

Applying smart parking system with internet of things (IoT) design

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Abstract. Managing parking system has become major issues in almost all malls in Jakarta. The majority of mall in Jakarta have difficulty to develop plan that enables to optimize their parking slots. Some malls use valet system to gain more profit or ease the customers, unfortunately the valet system price is quite expensive for major customers and it sounds unpopular. Therefore, many area of valet parking space is not maximized. The similar problems also faced by traditional parking system where it creates problems for customers such as difficult to find parking space, paper ticket missing and unable to locate car location. The purpose in this study is to propose a Smart Parking System (SPS) through the use of Internet of Things (IoT). The article applies smart parking system that enables online booking system, paperless ticket, cashless payments and automated guided parking. The objective of the article is expected to enhance the current online parking management system with IoT design, with the aim to be used as reference for parking management in malls.

1. Introduction

Shopping malls have been favorite place to go for urban society in big cities, such as Jakarta. Visiting shopping malls is already become part of their lifestyle. It is not a surprise where they can find almost everything in shopping malls. In order to make customers feel comfort during their visit to the shopping malls, mall management has provided their customers with various facilities, one of them is parking spaces.

In Jakarta, the use of vehicle especially car increase every year. The statistics shows that the growth of car increase by 6.48% annually and total of car in Jakarta in 2016 has reached 3,525,925 cars [1]. According to surveys, at least half those figures will occupy parking slots in the malls [1]. With the fast growth of cars has caused major problems especially in parking management problem. Common solution has been taken such as utilizing valet service, however, it is considered very expensive and unpopular amongst car users. Therefore, the valet parking spaces are rarely occupied. Figure 1 shows the flow of valet service comprises several steps.



Figure 1. Valet parking service

In contrast to valet service, the traditional parking system is considered more popular for most car users due to its cheaper cost. Figure 2 illustrates stages in common traditional parking system.



Figure 2. Traditional parking stages

Some malls in Jakarta have applied smart management system through using sensors to identify available slots and direct the users to the location [2]. Although it is equipped with sensors, the information may not report real time situation, where the car users are frequently misguided with delay reports. Other problems such as users may lose the ticket and difficulty to find the car location. The car users frequently take longer time to solve ticket problem and it considered as wasting time.

The article proposes of using wireless IoT that enables to identify available slots and real-time guidance the car users to available parking slot. The IoT enables to integrate the uses of sensors and CCTVs, with current database management system. The development of network and Internet technology such as the presence of IPv6, 4G, and WiMAX, can help implement IoT to be more optimal, and easier for the control room to manage spaces and cars [3].

Smart parking system has been widely applied in Europe and North America and combined with smart IoT. In addition to adopting advanced automation solutions and payment software and parking guides, the parking industry prepares to use technology adapted from the IT industry. Migration to smart parking systems, rapid development of wireless technology, big data analytics, and the evolution of contactless RFID

communications have become essential components of smart city to combat common big city problems such as increasing congestion, crimes, pollution, etc. [4]. The article proposes the use of smart parking system with the aim to be applied in all buildings in Jakarta.

2. Literature Review

2.1. Smart Parking System (SPS)

SPS refers to parking management system that combines cloud computing technology, database, and mobile devices in parking systems [4]. The system created is not just an operational system for managing parking lots, but also storing information and accessing up-to-date information on the condition of parking lots. The procurement of an automated parking lot operational system aims to provide fast, safe, monitored and transparent parking services. While access to information about parking lots, both position / profile and current conditions, is made to facilitate users in finding parking lots and monitoring the condition of the parking lot [5].

The parking management system has evolved from traditional with using manual tickets [6] into highly rely on the development IT technology and sensors. This service allows users to access online services such as mobile apps[7], with features such as: ease to find parking slot, and backup plan [8].

2.2. Internet of Things (IoT)

The IoT (Internet of Things) is a computational concept that describes every physical objects can be connected to the internet and can identify itself between other devices. As for capabilities such as data sharing, remote control, etc., including objects in the real world. Examples are machineries, sensors, electronics, collections, any equipment, including people that are all connected to local and global networks through embedded sensors and are always active [9].

IoT provides opportunity to solve problems, improve, simplify, ease and automated many various process that happen daily. IoT implementation has been carried out in various fields such as agriculture, health, and manufacture [10][11][12]. It's also used in home monitoring and smart parking [13][14].Through IoT implementation parking data can be gathered, monitored and analyzed to be used as foundation of decision making [15].

3. Methodology

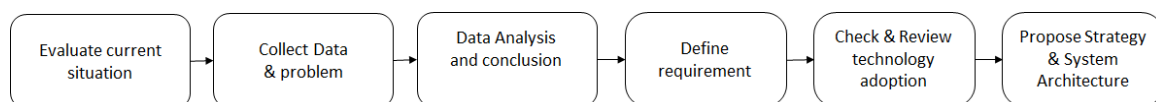


Figure 3.The Methodology Process.

The article uses keyword “smart parking system” and “Internet of Things” in the well-known databases such as: IEEE, ACM and AIS. The article selected and evaluated against the current parking systems. The article evaluates several parking systems in several luxury malls located in the South Jakarta. Interviews and observation have been conducted to managers that in-charge with parking management system, and the findings were benchmarked with those literature studies. Although it is still infant stage in pilot project, the outcome of the

article is expected to provide comprehensive solutions to parking system through integrating technology such as IoT, cloud, web and mobile.

4. Result and Discussion

Based on what has been discussed in introduction and literature review, the problem of parking system at malls can be solved through implementation of smart parking system that use IoT. SPS offers strategy and system to optimizing the parking lot for mall management and ease the parking process for customers through booking system, paperless ticket, cashless payments and automated guided parking. Booking system can be alternative to valet and cost more cheaper because it doesn't use people. Paperless ticket and cashless payments solve the problem of missing ticket and long queue. While automated guided parking will help customers to find the parking lot that available without the needs to check every floor and every lot. We propose the SPS as the following :

4.1. The Architecture

In this section will be discuss about the architecture of SPS. The parking system that we propose will make each system link one to another. The system that will be available is in-ground vehicle detection sensor. The parking sensor in the parking system use infrared. The sensor will often communicate with the signal light notification which is located above each parking lot using short range wireless. The sensor is used to specify whether the parking lot is empty or not. If it empty, the sensor will give signal and change the light to green. Otherwise if the parking lot is not empty or already being booked then the light will turn to red.

One of the system in the parking system will be mobile and web-based application. Mobile and web-based application is where the customer interact with the parking system. In the mobile and web-based application, customer can do various activities, such as check availability of parking lot in shopping mall, book the empty parking lot and pay the parking fee.

Another system is cloud. Cloud is used for database. It records every activity in the parking system. It stores the information from the users as well, for instance the time when customer make a booking, the time when the car is parked, duration of car parked, the total fees which customer need to pay, and the payment method.

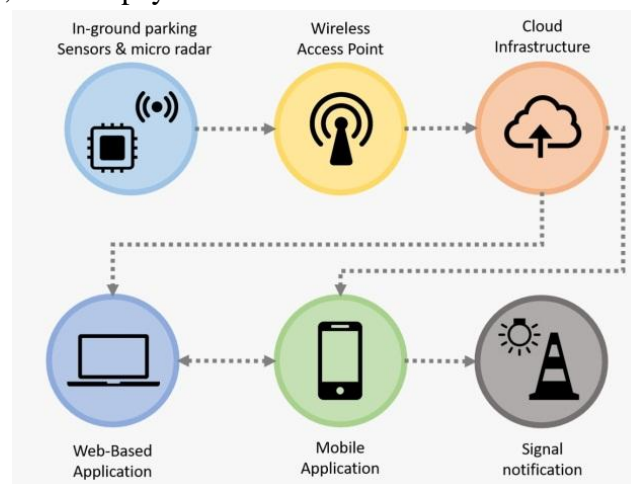


Figure 4.Smart Parking System (SPS) Architecture.

To realize this system, this article proposes SPS architecture with the AWS IoT platform acting like a cloud server to exchange information between end users and systems. The AWS cloud server provides facilities for interfacing gateway devices such as Raspberry Pi, and Arduino boards to control any application. Adjustment has been made on the AWS cloud server to establish communication between the Raspberry Pi and the server. For authentication purposes, a certificate must be made for that. Depending on the requirements, rules are made to evaluate messages sent by objects and determine what to do when the message is received. An action is selected and configured to send notifications to clients related to the message. To publish a message, a topic must be created. Subscriptions are made for topics where the communication protocol and end points of each client are defined. After creating a subscription, messages can be easily sent to certain clients. By using a MQTT broker, a topic can be subscribed to and published to send different messages.

Hardware components include gateway devices such as Raspberry Pi, Ethernet cables, computers/ laptops, and various types of sensors for monitoring. Raspberry Pi is connected to a computer/ laptop using an Ethernet cable. The USB cable is used to turn on the Raspberry Pi device. According to application requirements, the sensor is connected to a Raspberry Pi device for the purpose of remote monitoring. The Raspberry Pi device is programmed to drive data AWS cloud server. The proposed system was implemented successfully by integrating the AWS cloud server and Raspberry Pi device as shown in Figure 2 and Figure 3. As a prototype for remote monitoring, the IR sensor is connected to a Raspberry Pi device.

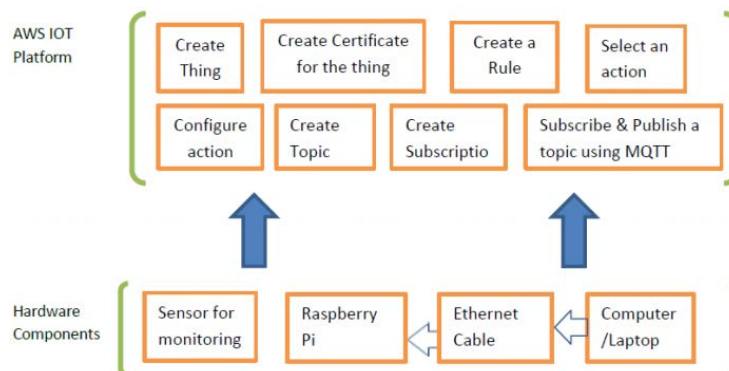


Figure 5.Theoretical Framework Smart Parking System (SPS) Architecture.

4.2. Implementation



Figure 6.Smart Parking System (SPS) Implementation

The SPS implementation uses integrated technology such as mobile, QR scanner, In-ground sensors, notification sensors, notification signal and parking monitor. The SPS implementation will benefit customers, parking staff and shopping mall management. The framework SPS (see figure 5) enables the car users can book the parking lot available online through smart device. They can create account, login, and fill the booking form. After digital parking ticket is generated and can be used to enter the shopping mall. Whenever the car users failed to book, they still can get the ticket manually through ticket machine in the form of digital ticket or paper ticket.

The automated guided parking system enables to direct the car users to empty parking lot that has been identified by the system as available. The system shows the status through notification light. It will also show the floor and total car with parking board or parking monitor. The parking info that is showed will help customers to find parking lot. If parking lot has been filled, the system will report that the parking lot has been filled and change the status of the parking lot in the SPS. The level of security produced is relatively high, where each vehicle that enters the system must be identified and given an access code using the QR Code. Vehicle owners will not be permitted to leave the system if they do not have the code given at the time of entry.

After the parking, customers can check the location of their car through application. This will help customers to find their car without the need to remember. After they are done they can pay with digital currencies and go home. Booking system that available in this article can be an alternative to valet that considered costly for customers. Currently, the implementation of the smart parking system has done in pilot project especially in some malls in South Jakarta.

5. Conclusion

The article proposes the smart parking system that combined with IoT that enables to solve the common problems faced by building managements. Although still in early stage in pilot project, the idea of article has been applied in several malls in South Jakarta. The implementation of SPS is expected to help customers, parking staff and shopping mall management. Customers will find easier to park the car in shopping mall with booking system, paperless ticket, cashless payments and automated guided parking. Booking system enables customers easy to find available parking slot, even before even arriving and with paperless ticket system eliminates the possibility of missing ticket. Cashless payment will ease the payment process while automated guided parking guides the customers to vacant parking slot without the need to going around.

Booking system can also become alternative for valet that cost more because the service given by valet staff. For shopping malls, SPS enables to lower traffic in and out of shopping mall and optimizing parking lot. SPS also benefit the parking staff in the form of ease monitoring and parking distribution. The author know that parking has been problem for Jakarta not only in shopping mall but also another place like park, tourist attraction, traditional market, restaurant, etc and because of that the author hope that this paper can be useful for parking problem in other place or future studies.

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