

PROSPECT OF ESTABLISHING SMART CAR PARK SYSTEM FOR COMMERCIAL BUILDINGS IN SRI LANKA.

ABEYNAYAKE M.D.T.E.^{1*} & MENOLI KAUSHALYA P.L.²

^{1,2}Department of Building economics, University of Moratuwa, Sri Lanka

¹mabeynayake@uom.lk

Abstract: ‘Car parking’ can be considered as a pivotal challenge and one of the major contributors to traffic congestion in urban areas. This challenge is a result of a dramatic increase in numbers of automobiles on the roads as well as surge in population. Recently, smart car parking management has become an ideal solution for the parking with the emergence of IoT technology. At present, the deployment of smart technologies has rapidly increased specially in the developed countries, in the world. Hence, this study aims to explore the challenges and problems for implementation of smart car system and to make recommendations for implement it to the Sri Lankan context. This research carried out in developed countries do not ideally and best suit for developing countries as the economic, social and cultural contexts of the developed countries are different from that of the developing countries. Therefore, this study goes beyond that and addresses about smart car parking system that assisted users to solve the issue of finding a parking space and to minimize the time spent in searching of the nearest available car park, based on the case studies encompassing commercial buildings within the Sri Lankan context. In this research, a comprehensive literature review was conducted with the view to review the concept of smart car parking system and semi structured interviews covering the case studies and expert interviews were carried out. Data gathered, was examined using cross case analysis utilizing qualitative analysis tool namely Nvivo 12 and content analysis. Results of the research can be applied to the Sri Lankan context stepwise in different stages. Therefore, this research has focused to identify the stages of developing smart car parking system along with the identification of benefits, barriers and suitable recommendations as well. Thus, the intended research outcome of this research which is to explore the establishment of smart car park system for commercial buildings in Sri Lanka to mitigate the traffic congestion and to effectively utilize the limited space is successfully accomplished.

Keywords: *Smart Car Park System (SCPS), Internet of Things (IoT), Congestion, Drivers and Barriers*

1. Introduction

Vehicles offer comfort to people, but parking causes serious problems at the same time due to poor management (Kasthrinaki, 2003). As car purchases and ownership increase in metropolitan cities due to dynamic economic growth, parking issues result in air pollution, congestion and safety threats, as up to 50 percent of traffic comes from cruising cars when searching for parking lots (Chaniotakis & Pel, 2015). Many cities around the world look forward to being intelligent alongside this (Aydin, 2017). One of the most common use cases in smart cities is the practice of smart parking solutions, which enable people to maximize their time, reduce fuel consumption and reduce carbon dioxide emissions (Geng & Cassandras, 2012). Further authors identified smart parking systems have a given architecture that includes different components such as sensors, software and communication protocols.

Today most parking areas in Sri Lanka run with or without a small computerized program using a small database (Gunasekara, 2015). It further described vehicle owners are usually required to walk around and manually check the occupancy of individual spots, and owners are also worried that they do not maximize profit because of inefficient parking slot management. It is a common issue in most urban city to find unoccupied parking spaces, particularly when different festivals are at peak times. This issue often exists in modern cities; people come by their cars, resulting in many cars vying for a few unoccupied parking spaces and protection for their parked cars (Alsafery, 2018). Difficulties in finding vacant spaces, improper parking and poor management are some of the parking many issues (Gunasekara, 2015).

The research related to smart concepts significantly appeared in various disciplines in the academic domain. Therefore, an important topic to consider is how to reduce the cost of data transmission and how to save resources and provide information in real time quickly. (Lin, 2017). In several countries, the concept of smart car parking

*Corresponding author: Tel: +94 715586655 Email Address: mabeynayake@uom.lk
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systems is gaining more interest lately because of the need for a modern way of locating accessible parking spaces. The IoT offers the ability to address these problems, as it can be designed to collect sensor data for smart cities monitoring points of interest (Alsaferi, 2018). Therefore, the study focuses on setting up a smart parking system for commercial buildings that is widely regarded as a trend in smart cities.

2. Literature Review

2.1 WORLDWIDE APPLICATION OF SMART PARKING

Since the early 1970s, intelligent parking control systems have been deployed across Europe, the UK and Japan (Shaheen, et al., 2005). In many developing countries, parking guidance and information (PGI) systems have been used since the 1970s, with portable electronic boards displaying variable signs, providing drivers with directions and vacancy parking data as they approach their destinations (Patrick, et al., 2019). Parking is an 11.8 billion dollar sector in the United States (European Commission, 2016). Smart parking systems are implemented in Los Angeles, San Francisco, Beijing, Stockholm, São Paulo, Shanghai and The Netherlands, according to the Science Research Group (2014). There are already many applications for free smart parking available online in web and mobile stores of Android or iOS (Paidi, et al., 2018).

While there are several implementation initiatives, very few drivers still can profit from intelligent parking (Lin, et al., 2017). The research further clarified that two of the most popular successful stories are SF Park (San Francisco) and LA Express Park (Los Angeles). However, if we tried to implement the same system in another area, it is always necessary to perform a preliminary test, select the most appropriate technology and then change the system according to the street layout of the city and the residents' habits (Alsaferi, 2018).

2.2 INTERNET OF THINGS (IOT) AND ITS IMPACT TO THE CAR PARK SYSTEM

Internet of Things (IoT) was first introduced at the auto ID center in 1999 and used for the first time by Kevin Aston (Hung, 2017). The fundamental meaning of IoT can be defined as anything that can be linked to the results of the Internet in the "IoT" (Thorat, 2017). Sensors, actuators, radiofrequency identification (RFID) tags are the things in the IoT (Thorat, et al., 2017). Things could be tracked, managed or monitored using Internet-connected remote computers (WANG, 2013).

2.3 NEED OF SMART CAR PARK FOR COMMERCIAL BUILDINGS

It's very usual to have massive crowds during peak times in locations like mega shopping malls and stadiums (Alsaferi, et al., 2018). In excess, too much frustrating for many people is the search for a parking space in a parking lot in commercial areas (Aydin, et al., 2017). Parking quest traffic can contribute significantly to congestion in central cities during peak journey times (Shaheen, et al., 2005). Discounts and seasonal sales provided by retailers in shopping malls will trigger thousands of customers during the same periods (Bong, et al., 2008). Many consumers ride in their own cars to the shopping malls and it's no surprise to see that parking spaces are still full at these periods (Punch, 2014). Studies into the parking behaviour of drivers, however, showed that this does not seem to deter many drivers from queuing at their preferred car park for substantial periods of time (Percival & Sedgwick, 2002). More problem increases with the high rate of growth in the new registration worldwide (Faheem, et al., n.d.).

2.4 WHAT IS SMART CAR PARK MANAGEMENT SYSTEM?

One of the most common applications in smart cities is the implementation of smart parking solutions, which enable people to maximize time, reduce fuel consumption, and reduce carbon dioxide emissions (Barriga, et al., 2019). SCPM refers to specific policies and schemes, which contribute to a more effective usage of parking services (Litman, 2006). Over the past decade, several research efforts have been investigating emerging IoT application scenarios where heterogeneous devices, ranging from smartphones and wireless sensors to network-enabled physical objects (example- radio frequency identification, FID, smart visual tags) can interact seamlessly in globally integrated communications platforms (WANG, et al., 2013). IoT can attach objects like smartphones, sensors and actuators as nodes, but most likely they are connected to CCTV cameras (Fraifer & Fernström, 2016).

2.5 BENEFITS OF SMART CAR PARK SYSTEM

The smart parking system is considered beneficial for parking owners, parking patrons as well as environmentally safe (Chinrungrueng, et al., 2007; Shaheen, et al., 2005). Before implementing a smart car parking system its benefits and its expense must be taken into account

2.5.1 Safe secure and easy for drivers and efficient space utilization

By using a smart parking management system, cars can spend less time driving through areas of a parking lot that have no room and can drive directly to the appropriate parking space (Lee, 2012). Going through the car park can be dangerous since other cars block drivers' vision and find it difficult to see other cars coming out of the other car park (Tang, et al., 2006). When using a parking management system, vehicles can be assigned to parking spaces and can transfer vehicles on their own, using conveyor belts, to a different location in a parking lot. (Matjasec & Conlagiu, 2011).

2.5.2 Environmentally friendly parking system

Through having a way of directing vehicles inside a parking lot, the amount the cars drive inside the parking lot can minimize (Patrick, et al., 2019). It would minimize the fuel used and the number of harmful gasses emitted into the atmosphere, including carbon monoxide (Zhilan, 2008)

3. Methodology

A comprehensive literature review was performed to review the concept of smart car parking system as a newest technology. The literature review was conducted by means of books, journals, conference proceedings, theses, studies, newspapers, magazines and publications were used as references. Along with the qualitative approach, the research strategy were designed with case study analysis. Investigating whether to have single or a greater number of cases to employed in case study technique, and difficulties of analysis of findings, is a foremost concern (Rose, et al., 2015). This mainly includes semi structured interviews ,case studies and expert interviews were conducted which well suit to explore the need of smart car park system to the Sri Lankan context and to identify factors affecting to the establishment of such system for commercial buildings. Finally, all data gathered was examined using cross case analysis using qualitative analysis tool namely Nvivo 12 and content analysis.

4. Discussion

4.1 FACTORS TO BE CONSIDERED WHEN ESTABLISHING SMART CAR PARK SYSTEM

Based on the results generated, all the respondents ranked economic and financial feasibility (10%) as the primary factor, followed by parking demand (9%), technological and features (9%), vehicle safety and protection (9%), location (9%), legal condition (9%), customer convenience (9%) also as major factors. The results suggest the adoption of smart parking is more influenced by those factors.

4.2 BENEFITS OF ADOPTING SMART CAR PARK SYSTEM

According to the findings, benefits namely, saves money, higher customer satisfaction, reduce the congestion, an organized parking saves the time, increase monthly revenue, decrease operational and maintenance cost, ensures the safety and security of vehicles and people, reduce environmental pollution, less frustration and high accuracy were found.

4.3 BARRIERS FOR THE IMPLEMENTATION OF SMART CAR PARK MANAGEMENT

According to the collected details, all the respondents from case study interviews perceived the physical and geographical restrictions, financial issues, legal constraints and design considerations are the major barriers confronted by them when establishing the SCPS. Apart from that, ventilation issues also act as an indirect barrier since for the ambience inside the car park should have constructed with proper manner. Selection of location also plays as a major barrier at the initial stage since it depends on some more factors such as building size, available resources and legal considerations as well in line with purview of respondents.

4.4 RECOMMENDATIONS TO OVERCOME BARRIERS

Technologies are always changing with the rapid advancement of the global. Also, some barriers might be introduced with those technological advancements. Therefore, the systems we use now can be changed later with some improvements raised through requirements at that moment. Along this case, to draw a better conclusion of the research, it was questioned about what recommendations should be added to the existing systems in Sri Lanka against the identified barriers. Introduce new technological features and improvements are such as sustainable and energy efficiency features and provide multiple payment options were foremost recommendation provided by them against the maintenance barriers, design considerations and physical and geological restrictions. Perform feasibility study prior to the implementation of the project, involve expert knowledge can be lower the barriers such as commercial risks, ventilation and environmental risks and physical restrictions. Also, collaboration between government authorities select most suitable and convenient locations and introduce new policies and regulations were raised against legal constraints. Apart from that, to be more readiness, actions such as involve expert knowledge, improve other supportive infrastructural developments and develop customer convenient structural design are recognized.

4.5 APPLICABILITY TO THE SRI LANKAN CONTEXT

Due to the lack of literature regarding its applicability to the Sri Lankan context, this section was mainly examined to know if there is any argument when it comes to local industry and to find out how to establish a SCPS stepwise.

According to the respondent E1, *"same as other technologies, after identifying the strategy and scope including the requirements it is required to perform a pilot test prior to the installation"*. He further clarified that *"a pilot test is a software testing that verifies a system under a real-time operating condition. Likewise, we need to evaluate the feasibility, cost, time, risk, and performance of the project"*. Similarly, E3 suggested to consider factors found out through the case study at the initial stage and then better to perform pilot test. In excess, he proposed that *"it is better to test network performance and generate test data prior to installation of the system. Also, the factors considered at the initial stage again need to be evaluated at the same time to ensure they are precisely concerned"*.

After identifying the initial stages of developing SCPS, E2 betoken that establishment of the system can be executed at next. Also, he suggested that *“system should integrate with other departments and needs to develop collaboration tool for parking managers after the system installation”* and it confirmed by E3. Adding a final stage for the development of SCPS, E1 stated that *“if operators need to change the parameters of the system, they can freely adjust them in the future”*. He further elaborated that *“maintenance, and documentation can be performed after the installation like other common technical systems. Then the KPI s can use to monitor the performance if needed”*. Likewise, a basic idea of establishing system was gradually developed.

However, E1 further described that *“since Sri Lanka is still a developing country, same technology uses by developed country might not be suitable for our country. So, some considerations like cost, expected outcome, requirements of the developer, risk, specifications should be evaluated”*. Similarly, E2 stated to refer the technology uses by the developed countries and adjust it according to our requirements. It is because, most of the developed countries are using advance technologies like Parking apps, automated valet parking, parking lifts etc. as per the examples given by him. However, E3 suggested that *“if we implemented that kind of technology it might be hard even to test within our country. Lack of financial resources, lack of government involvement are some reasons to them”*.

Altogether, the need of addressing the requirements of the user and conducting a preliminary test before the installation specially in a developing country like Sri Lanka with the aid of technology used by the developed countries were highlighted. However, following activities as shown in Table 1 were highlighted during the data collection consisting with four main stages for the guidance of establishing SCPS for commercial building in Sri Lanka.

Table .1 - Stages of Establishing SCPS for commercial building Source

<p>1. Strategy and scope-</p> <ul style="list-style-type: none"> • Identify the requirement to be fulfilled • Define required outcomes • Define current parking usage • Understand how other departments can benefit • Identify factors to be considered 	<p>2. Pilot test-</p> <ul style="list-style-type: none"> • Perform pilot test • Test network performance • Understand installation needs • Generate test data • Estimate the cost • Evaluation of the factors to be considered
<p>3. Establishment</p> <ul style="list-style-type: none"> • Establish the smart car system • Integrate with other departments • Develop collaboration tools for parking managers 	<p>4. Evolvement</p> <ul style="list-style-type: none"> • Adjust services parameters if needed • Undertake maintenance • Document parking success and gains • Monitor performance of the system

5. Conclusion and recommendations

Smart car parking system has become popular among smart cities all over the world. According to the findings of the research, Sri Lanka must be encountered different path to the establishment of smart car parking system since the context is different when it comes to the developing country. Therefore, this research has focused to identify the stages of developing smart car parking system along with the identification of benefits, barriers and suitable recommendations as well. Thus, the intended research outcome of this research which is to explore the establishment of smart car park system for commercial buildings in Sri Lanka to mitigate the traffic congestion and to effectively utilize the limited space is successfully accomplished. Accordingly, recommendations are important to establishment of smart parking system with beneficial for parking owners, parking patrons as well as environmentally safe in urban areas in Sri Lanka

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