*. Parking Network. <https://www.parking-net.com/parking-industry-blog/skyline-parking-ag/automatic-parking-system>
- Orrie, O., Silva, B., & Hancke, G. P. (2015, November 9-12). *A wireless smart parking system*. IECON 2015 – 41<sup>ST</sup> Annual Conference of the IEEE Industrial Electronics Society. Yokohama. Japan. (pp.4110–4114).
- Paidi, V., Fleyeh, H., Håkansson, J., & Nyberg, R. G. (2018). Smart parking sensors, technologies and applications for open parking lots: A review. *IET Intelligent Transport Systems*, 12(8), 735–741.
- Parklio.com. (2021). *Retail & Shopping Mall Parking Management Solutions and Systems*. <https://parklio.com/en/use-cases/retail-and-shopping-mall-parking-management-solutions-and-systems#01>
- Patil, M., & Bhonge, V. N. (2013). Wireless sensor network and RFID for smart parking system. *International Journal of Emerging Technology and Advanced Engineering*, 3(4), 188–193.
- Shah, A., Shah, D., Satpute, A., Shinde, M., & Shinde, S. (2021). Literature review on parking system. *International Journal of Engineering and Technical Research*, 10(10), 100–104. <https://doi.org/10.17577/IJERTV10IS100061>
- Singh, P., & Gupta, K. (2016). Intelligent parking management system using RFID. In M. Pant, K. Deep, J. Bansal, A. Nagar, & K. Das, (Eds.), *Advances in Intelligent Systems and Computing: Proceedings of fifth international conference on soft computing for problem solving*, 436, (pp. 497–505).
- Smart Parking Infrastructure. (2020). In Global Infrastructure Hub.
- Thomas, P. A. (2019, June). *Major challenges in managing parking lots*. Asmag. <https://www.asmag.com/showpost/28445.aspx>
- Yahng, J., Portilla, J., & Riesgo, T. (2012, October 25-28). *Smart parking service based on wireless sensor networks*. IECON 2012 - 38<sup>th</sup> Annual Conference on IEEE Industrial Electronics Society, Montreal, QC, Canada.