Czech University of Life Sciences Prague

Faculty of Economics and Management

System Engineering and Informatics

Diploma Thesis for An innovative parking booking system (Information Technology)

Dhruval Patel © 2023 CULS Prague

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

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Faculty of Economics and Management

DIPLOMA THESIS ASSIGNMENT

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Thesis title

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Objectives of thesis

- Do research on the current reservation system to determine its strengths and weaknesses.
- To investigate the benefits that may be gained by implementing the suggested system.
- To create an online parking system using php and android as the primary technologies.

Methodology

The chapter headed "Research Methods" provides an overview of the methodology and procedures used to conduct the research on PHP-based online parking management systems. The aim of this chapter is to offer a description of the research strategy, data collection techniques, and data analysis procedures employed to achieve the study objectives (Hu et al., 2019). When it comes to ensuring the validity, reliability, and generalizability of the findings, the importance of the chapter dedicated to the research procedure cannot be emphasized.

The chapter headed "Research Methods" provides an overview of the methodology and procedures used to conduct the research on PHP-based online parking management systems. Some of the techniques of data collection employed for this study included document inspection (Iqbal Munawar, Anisa Rizky and Pajar Rusman, 2022). Data analysis methods used included descriptive and inferential statistics, coding, classification, and the identification of overarching themes. The chapter on research procedure is very significant since it helps to guarantee that the study's results are accurate and credible.

The proposed extent of the thesis

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Keywords

Sensors, mobile application, Prague, online reservation, parking management, cashless payment

Recommended information sources

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Declaration

I declare that I have worked on my diploma thesis titled " An innovative parking booking system (Information Technology)" by myself, and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that it does not break the copyrights of any person.

In Prague on 31/03/2023

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Dhruval patel

Abstract

The smart parking system in Prague is an innovative solution that leverages the power of technology to optimize the management of parking spaces in the city. This system employs a combination of sensors, mobile applications, and cloud-based software to provide real-time information on the availability of parking spots, enable online reservations, and facilitate cashless payments. The system is designed to reduce traffic congestion, enhance user convenience, and improve the overall efficiency of parking management in Prague. This abstract provides a brief overview of the PHP-based smart parking system in Prague and highlights its key features and benefits.

Keywords: Sensors, mobile application, Prague, online reservation, parking management, cashless payment, traffic congestion

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1. Introduction

An innovative parking booking system that streamlines the process for customers to make in-advance reservations for parking places through the internet is the concept that has been proposed. It is an effective strategy for addressing the time-consuming problem of finding parking in congested city areas (Barriga et al., 2019). In order to accomplish this goal, this project offers customers a web-based reservation system that enables them to explore parking lots, choose a place, and check to see whether it is available.

In this scenario, the primary camera function is added so that when a parking reservation is made, the system can scan the car's unique license plate to verify the reservation if a vehicle is waiting in line for a reserved parking spot. This is done to prevent people from parking in spots that have already been reserved. In this instance, the green regions indicate availability that has not been booked, but the red areas denote reservations that have been made.

The proposed system includes provisions for both parking on the spot and making reservations in advance. It is recommended that the user think about making a reservation in advance if they are aware that they will be present at a certain place at a particular time. Users can make reservations, and doing so may provide favorable outcomes by enabling them to secure their desired seating configuration.

Nevertheless, those who want to make reservations are required to make a payment in advance, which will not be refunded in the event that the reservation is cancelled. Every user has the ability to cancel their reservation at any point throughout the reserve period. Shortly after making a payment, customers are sent an email confirming their reservation and providing them with a parking lot number.

With the assistance of a client app, reserving a parking place is possible directly from an Android smartphone. The repository for the server-side web service is often implemented as a web service.

Assumption: In this case, for the proposed system, the main camera function is only an assumption as of right now, and the only thing that will be utilised for verification is the number plate.

1.1. Problem Statement

Those who use automobiles often spend a large amount of time in parking lots seeking a space to park their cars. In today's ever-busier working environment, motorists only have a little time to look for a parking place, so they often have to go around parking lots many times. This causes them to waste a lot of time. One of the biggest causes of stress in the lives of people who drive in various settings, notably near retail complexes, universities, city centres, and many other crowded working sites, has been recognised as the process of finding parking.

This is especially true in a great number of different fields. Finding parking with just one's own two eyes, as is customarily done, is laden with a myriad of aggravating obstacles that one must work through one at a time.

When a motorist is walking towards a vehicle or is already inside the car, other motorists waiting to locate parking commonly make signs, whistle, or try to do anything else to determine if the driver in question is going to pull out of the parking place. Even though the answers to these types of questions might be useful most of the time, the conditions that arise as a consequence are often ones that other drivers will find bothersome.

In highly populated towns and cities, parking management is a challenge that, with time, only grows more complicated. This is especially true in situations where there are few parking spaces. It is hard to place an adequate amount of emphasis on how essential it is for cities of this size to have efficient parking management systems. The objective of this study is to come up with a solution to the challenges stated above by using the most modern communication and sensing technologies that are now available.

1.2. Aim

Making it possible to book a parking place in advance or right there and then with the help of android and PHP is the purpose of this project.

1.3. Objective

• Do research on the current reservation system to determine its strengths and weaknesses.

• To investigate the benefits that may be gained by implementing the suggested system.

• To create an online parking system using php and android as the primary technologies.

2. Literature Review

2.1. Introduction

This chapter provides a summary of previous research on online parking management systems built using PHP. It also demonstrates the effectiveness of these systems and the benefits they give. According to the studies reviewed, online parking management systems can improve parking management effectiveness and efficiency, provide users with real-time parking information, reduce traffic congestion and pollution, improve accessibility, increase revenue for parking operators, and improve customer satisfaction (Abd Kadir, 2021). All of these advantages may be obtained by enhancing the system. The use of PHP technology has a number of advantages, making it a viable alternative for the construction of functional and cost-effective parking management systems.

The literature review emphasizes the need for parking operators to embrace PHP-based online parking management systems in order to improve the overall parking experience for customers and efficiently manage parking demands. Because of the challenges experienced by traditional parking management systems, online parking management systems have been developed as a solution. These systems employ technology to manage parking places, fees, and access, therefore

improving the overall parking experience for both parking operators and users (Anitha et al., 2021). Because of the versatility and cost-effectiveness of PHP technology, the adoption of online parking management systems has grown in popularity. The goal of the chapter on literature review is to provide an overview of the existing research on online parking management systems based on PHP, emphasising their efficiency as well as their benefits.

2.2. Parking space management a problem

Parking space management is an essential component of both urban planning and transportation management. Due to the rising number of vehicles on the roads and the limited quantity of parking spaces, traditional parking management strategies have been demonstrated to be worthless and inefficient (Fahim, Hasan and Chowdhury, 2021). As a remedy to this problem, the introduction of online parking management systems has created a parking management technique that is both more effective and more streamlined than old ways. These systems employ technology to manage parking places, fees, and access, therefore improving the overall parking experience for both parking operators and users.

The number of people living in urban areas led to a growth in the demand for cars and other forms of transportation. It is difficult for vehicles to locate a parking spot in most urban regions, particularly during peak traffic hours. Parking without proper discipline might put the vehicle at risk of being damaged (Iqbal Munawar, Anisa Rizky and Pajar Rusman, 2022). Therefore, giving a fair number of parking spots and a large number of slots is necessary to assist the user in securely parking their vehicle. In its most basic form, the parking system was among the most widely used and rapidly expanding solutions for smart cities. Most of the current parking lots do not have any organized structure. Most of them are administered manually, which is time-consuming and rather inefficient.

The needs of each user should adhere to the following criteria:

I. User-friendliness

ii. Needs to be more efficient

iii. They should increase security.

The Android application, which goes by the name "valid spot," was designed to assist users with making online parking reservations. The user of this program may examine numerous parking places and then pick one area to determine whether a parking spot is now available (Islam et al., 2020). This system allows users to cancel their reservations, an extra function provided as an option. If a parking spot is available in the parking lot, users can reserve it for a certain time window.

Additionally, it uses wide land for parking while maintaining safety. Therefore, it will eliminate the issues with parking and traffic. Because of this, there is no requirement to utilize an extra expensive camera and scanning gear for verification (Logix, 2018). Using the Registration certificate, also known as an R.C. book, for verification in this system helps to cut down on the additional costs.

2.3. Prague

The Czech Republic's administrative centre and largest city are Prague. It is situated in an approximately central location within the Bohemian area. In 2019, the population of the city of Prague was 1 324 277 people (Naeem et al., 2020). The overall length of the city's road network is 4,047 kilometres, while the city covers an area of 496 square kilometres. The motorization rate, which includes all vehicles, is 861 cars and trucks for every one thousand people, which equates to 1.2 people per vehicle.

The motorization rate, which includes private automobiles, is 689 cars for every 1000 residents (1,5 citizens per vehicle). These numbers pertain to the year 2019. The motorization (personal automobiles) in Prague (Prague is blue, the Czech Republic is red), with the Czech Republic as the background.

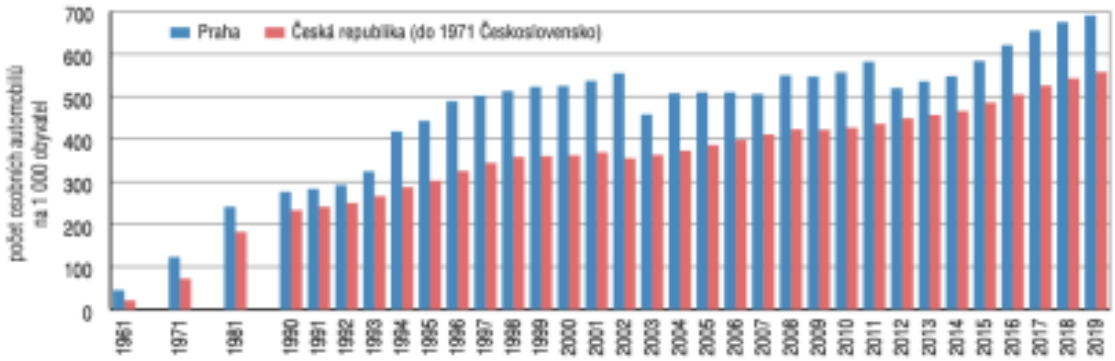

Figure 1: Prague Parking System

Image Source: (2023)

The parking situation in Prague is shown in the above graph. They have done this study annually from 1961 up to 2019. Ceska seems to be in blue, and praha seems to be in red on the maps being studied. Then, the lowest rate ratio is shown in 1961 for both categories (Nosratabadi, Jahandide and Guerrero, 2021). And 2019 has the highest rate of all.

A separate algorithm was used between 2003 and 2007, and beginning in 2012, the central vehicle registry maintained by the Czech Transportation Ministry has been utilized.

The degree of motorization is already relatively high, and the trend is going in the right direction. The number of persons that go to Prague daily is 164.3 thousand (Rana, 2019). As a result, there is a greater demand for parking space than ever before. P+R parking for commuters is either expanding or creating additional lots, and there are plans to construct more pay parking zones (on-street parking).

On-street parking

Paid parking zones are the names given to the on-street parking spots in Prague. These regions are broken up into three distinct categories:

• blue (residents)

• orange (visitors)

• purple (mixed)

The blue zone is reserved first and foremost for the inhabitants of the neighbourhood, with paid parking available for guests. There is a stringent time restriction for those who park in paid spots in the blue zones (such as a 1-hour maximum). Only parking spots that cost money may be found in the orange zones (no residents). And last, the purple regions are formed by combining the blue and orange zones.

The ticket is only available in digital form. The license plate of each vehicle is the primary identifier used by the system (Saeliw et al., 2019). Visitors can pay through a ticket machine, on which they must write their license plate, or via mobile applications on their own devices. It is included in the user interface of many mobile applications (for example, PID Ltaka, Moje Praha, MPLA, Citymove, and many more). The monitoring vehicle is responsible for exercising authority over the parking permit. The surveillance vehicle is fitted with cameras, and the system examines the license plate to see whether it matches the evidence at the central location. Those who drive electric cars with license plates that begin with the letters "EL" are entitled to automatically paid parking at no additional cost.

In the entirety of Prague, there are approximately 70,000 single blue zones, designated as residential; more than 40,000 purple zones, designated as mixed; and more than a thousand orange zones, designated as visiting zones (Singh, Pan and Park, 2021). In all, there are 111 431 parking lots that need payment.

Off-street parking

There are 21 P+R parking lots in Prague, with a combined capacity of 3,946 parking places. 14 P+R parking spaces have maintenance and opening hours, charge a daily fee of 20,000 Czech crowns and are charged for parking (from 4 am to 1 am). There is no charge to park in any of the other seven spaces since they are not maintained (WAHYUNI, Saleh and Koriyanti, 2019). Due

to the entrance/exit gate and also the data gathering, this thesis will concentrate on the 14 paid P+R parking spots that were previously indicated. The majority of P+R parking spots are located close to the metro stations. The remaining ones may be found in the areas close to the railway terminals.

Figure 2: Off-street Parking

Image Source: (*Avertissement de Redirection*, 2020)

The number that was provided above pertains to off-street parking in Prague. They have used two different color markers for the parking and non-parking areas (Wikipedia, 2023). Blue indicates that drivers are permitted to stop their vehicles in that area. In addition, the color red denotes a location that is not allowed for parking.

The parking ticket is handed to the motorist at the entry gate as soon as the user drives into the parking lot. There will be a ticket machine at every parking spot where one may pay the required charge. Therefore, the process revolves around the use of paper parking tickets. On the other hand, a counter at the entrance/exit gate keeps track of how many vehicles are already in the parking lot.

In 2019, the P+R Letany was fitted with cameras capable of reading license plates (Ahad et al., 2022). This solution enables users to pay for on-street parking using the smartphone applications discussed. The automated opening of the gate at the exit is another way that it helps to speed up the evacuation. This project served as a test run for the new system1. Chargers for electric cars were installed at the other two P+R parking lots (P+R ern Most two and P+R Rajská zahrada) located in the Czech Republic.

The SUMP will be the site of the next phase of P+R parking construction in Prague until the year 2030. (Sustainable Urban Mobility Plans). It is anticipated that shortly, over 9 thousand additional parking spaces will be created in Prague, and over 9 thousand different parking spaces will be created in the neighbouring areas of Prague (by the big train nodes).

2.4. Prediction of parking occupancy

To ensure that motorists get services with the highest possible standard, this Parking assist concept developed with the goal and pervasive computing was invented. The ability of such systems to accurately estimate vacant parking areas is vital to their success. Integrated have evolved into the most critical components of such Systems (intelligent transportation systems). Another primary objective of another parking space is to locate and make accessible suitable adequate parking space that is free (Kunwar, 2019). It is tough to identify appropriate parking areas in big cities due to the growth in the number of cars caused by electric drivetrains. Even supplying travellers in an even more immediate region with fast data will be adequate for them. It's far more beneficial to make a forecast with timing because once the driving will arrive at the location for those providers who are located farther away. To make an accurate forecast, differentiating the day is essential. It indicates different hours at work, vacations etc.

Drivers value the traffic information offered by parking guidance systems, which is supported by the evidence presented in this research. Those exact mechanisms have good impacts also on the vehicle. Still, rather outings of car drivers since such frameworks boost the likelihood of locating a usable parking lot and reduce the overcrowding attributed to searching for said car space. Those

exact mechanisms also make it simpler to find accessible parking. This is also beneficial to the person operating the vehicle (Sieck, Calpin and Almalag, 2020). When the motorist arrives at the location, there is a greater likelihood that they will park there. Suppose parking systems (such as VMS or smartphone apps and others) can provide the "future" (at the arrival time) fullness with a degree of confidence. In that case, the motorist will be a more leisurely time left peaceful while he is travelling. So there is a good chance that such driving will arrive now at a place with sufficient opportunity to find parking.

2.5. Exisiting Parking System in Prague

The city of Prague is bustling with activity, and despite its size, there are just a few parking spaces accessible for automobiles. It has become evident that traditional parking management techniques are unable to satisfy the city's parking space needs. As a consequence, a parking management system that is both efficient and effective is required (Hampel and Vránová, 2021). The advent of an online parking management system as a solution to the problem has resulted in the deployment of a more streamlined parking management approach. These systems employ technology to manage parking places, fees, and access, therefore improving the overall parking experience for both parking operators and users.

In recent years, R&D efforts have been focused on the development of online parking management systems. Numerous research have shown the use and benefits of these systems (Herrchen et al., 2022). Because of the scalability and cost-effectiveness of the technologies, the adoption of PHP-based online parking management systems has grown in popularity.

According to a study undertaken by the European Parking Association, the introduction of an online parking management system in urban areas may result in an increase in parking occupancy rates of up to 20%, resulting in an increase in revenue for parking operators. According to the study's results, the system has the ability to minimize the amount of parking violations, increase customer satisfaction, and deliver data-driven insights to parking management (Navrátilová et al.,

2021). According to the study's conclusions, metropolitan regions need a comprehensive and integrated parking management system to properly manage parking demands.

According to research conducted by the Center of Transportation Studies at the University of California, Berkeley, using an online parking management system may enhance air quality and decrease traffic congestion (Růžička, Navrátilová and Tichý, 2019). This is accomplished by reducing the number of automobiles that are driven about looking for parking places. According to the study results, there is a huge demand for a user-friendly and efficient parking management system. This is required to reduce the negative consequences of parking on the surrounding ecosystem.

Furthermore, research published in the International Journal of Innovative Research in Science, Engineering, and Technology discovered that using online parking management systems can improve parking access for drivers with disabilities, resulting in a more inclusive and accessible parking experience (Navrátilová and Lehet, 2022). The study emphasises the need of including accessibility features in parking management systems so that they can fulfil the needs of a varied variety of users.

Others have also noticed that the PHP technology, which is both adaptable and cost-effective, might be leveraged to construct online parking management systems. PHP-based online parking management systems provide a variety of advantages to consumers, according to study published in the International Journal of Computer Applications (M et al., 2023). Some of these advantages include easy maintenance, scalability, and interoperability with a wide range of systems. The study emphasises the need of parking operators using the benefits of PHP technology in order to construct successful parking management systems.

Table 1 Existing available system

Existing system	Proposed system

Current parking systems are often positioned just in front of the parking lot. There will be a security officer at the entrance to the parking lot who will provide a token to each vehicle.	The core of the system is a software. So, there is no need to install anything in front of the door or use a token.
Current parking solutions rely mostly on hardware parts.	The software behind this parking system is top-notch. It is only a smartphone app.
Currently, there is a set fee for parking a vehicle in the garage. Parking a vehicle for one hour or eight hours makes no difference (Orlovskyi and Kopp, 2022).	In the system, an internal counter is planned. For the purpose of the parking space owner application, it will function as a stopwatch. The precise parking fee for each vehicle may then be calculated.
In the current setup, there is no way to use a neighbor's parking spot if they are not using theirs. All current infrastructure is intended for massive parking lots.	Owners of private parking slots will be able to generate money off of the spaces even when they aren't being used.

Advantages by proposed system

• Users are able to get information on parking slots for certain locations.

• It reduces the amount of time an individual has to spend looking for a vacant parking place in such a huge parking lot (Orlovskyi and Kopp, 2022).

• The programme provides the user with a graphical depiction of the parking places that are currently accessible to them.

• Clients have the option to pay instantly online and confirm their reservation in this manner.

• There is no longer a need for the involvement of human labour in the administration of parking spaces. •

The system generates an electronic invoice for the allotted amount of time that can be seen online and also sends out an email notification.

Through the implementation of parking zones, parking spaces for motor vehicles are restricted across the majority of the city. Parking is allowed for residents only in the city's central business district. Motorists may use parking meters, mobile websites and apps that simulate parking meters, or virtual parking meters to pay for parking.

In addition to that, there are a significant number of parking garages both underground and above ground. They can find a list of garages, information about above-ground parking lots, and details on parking zones on this page. Garages attached to retail centers often have spaces available for extended periods. If they combine their trip to the parking garage with their shopping, they may get free parking for several hours.

Online reservations may also be made in advance via the business MR. PARK IT for parking spots in garages ranging in size from small to big and located in conveniently accessible areas across the city. After that, users may either use the cell phone to open the garage door or ask the attendant to do it for free.

There are catchment parking areas located in a variety of places in the outskirts city of Prague. These parking lots are designated as P + R (park + ride) parking areas. They are a good choice for those who drive into the city but want to use the public transportation system instead of their own vehicle (Sarker et al., 2020). The daily parking price ranges from CZK 50 to CZK 100. If they do not pick up their car on the same day that they originally parked it, there will be required to pay an additional service charge worth CZK 100 on top of the parking cost. The car parks shut when the metro stops operating for the night. A listing of P+R parking lots and other information.

2.6. Existing technologies with parking management systems

Data sources and sensors

Different kinds of sensors are related to the innovation and technologies of information and communication (ICT) that are essential components of smart cities. Unconventional smart city infrastructure takes the form of sensors operating on the Internet of Things (IoT) principle. It might be any number of different sorts of gadgets, such as RF identifying tags, mobile phones, and many other things (Hu et al., 2019). In addition, these components can interact with one another and work together to achieve the desired results. Several methods (studies) integrate diverse data sources, such as the transactions made at parking meters, the speed of traffic, the conditions of the weather, and a great number of other factors which may increase the accuracy of predictions. Different prediction approaches are used due to the utilization of diverse data sources (such as neural networks, convolution neural networks, and regression models). Generally, there are two ways to forecast short-term parking needs and availability:

1) Create a microscopically accurate model of the stochastic driving patterns of individual motorists by basing it on arrivals and departures

2) A model of parking space use derived from historical and current observations of parking space utilization in real time

According to the available research, the sensors embedded into the ground do not perform very well. These sensors are installed underneath each parking garage and can identify parked vehicles. However, there is a high cost associated with the installation and upkeep of the sensors (Melnyk, Djahel and Nait-Abdesselam, 2019). As a result, using the information from the parking ticket office for such a forecast may be more effective.

Prediction methods

It is common practice to employ a time-series modeling method to anticipate the outcomes of transportation-related issues (such as parking occupancy) (for example, Neural Network Models

for Time Series Prediction). Because of the temporal pattern of the parking data, it is appropriate for this particular scenario.

The technique of prediction that is discussed in the paper makes use of LSTM (Long Short-Term Memory), FNN (Fuzzy Neural Networks), and Graph CNN (Convolution Neural Networks) (multi-layer feed-forward decoder). The link between these systems is more effective in commercial districts than recreational areas and works better for block-level parking (Farooqi et al., 2019). This model also considered the current weather conditions and the average speed of the surrounding traffic. The information about the weather was beneficial for predicting where people would park in recreational areas.

Training and testing are the two components that make up the short-term prediction based on neural networks for the difficulties with transportation. During the training phase, a straightforward back-propagation method is used. This algorithm's learning rate and momentum have been genetically tuned for optimal performance, along with the extensive description being included. The neural networks can sufficiently record the parking occupancy in real-time and have a good chance of correctly predicting it for the following half an hour (Jabbar et al., 2021). This is the conclusion that can be drawn from the data collected by the sensors used for the Smart Santander project from Spain. This project employs sensors connected to the internet of things to measure occupancy. A Bagging Regression (BR) method, described in, uses sensors connected to the internet of things.

Rich spatiotemporal information may be gleaned from the data provided by the parking machine for on-street parking. This information may be utilized to identify trends in parking availability, and as a result, parking availability can be predicted based on these patterns (Lou et al., 2020). It was determined by using techniques such as neural networks and regression trees.

The forecast of on-street parking uses a total of four different methods. These algorithms were investigated further and contrasted with one another. Only historical information is used in two techniques (Mean and Variation of availability and Normally Distributed Availability). The other

two approaches include actual statistics (Normally Distributed Availability Variation and Non-homogeneous Poisson Distributed Arrivals and Departures). The main takeaway from this study is that having access to real-time information results in improved performance up to a specific prediction horizon (Jusat et al., 2021). In, the prediction of parking occupancy is carried out using three different approaches: regression tree analysis, neural network analysis, and support vector regression. These procedures' effectiveness was evaluated using San Francisco and Melbourne datasets. The conclusion that can be drawn from these datasets is that a regression tree that includes a feature set (such as the time of the data or the day of the week, for example) has the highest performance.

2.7. Technology Used In Smart Parking System

People are forced to wait for extended periods at parking meters or drive in circles until a parking place within walking distance from their destination becomes available (Xiang and Pan, 2022). It should come as no surprise that many drivers have given up and are opting instead to park illegally or utilize public transit.

The good news is that various innovative solutions are being developed to assist motorists in reducing the time they spend searching for parking places and to assist cities in keeping up with the increased demand for parking spaces. The drivers, the cities, and also the environment will all reap the benefits of the developing smart technologies that are being developed for parking.

Smart Sensors

The device known as smart sensors can locate vacant parking spots and direct cars to them. This parking technology uses GPS to determine the position of the motorist and then provides them with real-time instructions to the parking spot closest to them (Najmi et al., 2021). It delivers alerts and information about traffic to the drivers' cell phones.

The laborious practice of methodically scanning each row within a lot for an available place or circling the lot numerous times while waiting for a space that opens up is almost eliminated by smart sensors (Lin and Cheung, 2020). By alerting drivers whenever they park in such a limited

location without permission, they also reduce the number of persons who park illegally near loading zones, disabled parking places, and other restricted areas.

While the technology for autonomous parking is already there in some automobiles, these sensors will be deployed in parking lots and on parking meters, making them available to a far wider audience.

However, smart sensors can more than inform users in real time whether or not there are any vacant spots available (Lyu and Fan, 2022). They will also send traffic updates for the smartphone and let them know where available spots are located so that users can choose the best route to travel.

Several communities, including Santa Monica, California, have already used this technology for smart sensors. The city has equipped its smart parking meters with sensors that can determine when a vehicle has been parked and send an alert to the appropriate municipal employees. These intelligent sensors guarantee that individuals are not using the same parking meter throughout the day and give the city valuable data regarding where most tourists are parking, such as at Santa Monica park.

Driverless Parking

The technology behind driverless parking allows vehicles to find vacant parking spots on their own and park in them without human assistance. Vehicles capable of parking themselves use several sensors and cameras to assess their surroundings to park in a suitable spot (Barriga et al., 2019). With this new technology, drivers won't have to stress about locating a parking place or being disoriented in a vast parking lot, saving them a significant amount of time.

Laser sensors are part of the smart parking technology that allows autonomous parking. These sensors scan their surroundings to identify any vacant parking spots. After that, cameras check to ensure the vehicle has parked in the correct spot. Companies like Bosch, as well as Daimler, are in the process of developing this technology at present.

The parking experience will be vastly enhanced with fully-automated, intelligent parking technologies (Bock, Di Martino and Origlia, 2020). Passengers may get out of driverless automobiles, and the vehicles can park themselves after dropping off their passengers. People unfamiliar with the region may use smart sensors to find parking spaces near their destination that are free of charge. This saves them the hassle of driving aimlessly, hunting for a parking place or shelling out more money for a more costly space.

Because self-driving cars can park through tight spaces more easily and effectively than most human drivers, parking innovation would also help reduce pollution and congestion (Sotres et al., 2019). This will mean less time spent circling the lot, waiting for a space, and adjusting their vehicle for several weeks to match into a tight space.

It is expected that smart garages will begin to increase in large cities as smart parking becomes more widespread. In these scenarios, drivers would pay for a "smart spot" as soon as they depart their automobiles, and their vehicles will park themselves.

Parking Apps

Another rising trend drivers are embracing to ease the parking experience is the technology based on applications. Apps that are smart about parking function in conjunction with other forms of intelligent technology, such as sensors installed on parking meters, to assist drivers in locating the parking place nearest to them without requiring them to drive about aimlessly (Sehrawat and Gill, 2019). These intelligent mobile applications give drivers information about parking places by using smart meters' data and updates from intelligent sensors. This opens up a wide range of options and saves drivers time and money.

These apps also give users the ability to pay for parking using about there mobile devices, which allows them to enter their license plate number as well as payment information, manage the amount of time they spend in the parking spot, and even add additional payment if their meter is getting close to running out of time. After just a long day at work, shopping, or other activities, some people even utilize the zones as well as lot numbers to assist them in finding their automobiles.

The motorist, the city, and the environment will reap the benefits of some of the advantages of the intelligent parking systems now under development. Cars will be able to park themselves in driverless parking lots, which will be a time-saving feature (Koumetio Tekouabou et al., 2020). Because intelligent sensors can identify vacant spots and direct cars to them, there is no longer any need to drive about aimlessly in search of a parking place. New parking assistance applications are now being developed, and they will provide drivers with real-time parking place information.

The parking process for drivers is being made more accessible by integrating driverless cars, intelligent parking sensors, and modern parking app technology. In addition, intelligent parking technology contributes to the preservation of the environment by cutting down on the amount of time spent driving about in search of a parking spot, as well as the number of pollutants and greenhouse gasses linked with this additional time spent driving (Ke et al., 2020). They will also cut down on traffic and pollution throughout smart cities by guiding cars to available parking places in a manner that is more efficient than what intelligent sensors are now capable of doing.

By reducing the amount of time spent driving about looking for a parking spot, environmentally friendly parking technologies may help cut down on both carbon dioxide emissions and the amount of time spent driving in cities. Autonomous vehicles can park in congested areas more quickly than a human-driven vehicle ever could, and advanced sensors assist human drivers in determining the most time and fuel-effective routes towards their destinations.

As a result of the many automobile parking innovation technologies that are now under development on a global scale, the future of parking is bright.

At GET IT, they create solutions for self-parking and valet parking that do not need tickets by harnessing the potential of new intelligent technologies (Abd Kadir, 2021). They assist in improving the overall parking experience for our customers by reducing the time, money, and frustration they have to spend.

Using their technologies assists parking managers in streamlining management operations, increasing efficiency, and improving their bottom lines while contributing to a more ecologically responsible approach to mobility.

IoT-based parking

A web and mobile application are used by a smart parking system based on the Internet of Things to convey information about available and occupied parking spots.

An Internet of Things (IoT) device, complete with sensors and devices, has been installed in each parking place. The user is provided with up-to-the-minute information regarding the availability of each parking spot, giving them the flexibility to choose the most appropriate alternative. In metropolitan places, finding a parking spot might be difficult (Ahad et al., 2022). Still, this one solution can start a domino effect of other positive outcomes, such as reducing the amount of traffic congestion and improving fuel economy.

A fundamental flowchart for the entirety of the process of intelligent parking IoT looks like this:

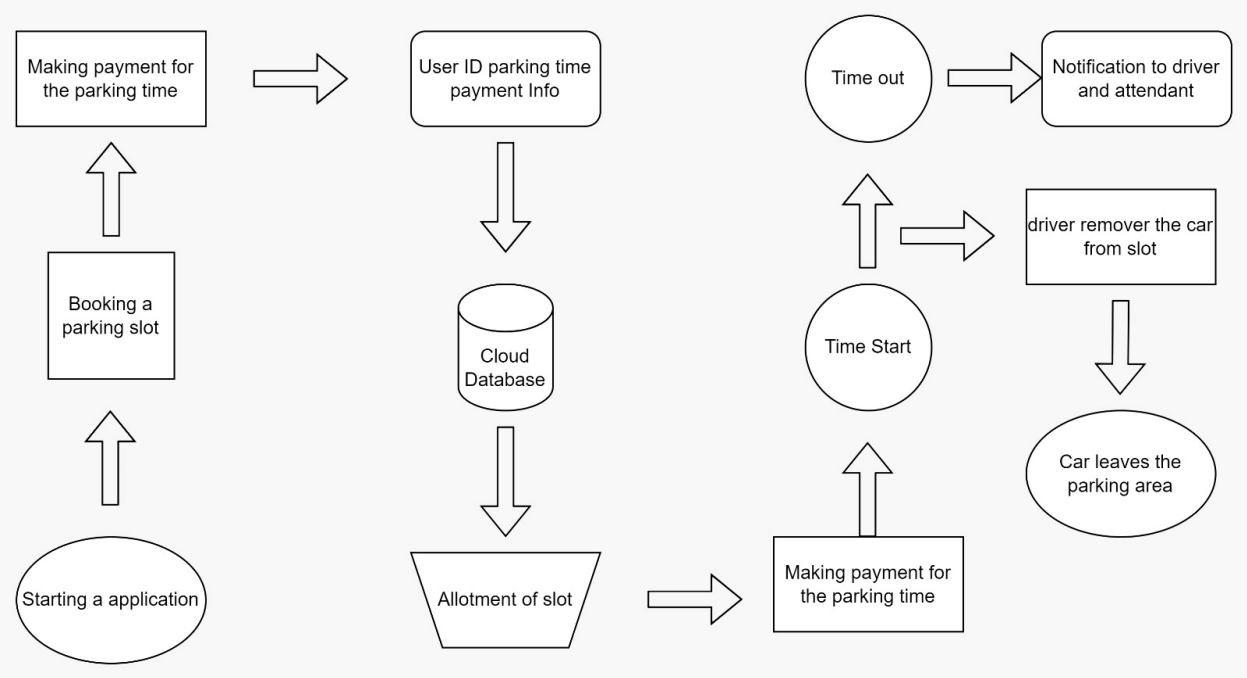

Figure 3: IoT Flowchart for Smart Parking

Data Source: Self made

The above figure is the IoT flowchart for smart parking. The above starts from the starting application. It then goes to booking a parking slot. Then, last, there is car leaves the parking area. There is one parking time payment information that requires a user id and can only be accessed with that user id.

Parking their vehicle may be a significant headache in the crowded cities of the modern day. Said there are an excessive number of automobiles on the roads and insufficient parking spots available. Because of this, there is a pressing need for effective parking management solutions. As a result, they demonstrate the usage of an IOT-based intelligent parking system that allows the effective use of parking spaces utilizing IOT technology (Anitha et al., 2021). To show the notion, they utilize infrared sensors to determine whether or not a parking space is occupied and then replicate gate opener motors using dc motors. They are now connecting to the internet with a wifi modem,

and an AVR microcontroller handles the system's operation. Their company uses IOT Gecko for internet connection and GUI design for IOT administration. The system uses infrared (IR) sensors to determine whether or not parking spaces are occupied. Infrared technology is also used to determine when a vehicle arrives at the gate to enable automatic gate opening. The system takes a count of the available parking spots and syncs the information with a cloud server so that users may check the availability of parking spots online (Ali et al., 2020). This feature allows users to look for available parking spots online from any location and enjoy hassle-free parking. As a result, the system addresses the challenge of parking faced by cities and provides users with a useful Internet of Things-based parking management system.

2.8. Applications of Smart Parking Systems using IoT

Living in smart cities may improve due to greater space use, less traffic, improved air quality, and enhanced effectiveness of public services (Ahmed et al., 2019). In addition, smart cities provide a large number of employment and business options, in addition to robust social connections.

The Internet of Things initiative for smart parking will assist in:

The seamless flowing of traffic

Adjustments to public transportation routes may be made in real-time in response to changing demand, and intelligent traffic signal systems can help reduce congestion.

Energy efficiency can be improved

When monitoring in real-time, one can track down both power use and energy consumption.

Cities can be made safer

With the proliferation of Wi-Fi communications and Internet of Things technologies, cities may employ technology to enhance their citizens' safety and the speed with which emergency services can respond to incidents (Loong, Isaak and Yusof, 2019).

Encouragement of greater citizen engagement

Citizens can solve everyday issues, enabling neighbors to engage with one another and exchange resources to better their towns and neighborhoods.

Synchronization of the Access to parking lots

The synchronisation of accessibility to parking spaces is a fundamental research problem determining how efficient a parking system is. The effectiveness of a parking system is dependent on this issue. The report on work performed on synchronising the entrance to parking lots by integrating the driving simulation paradigms into the car park simulation. This was done to improve efficiency. The driving philosopher's paradigm views the circumstance as a problem comprised of a collection of processes called P and a set of resources called R (Al-Turjman and Malekloo, 2019). Take, for instance, the equation P = P1, P2.... (Pn-2), (Pn-1), and pn, with R equal to R1, R2,..... (Rn-2), (Rn-1), Rn}. It is helpful to think of the processes and resources as taking place in a revolving door, with the vehicles serving as representatives of the operations and the parking spaces serving as representatives of the resources. There are two different kinds of procedures taken into consideration. They consist of I init processes, which depict the activities that have not gained a resource in the roundabout, and (ii) transit processes, which indicate the procedures that have gained a resource in the roundabout.

The guiding philosophical paradigm tries to find solutions to the following issues. Must guarantee that:

- Each resource in the roundabout is held by no more than one process.
- Each process will only go with food for an excessively extended time.
- The roundabout will not enter a stalemate state at any point.

In this method, an algorithm was designed based on the concept that processes synchronously communicate, and the computation was performed in rounds (Sarkar et al., 2022). Every procedure is broken down into these three stages:

1) The sending phase : The procedure will enquire about the availability of resources from the various parties.

2) The phase of receiving: The procedure will save the information before moving on to the subsequent step.

3) The phase of computation: The procedure determines the message that will be sent in the subsequent step.

Using the processes described above, many algorithms for data processing were built. These are the following:

The algorithm for the serial order: This makes it possible to complete just one procedure at a time in the roundabout, with the process which has been waiting for the longer period being given precedence over the other process.

The Concur1 algorithm includes the following: When two different algorithms compete for the same resource at the same time, this ensures that processes already running are given precedence over new processes.

The Concur2 algorithm includes the following: When two processes simultaneously request the same resource, this ensures that the newly created process is given precedence over the one already in motion.

A car park simulator is used to carry out the actual installation of this system. A programme known as a parking space simulator simulates the interaction between vehicles and parking lots, guiding drivers to the vacant parking spot located in the lot that is most conveniently located for them

(Unterluggauer et al., 2022). The virtual experience of parking a vehicle takes place in a mapped and detailed setting. The following constituent parts make up the system:

i) **The automobile:** It requires finding a parking spot.

ii) **Car Park:** The garage or parking lot has a predetermined number of parking spaces. Only vehicles parked in paid parking spaces can receive the availability information broadcast by the parking lot.

iii) **To Bring It Full Circle:** This brand-new entity was just introduced, and it stands in for a roundabout on the map itself. It does this by interacting with the vehicles entering and leaving the simulation to maintain synchronisation amongst the vehicles.

iv) **Simulation centre:** The actual world does not include any physical objects that relate to this (Bradford and Sherry, 2023). It's primary function is to provide a birds-eye perspective of the system, including all vehicles and parking lots.

The transmission control protocol (TCP) and multicast channels were once used for the components to communicate successfully. At the moment, communication is carried out within a certain radius. In other words, vehicle A will only pick up the signal sent by vehicle B if both vehicles are within the same radio frequency range.

As explained above, the job that is being done involves some very laborious processing. For cars to interact, they must be within range of one another (Gomez-Lagos, Candia-Vejar and Encina, 2021). The related stages also make it difficult to get information on parking promptly. As a result, there is a pressing need to develop a method that speeds up the processing time of intelligent parking.

Ultrasonic sensor technology

Siemens AG developed another system (SIPARK) based on ultrasonic sensors. There is one of them mounted high above each parking spot to check whether it is in use. And over 70,000 parking spots have made use of this. Better pay terminals that take a variety of payment methods, including

cash and non-cash choices like credit cards, are being employed to facilitate the system's widespread adoption.

M. Crowder and C. Michael Walton have compiled a paper investigating the need for intelligent transportation systems (ITS) in several locations. Business districts, airports, or transportation hubs are included in this category (Anitha et al., 2021). According to the survey findings, college campuses have grown into a right-pressure zone with an increasing demand for an adequate parking solution. This study provides further facts about the need to provide information to motorists in real time to solve the problem of reducing traffic congestion.

This research examines several parking information systems, including the St. Paul Advanced Park Information system (St. Paul APIS) from Minnesota, the intelligent parking system in Phoenix, Arizona, the Seattle centre APIS, and others.

The St. Paul Automated Parking Information System (APIS) places static signs across the city to inform drivers of the roads' overall state and parking spaces' whereabouts. Image 1 below is a schematic depicting a VMS sign located in St. Paul town and notifying vehicles of the road's current status (Barriga et al., 2019). These signs are known as variable message signs (VMS), and they can show various messages according to what the traffic control crew has programmed into them.

Figure 4: Variable Message Signs

Image Source: (*Variable-Message Sign*, 2023)

A variable message sings discussed in the figure that was just presented. It indicates whether or not a parking slope is available in the specific parking location being referred to. Only one user will access the parking area if there is an open parking spot.

A similar sign may also indicate where parking is available in a city. Parking lot status may be communicated using changing message signs (Bock, Di Martino and Origlia, 2020). Notifications like "full," "closed," and "open" may be shown on electronic signs. This technology tracks vehicles entering and leaving the parking garage. In Image 2, they see a PGI installed at the entrance to a parking garage with many levels.

Figure 5: Display Board at Parking Entrance

Image Source: (Logix, 2018)

The picture that you see above is the display board that is located at the parking entrance. This sign is shown on the board maintained at the parking lot's access. In addition to this, it displays the location of the empty spot on which level the parking lot is located.

This technology was developed to reduce the number of distractions experienced by drivers and to increase their ability to concentrate on rapidly locating parking spaces. The motorist can make significant time savings, as seen in the image that can be found above, by going directly towards the levels that also include free parking spots (Logix, 2018). This system resembles the one that was put in place at the airport in Cape Town, which gives drivers information on the current state of the various parking garage levels.

A phoenix event parking and traffic Updates system was created specifically for Phoenix, Arizona. This system is quite similar to the one used in St. Paul. It is an enhancement of the systems that existed earlier on and was known as sunburst, managed by the police to watch the activities in the downtown area. It does this by spreading real-time information via variable message signs.

Advanced parking information management, or APIS, is an intelligent parking system in Seattle, Washington. This system is a component of the broader Seattle intelligent Trek Model deployment initiative, which aims to improve the overall efficacy and performance of the roadways and

transportation systems to keep up with growing demand. The fundamental architecture of this consists of five components:

(i) Monitoring the entry and exit of cars at each of the three parking facilities is one of the responsibilities of the parking facility monitoring subsystems.

(ii) At key junctures near the Seattle Center, parking information signs advise motorists about available spaces in parking lots and lead them in the right way.

(iii) The communications subsystem makes it possible for the central computer, the car detection system, and the parking important distinction to communicate with one another.

(iv) The centralized computer system determines the lot's occupancy based on the car detectors, instructs the signage to display the necessary message, and permits the attendant's involvement.

(v) Interfaces with the outside world ease communication between the main computer and many other systems, such as Smart Trek VMS.

The broadcast of information to provide passengers with pre-trip information about parking garages is the primary objective of this system (Bradford and Sherry, 2023). This system was implemented to ensure University of Washington's Cable TV, local commercial radio stations, and the local transportation authority could get traffic information.

In today's increasingly congested environment, each of the methods discussed in the previous paragraphs has significantly contributed to finding a solution to the growing need for parking spaces. In general, the most advanced technology now available for the systems that have been mentioned may be broken down into three primary categories: parking facility equipment, a central computer and connections, and signs (Farooqi et al., 2019). Vehicle counters and space monitors are included in the parking equipment installed at each location so that activity may be tracked at each location. After that, the central computer regulates VMS by providing information that assists in traffic navigation. In addition, the computer may be set up to broadcast messages simultaneously

through radio frequency, a dedicated phone line, an Ethernet link towards the local radio, television, or the Internet, or all three options. Nonetheless, there is still a significant amount of work to be done to improve drivers' effectiveness and access to real-time information.

2.9. Synchronization of the Access to parking lots:

The synchronisation of access for parking lots is just an important research problem determining how efficient a parking system is. The efficiency of the parking system is dependent on this issue. The authors, Rachid G and Sebastian B, present the work to synchronise the access to parking lots by integrating a drive philosophers paradigm into the car park simulation. A driving philosopher's paradigm views the circumstance as a problem comprising a collection of processes called P and a set of resources called R. P = P1, P2,..... (Pn-2), (Pn-1), pn, for example, and R = R1, R2,..... (Rn-2), (Rn-1), Rn. It is helpful to think of the procedures and assets as taking place in a revolving door, with the vehicles serving as representatives of the processes and the parking lots serving as representatives of the resources. There are two different kinds of procedures taken into consideration (Gomez-Lagos, Candia-Vejar and Encina, 2021). They consist of I init processes, which represent the processes that have not gained a resource during the roundabout, and (ii) transit processes, which represent the processes that have gained a resource during the roundabout. The guiding philosophical paradigm tries to find solutions to the following issues. To guarantee whether (1) each resource in the roundabout is held by no more than one process, (2) no process will go without food for an excessively extended length of time, as well as (3) the roundabout will not enter a stalemate state at any point.

In this method, an algorithm was designed based on the concept that processes synchronously communicate, and the computation was performed in rounds. Every procedure is broken down into three distinct steps:

1) Send phase: Throughout this procedure, requests for assistance from different parties are made.

2) Receive phase: The process takes in the data and saves it from proceeding to the next step.

3) Compute phase: The procedure then calculates the following phase's message to transmit. Using these steps, other algorithms were created. Among them are:

The serial algorithm: This means that only one process at such a time may use the roundabout, and the one with the longest wait time will be prioritized.

Concur1 algorithm: This ensures that processes already running are given precedence over new processes if two algorithms are running in parallel, competing for the same resource.

Concur2 algorithm: When two processes simultaneously request the same resource, this ensures that the newly created process is given precedence over the one currently being processed.

A car park simulator is used to carry out the actual installation of this system. A programme known as a car park simulation simulates the interaction between vehicles and parking lots, guiding drivers to the vacant parking spot located in the lot that is most conveniently located for them (Hampel and Vránová, 2021). The virtual experience of parking a vehicle occurs in an area mapped out and detailed. The following constituent parts make up the system:

- *The car:* It has a parking problem.
- *Car Park:* The garage or parking lot has a predetermined number of parking spaces. Only vehicles parked in paid parking spaces can receive the availability information broadcast by the parking lot.
- *Round about:* This is a brand-new map feature that stands in for a roundabout. It communicates with vehicles as they enter and leaves the simulation to keep them in time with one another.
- *Simulation center:* There is no real-world counterpart to this. Its primary function is to provide an overall system picture, including all vehicles and parking lots.

The transmission control protocol (TCP) and multicast channels were formerly used for communication between the components. The current range of communication could be bigger. That is to say, if car B is still within range of vehicle A, then car A will receive car B's message.

The processing in the previous job is relatively time-consuming. Vehicles can only exchange data with others within radio range. In addition, the several steps prevent easy access to parking information (Herrchen et al., 2022). Thus, a faster processing system is required to enhance intelligent parking.

3. Research Methodology

3.1. Introduction

The chapter headed "Research Methods" provides an overview of the methodology and procedures used to conduct the research on PHP-based online parking management systems. The aim of this chapter is to offer a description of the research strategy, data collection techniques, and data analysis procedures employed to achieve the study objectives (Hu et al., 2019). When it comes to ensuring the validity, reliability, and generalizability of the findings, the importance of the chapter dedicated to the research procedure cannot be emphasised.

The chapter headed "Research Methods" provides an overview of the methodology and procedures used to conduct the research on PHP-based online parking management systems. Some of the techniques of data collection employed for this study included document inspection (Iqbal Munawar, Anisa Rizky and Pajar Rusman, 2022). Data analysis methods used included descriptive and inferential statistics, coding, classification, and the identification of overarching themes. The chapter on research procedure is very significant since it helps to guarantee that the study's results are accurate and credible.

3.2. Study Design

The philosophy is grounded on the research and their ideas of what is true, real, and knowable. It discusses the underlying philosophical assumptions that shape research questions, methodology, and findings. Pragmatism was chosen as our research philosophy to analyse an IoT-based smart parking system. Pragmatism is a school of thought that places a premium on taking direct action and learning by doing rather than relying on theoretical justifications. One may use a pragmatic

approach to understand better the barriers to and opportunities for improvement in implementing an Internet of Things-based smart parking system (Al Maruf et al., 2019). This might entail gathering feedback from parking lot owners and users via interviews to further tailor the smart parking system to their needs.

Justification

The pragmatic approach is warranted in the research since it allows for various viewpoints and, by extension, potential new insights into the research subject. Studying an IoT-based smart parking system lends itself to pragmatism because it focuses on actionable knowledge and experimentation (Jabbar et al., 2021). The difficulties and restrictions associated with implementing such a system may be identified using the method and solutions considered. If they own or use a parking lot and want to learn more about the people who use it and how they use it, conducting interviews with them may be a great resource for gathering information for designing and implementing a smart parking system.

3.3. Study Size

The length of the research, the number of participants, and the number of parking spots in the space may all factor towards the total study size. The length of the study may be affected by variables beyond the researchers' control, such as weather, seasonality, and other factors that may influence parking habits (Al-Turjman and Malekloo, 2019). A smaller study size centred on only that area would be appropriate. The number of parking spots, number of users, and length of study may all contribute to the scope of the research. The study size may also be affected by the research design. For instance, the number of sensors used to track parking availability might determine how many participants are needed for the research.

3.4. Sampling strategy

The sampling strategy for a smart parking system using IoT will depend on the research question, objectives, and methodology of the study. One possible sampling strategy is random sampling (Islam et al., 2020). This entails randomly sampling smart parking system parking lots and

collecting occupancy and user activity statistics. This sampling approach helps guarantee that the findings are representative of the population and eliminate data-gathering bias.

Procedure

The study for the analyse is qualitative approach, and it entails collecting and examining data that is not numerical, such as via interviews, surveys, or observations. This method may be effective in gaining knowledge of the perspectives, attitudes, and inclinations held by parking lot owners and users concerning the smart parking system (Diaz Ogás, Fabregat and Aciar, 2020). For instance, conducting interviews with those who own parking lots and people who use parking lots might give insights into their experiences and perspectives on the system. Finding recurring themes and patterns in the data may be accomplished using the qualitative method, which may entail using thematic or other qualitative data analysis approaches.

Qualitative research may be quite useful to understand the users' experience with the smart parking system, including their perspectives, requirements, and expectations. Various contextual variables that may be better understood via qualitative research influence the adoption and usage of smart parking systems. User happiness with the smart parking system can be assessed via qualitative research.

3.5. Exclusion Criteria

Exclusion Criteria for Smart parking System using IOT is establishing a maximum vehicle length and width that ensures the innovative parking system can accommodate all cars. There are several regions where the intelligent parking system may need to be fixed, such as small streets, heavy traffic, or uneven terrain. When designing parking lots, it's crucial to keep such areas out of the equation, so they're easily accessible and handy for consumers (Jusat et al., 2021). In several regions, the intelligent parking system is probably not a good idea due to high vandalism or theft rates. Because it relied on the internet, the intelligent parking system could not be applicable in places with spotty or no internet service. A user with special requirements, such as a need for disability parking or electric car charging, may find the intelligent parking system insufficient.

3.6. Data Analysis and Reporting

The system uses parking spot sensors to identify vehicles. A central system may gather real-time parking availability and occupancy data from these sensors. The approach can measure parking occupancy, duration, and turnover. Parking lot cameras may record cars arriving and leaving. The approach may be used to gather licence plate data, vehicle entry and exit counts, and parking time. A smartphone app can book parking spots in advance. The approach collects parking demand, user preferences, and use trends (Herrera-Quintero et al., 2019). Wi-Fi access points in parking lots may identify Wi-Fi-enabled gadgets. The appraoch may estimate parking demand by gathering population data. Bluetooth beacons in parking lots may recognise Bluetooth-enabled devices. This approach may estimate parking demand by collecting population data.

3.7. Ethical Consideration

The following are some ethical consideration that should be taken into account:

Privacy: Privacy issues arise when sensors, cameras, and other Internet of Things devices are used to track parking availability and use. To safeguard people's privacy, it's crucial that the data we gather be rendered anonymous.

Informed consent: Every participant should be made aware of the study's goals, how their data will be utilised, and how their privacy will be safeguarded (Ke et al., 2020). Everyone involved has to provide their full, informed permission.

Data security: It is essential to store and protect the information gathered by IoT devices safely. Data loss may compromise subjects' privacy and tarnish the institution's and researchers' names.

Transparency: Researchers must be upfront about what they did to obtain data and the algorithms they used to analyse it. Participant and community trust will be bolstered as a result.

Fairness: Anyone without internet access may be disadvantaged in an intelligent parking system that relies on IoT devices (Manjula et al., 2021). Everyone should be able to participate in and benefit from the system.

Benefit and harm: The researchers designing the IoT-based innovative parking system need to weigh the advantages and disadvantages of the proposed approach. The system should be built to have the most positive effects with the least bad ones, and researchers should be ready to deal with any unintended repercussions.

3.8. Risk Assessment

Assessing the safety of an Internet of Things (IoT)-based smart parking system entails teasing out the many points of failure that might compromise the system's integrity. Data security, system performance, and the dependability of the Internet of Things (IoT) devices and sensors utilised in the parking system are all areas that need to be investigated. Evaluating the possible effect of these risks and creating methods to minimise or manage them are also part of the assessment process.

3.9. SDLC waterfall

The SDLC (Software Development Life Cycle) waterfall technique may create a sophisticated parking management system in Prague. Studies rely heavily on research technique since it helps researchers determine what questions they need to ask and how they may best answer them. To investigate the already-in-place system, they are using the tactic of gathering secondary data. The online research papers that may be accessible use qualitative research and reference a wide range of academic periodicals. The process is sequential, consisting of several steps that must all be completed before going on to the next. The first step in developing a smart parking system is the requirements gathering phase, during which the project team gathers needs from stakeholders, including parking operators and drivers (Rana, 2019). The project team then moves on to the analysis and design phase, examining the collected requirements and creating the system architecture and user interface. The smart parking system's genuine development starts in the implementation phase. The next step is testing when the project team puts the system through its paces to ensure it meets expectations and operates as planned. The system may be put into use in the garage or parking lot once it has been thoroughly tested. In the last stage, known as "maintenance," the project team performs routine checks and fixes to the system to keep it running

smoothly. To guarantee a successful development and deployment that serves the interests of all parties involved, the SDLC waterfall technique may be used to create a smart parking system in Prague.

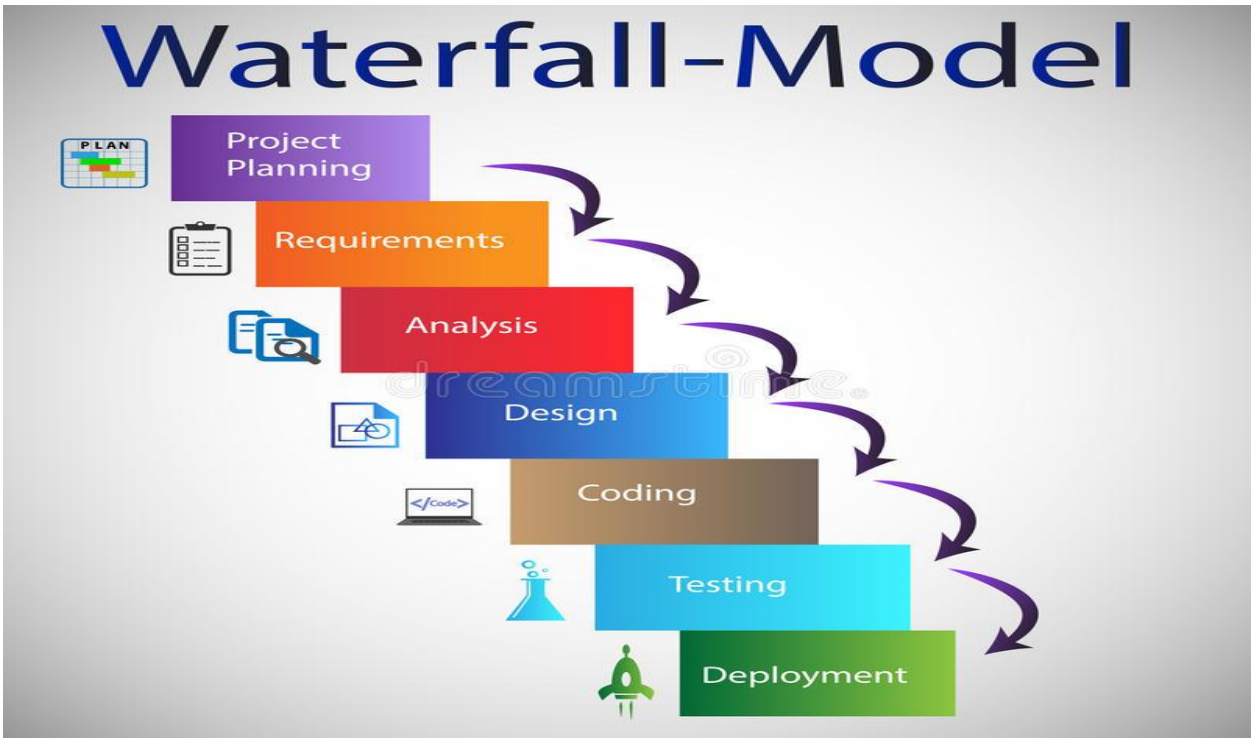

Figure 6: Waterfall-Model

Image Source: (Rana, 2019)

The statistics shown above are from the waterfall model. Initially, there is the part for planning the project, and then there is the section for the requirements (Koumetio Tekouabou et al., 2020). After that follows the analysis, the design, the coding, the testing, and finally, the deployment of the software.

A Smart Management Field Test

An investigation of intelligent management in the field is detailed.

With this setup, there are two dynamic user interfaces where users may post different messages at different times (CMS)

i) The first shows drivers in the nearby corridor along the route information about the availability of parking spaces.
ii) The second one is a central intelligent reservation system which allows commuters can check parking availability as well as reserve a place via the use of the telephone, mobile phone, internet, and personal digital assistants (PDA)

This technology combines the average traffic data from the entrance through to the exit to offer precise and up-to-the-minute counts of the available parking spaces. This test used all fifty parking spots available. When they park in the intelligent parking lot, users who have made en-route reservations via the system will call in their vehicle registration numbers using their mobile phones. Users had to have parking permits or license plate numbers for advanced reservation parking that matched those submitted to the enforcement staff in real time through PDA for en-route parking bookings. In addition, a variety of tests on the behaviours and reactions of motorists, such as readiness to pay, comments on various components of the system, and a great many others, were carried out during this field test.

4. Proposed system

4.1. Implementation plan

An online parking management system created using PHP:

As the first step in determining the scope and demands of the parking system, determine the features and capabilities of the parking system. Some of the primary features include user registration, parking spot reservations, payment processing, and an administrator dashboard for monitoring and operating the system.

Build the database schema: The database schema must be constructed so that it can store user data, parking lot data, reservation data, and payment data. MySQL or any other suitable relational database might be used to construct the database.

Build the user interface: The user interface should be designed in such a manner that the user has a pleasant experience. The dashboard for managing reservations, together with the registration form, the page for logging in, the form for creating parking reservations, and the form for processing payments, must be included in the user interface.

Build the backend: PHP should be used to create the parking system's backend. The backend should handle user authentication, reservation processing, payment processing, and database management.

Install a payment gateway: In order for consumers to pay for parking online, the parking system must be supplied with an installable payment gateway. Payment gateways such as PayPal, Stripe,.

Do system tests It is critical to run system tests to ensure that all of the system's features and operations are functioning correctly. In addition to testing for safety, you should test for functionality and usability throughout the testing process.

Launch the system: After all of the testing is completed, the system may be launched. Before the product is released, a comprehensive marketing plan aimed at attracting clients to the system must be implemented.

Support and maintenance should be provided: once the system is operational, ongoing support and maintenance should be provided to ensure that it is running effectively (Kunwar, 2019). Addressing bugs, staying up to date on security updates, and increasing performance are all instances of this.

It is a high-level implementation plan for a PHP-based parking system that is available online. This strategy may be modified to match your organization's requirements as well as your budgetary limits.

Justification for php and MYSQL

PHP and MySQL, two widely used technologies, are often used in the development of web-based applications. Both of these software systems are open-source, which means that anybody may use them for free and that a vast community of programmers is continually striving to improve their capabilities (Lin and Cheung, 2020). In this section, we will look at why PHP and MySQL were chosen as the backend programming languages for the online parking management system that is currently being developed.

PHP

PHP is a server-side programming language designed primarily for use in web development. It is widely utilised in the development of dynamic web pages and online applications. PHP is an excellent choice for developing an online parking management system for a variety of reasons, including the following:

PHP is open-source software, which means it is free to use and there are no fees to get a licence to use it. As a result, it is a viable option for the creation of web-based applications.

PHP's syntax is simple and relatively similar to those of other computer languages, making it an easy language to learn (Logix, 2018). It also has a big developer community that is ready to share their experience and resources, making it much easier to get started with the platform.

PHP works with a wide range of operating systems, including Windows, Linux, and macOS. This characteristic is known as cross-platform compatibility. As a result, the process of designing and delivering applications across many platforms is streamlined.

PHP is backed by a wide community of developers, all of whom are always trying to improve the language (Loong, Isaak and Yusof, 2019). As a result, there are a variety of tools available, such as libraries, frameworks, and tutorials, making the development process faster and more effective.

MySQL

MySQL is a prominent relational database management system that is utilised in web development when combined with PHP. MySQL is used in tandem with PHP. MySQL is an excellent choice for developing an online parking management system for a variety of reasons, including the following:

MySQL, like PHP, is open-source software, which means it may be used for free and is easy to distribute.

Scalability: MySQL is scalable, which means it can handle massive amounts of data and can be expanded as needed. As a result, it is an excellent choice for designing a parking management system capable of serving a large number of consumers.

High Performance: MySQL was designed from the bottom up with high performance in mind, and it can execute thousands of transactions per second (Lou et al., 2020). As a result, it is an excellent choice for the development of an application that requires speedy access to and processing of data.

MySQL has a variety of cutting-edge security techniques that prevent unauthorised users from accessing the database and ensure data integrity.

To summarise, PHP and MySQL are excellent choices for developing an online parking management system. PHP is a popular programming language because it is easy to learn, affordable, and has a large developer community. MySQL offers numerous security features in addition to scalability and speed. The combination of diverse technologies leads in the development of a strong and time-saving platform for the development of web-based applications.

4.2. Modules

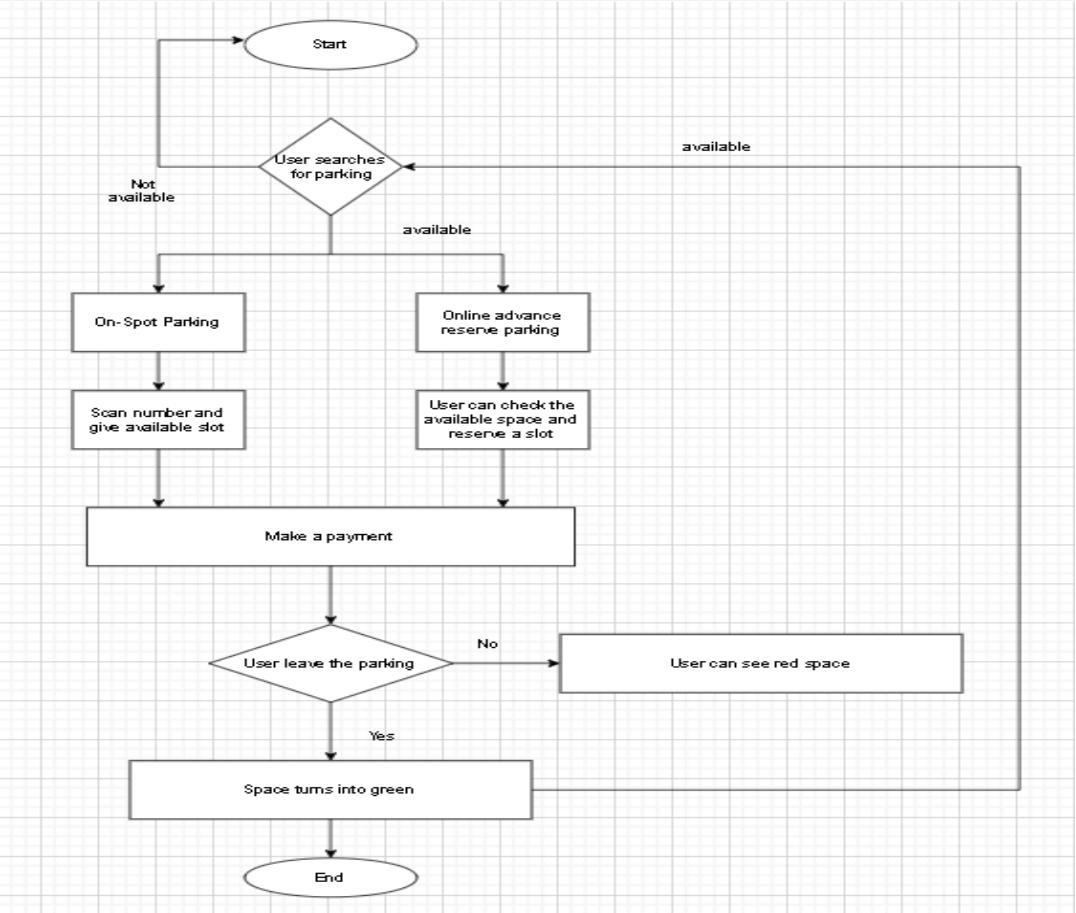

Figure 7: Flow chart of proposed system

Image Source: (Self Work)

Admin:

• **Login:** Admin can login to their personal account using their ID and password.

• **Add Parking Lots:** Admin can add new parking lots to the system, with their location and capacity.

• **View Parking Lots:** Admin can view a list of all parking lots in the system, along with their current occupancy and availability.

• **View Parking Lot Details:** Admin can view detailed information about a specific parking lot, including its location, capacity, and current occupancy.

• **View/Edit/Delete Parking Lot:** Admin can view, edit, or delete a parking lot in the system.

• **View Transactions:** Admin can view a list of all parking transactions in the system, including the time of entry and exit, the amount charged, and the parking lot used.

• **View User Feedback:** Admin can view feedback messages sent by users of the system.

Client:

• **Login:** Clients can login to their personal account using their ID and password.

• **Find Parking:** Clients can search for available parking spots near their current location, and reserve a spot if desired.

• **View Reservations:** Clients can view their current parking reservations, including the location, time of entry and exit, and amount charged.

• **Cancel Reservations:** Clients can cancel their parking reservations if they are no longer needed.

• **View Transaction History:** Clients can view their transaction history, including all parking transactions they have made in the system.

• **Send Feedback:** Clients can send feedback messages to the admin regarding the working of the system.

4.3. Advantages

Effectivity Enhanced: Parking may be made more efficient with smart sensors to track space availability and an autonomous parking system to park vehicles. This has the potential to ease gridlock and boost circulation around the city.

Convenience: Parking apps make it simple for drivers to find and book spaces and make payments from their vehicles (Lyu and Fan, 2022). In addition to saving time and effort, driverless parking removes the need for drivers to seek parking spaces actively.

Cost Savings: The fees that are normally connected with parking enforcement and parking management may be lowered with the use of an intelligent parking system. Also, motorists may save money on petrol and car wear and tear by spending less time around the block looking for a parking spot.

Sustainability: A smart parking system may aid in the fight against climate change and the preservation of urban air quality by decreasing the time spent driving about looking for space. Reduced traffic and improved air quality are two other benefits that may result from the introduction of driverless parking.

Analytics of Data: A smart parking system may gather data on parking patterns and use them to maximise parking operations and enhance the system's overall efficiency. Future urban planning and development efforts may be better informed with this information.

4.4. Limitations

High starting costs: A smart parking system's infrastructure, sensors, and technology might be expensive. Due to the specialised hardware and software requirements, the initial investment in a driverless parking system might be substantial.

Dependence on Technology: Technology is crucial to the success of an intelligent parking system. Drivers and parking lot managers might be inconvenienced if the technology malfunctions and the system won't function as anticipated.

Accessibility Issues: Some motorists may need access to the smartphones or autonomous vehicles necessary to operate a smart parking system (M et al., 2023) . This may reduce the system's use for certain motorists and restrict their access.

Privacy and Safety Issues: Users' personal information may be at risk if parking data is collected and analysed. There must be robust safeguards to preserve user information's confidentiality.

Upkeep and Preservation: Maintaining the integrity of a smart parking system is a continual process. Especially if the system is complicated or requires specialist hardware, this may be a time-consuming and expensive endeavour.

4.5. Applications

On-street parking: To keep drivers up-to-date on parking availability, smart sensors may be placed in on-street parking areas to track use. The effectiveness of the parking system and the alleviation of traffic congestion are two potential benefits.

Off-street parking: Off-street parking garages and lots may benefit from smart parking systems by allowing cars to book places before arrival. Vehicles may be parked automatically with the help of driverless parking systems, relieving drivers of the stress of finding a spot in a crowded garage or lot.

Airport parking: At airports, drivers may utilise smart parking technologies to find and book parking places in advance (Melnyk, Djahel and Nait-Abdesselam, 2019). Vehicles may be parked automatically with the help of driverless parking systems, relieving drivers of the stress of finding a spot in a full garage or lot.

Malls and other enclosed shopping areas: Parking garages and malls may use smart parking systems to assist customers in finding and booking parking spaces. This has the potential to increase parking system efficiency and decrease traffic congestion.

Centres for public transportation: To assist motorists in finding and booking parking spaces in advance, smart parking systems may be used at railway stations and bus terminals. This has the potential to increase parking system efficiency and decrease traffic congestion.

4.6. Hardware components

Sensors: These are essential pieces of hardware for a smart parking management system. It is possible to place sensors in parking spots to identify whether or not a car is currently using the space. A wide variety of sensors are available, including ultrasonic, magnetic, and infrared sensors, among others. These sensors can be linked to a centralized management system for the parking lots.

Cameras: Parking lots may be monitored with cameras, which can also offer visual feedback on the number of open parking spots. Also, they might be used in the field of security.

Screens for public display: They can display information to vehicles about the availability of parking spaces in real-time (Naeem et al., 2020). Display monitors may be mounted on individual parking spots or at the entrance to the parking lot, whichever is most convenient.

Payment systems: Installing payment kiosks or terminals at strategic locations is one option for establishing a paid parking system. They may take payments in cash, credit cards, debit cards, or even mobile payment systems.

Systematized methods of communication: A communication network is necessary for a smart parking system to transfer data between all system components. This might be a wired or wireless network, such as Wi-Fi or Bluetooth; alternatively, it could be a Bluetooth or Wi-Fi network. **Control unit:** It is possible to employ a centralized control unit to administer the sensors, cameras, payment systems, and any other hardware components (Najmi et al., 2021). The control unit may be linked to a management system hosted in the cloud to facilitate data storage and analysis.

A source of power: A power source is required to ensure the proper operation of the hardware components. This may be supplied by a local power grid or by batteries and solar panels installed on the property.

4.7. Software components

Software for managing parking spaces: This essential software component is responsible for managing the whole of the intelligent parking system. It contains the algorithms for processing data from sensors, cameras, payment systems, and other hardware components. Also, it manages the availability of parking spots and the prices associated with those spaces.

Mobile application: It is possible to design a mobile application that offers drivers real-time information on the availability of parking spots and allows them to book parking spaces in advance. Also, users may use the app to make purchases and sign up to get notifications when their parking periods are about to run out.

Web portal: The dashboard for managing the parking system may be made available to parking operators by creating a website (Navrátilová and Lehet, 2022). The site can give statistics on the use of parking spaces, income, and other crucial real-time parameters.

The use of analytics and reports: The information collected by the sensors and the other hardware components may be processed with the help of analytical software. This may give useful insights into the patterns of usage of parking spaces, trends in income, and other performance measures.

Incorporation of elements from other systems: Combining the parking management software with other systems, such as those that oversee public transit or traffic management in the city, is possible. This may provide extra data and make the system more capable of efficiently managing parking spots.

Security: There is the potential for the smart parking system to include security software, which would safeguard data from being accessed inappropriately or being compromised by cybercriminals (Navrátilová et al., 2021). Encryption, authentication, and several additional precautions are examples of this security mechanism.

5. Testing

After the installation of a smart parking system, a specific testing procedure has to be carried out to identify whether or not the system functions as expected and whether or not it is up to the required level. The following are some of the steps that might be performed to evaluate a smart parking system after its design has been finished in its entirety:

System testing: The first thing that must be done is system testing, which comprises analysing the system's performance as a whole. This is the most important step in the process. This includes testing, not just the user interface but also the components of the user interface, the communication network, and the hardware components (Nosratabadi, Jahandide and Guerrero, 2021). It is necessary to do the testing utilising a wide range of real-world scenarios and settings to provide confidence that the system will perform as expected when it is put into production.

Testing is an essential component of software development, and a rigorous testing approach is required to ensure that the programme meets all of the requirements and operates as intended. In this article, we will go through a testing method for a PHP-based online parking management system. Testing will take place at the student level.

Functional Testing:

"functional testing" refers to the process of verifying that the system functions as defined in the requirements. It ensures that the system can perform the tasks for which it was built and that the requirements are met (Rana, 2019). The following types of functional testing may be performed within the context of the online parking management system:

Test the user registration process to ensure that users can enter valid information when registering for an account and that the registration process is completed effectively.

Check the availability of parking spaces by verifying that users may successfully explore and reserve available parking spaces.

Test the admin dashboard's functionality to confirm that the administrator can manage reservations, see reports, and do other administrative tasks.

The evaluation of the degree of integration: Testing the integration of the various components of the smart parking system comprises establishing whether or not those components maintain their proper functionality after being merged with the various other components of the system (Růžička, Navrátilová and Tichý, 2019). While testing the integration of the components, one should ensure that the communication network between the components and the accuracy of the data transmission is evaluated.

Functional testing includes the following: To validate the operation of the intelligent parking system, it is necessary to verify that it performs following its intended purpose and is up to the required standard (Saeliw et al., 2019). This entails determining whether or not the system can locate parking spaces that are now unoccupied, bringing either the whiteboard or the blackboard up to date, and establishing connections with other aspects of the system.

An analysis of the performance is as follows: Evaluating how effectively a system functions under a range of pressures and situations is one of the aspects considered while testing its performance. This requires determining how long it takes the system to respond to queries, as well as determining whether or not it is scalable and whether or not it can handle a large volume of demands.

Investigating the safety of the situation: Testing for security ensures that the intelligent parking system is secure and can protect itself against intrusions from users who are not authorised to use it and attacks (Sarkar et al., 2022). This includes evaluating the system's authentication and access control mechanisms, as well as the system's data encryption and protection procedures.

Testing to determine whether or not the users will accept it: The user acceptability testing procedure should always include testing the system with end users to ensure that it fulfils their expectations and is easy to use. This is a vital aspect of the testing process. This entails evaluating not just the system's overall functioning but also the user interface, user experience, and overall usability.

Checking for a behavior change: Testing for regression comprises retesting the system after any changes or repairs have been completed to ensure that the system continues to operate correctly and does not introduce any new issues. This is done to test whether or not the system has caused any new problems.

Testing procedures for a smart parking system will include system testing, integration testing, functional testing, performance testing, security testing, user acceptability testing, and regression testing after the development of the system has been finished (Sarker et al., 2020). By adhering to the processes mentioned earlier, the developers of the intelligent parking system will have the ability to confirm that it carries out its functions as anticipated, that it is up to the set standards, and that it can be relied upon by its end users.

6. Finding and analysis

Admin Table

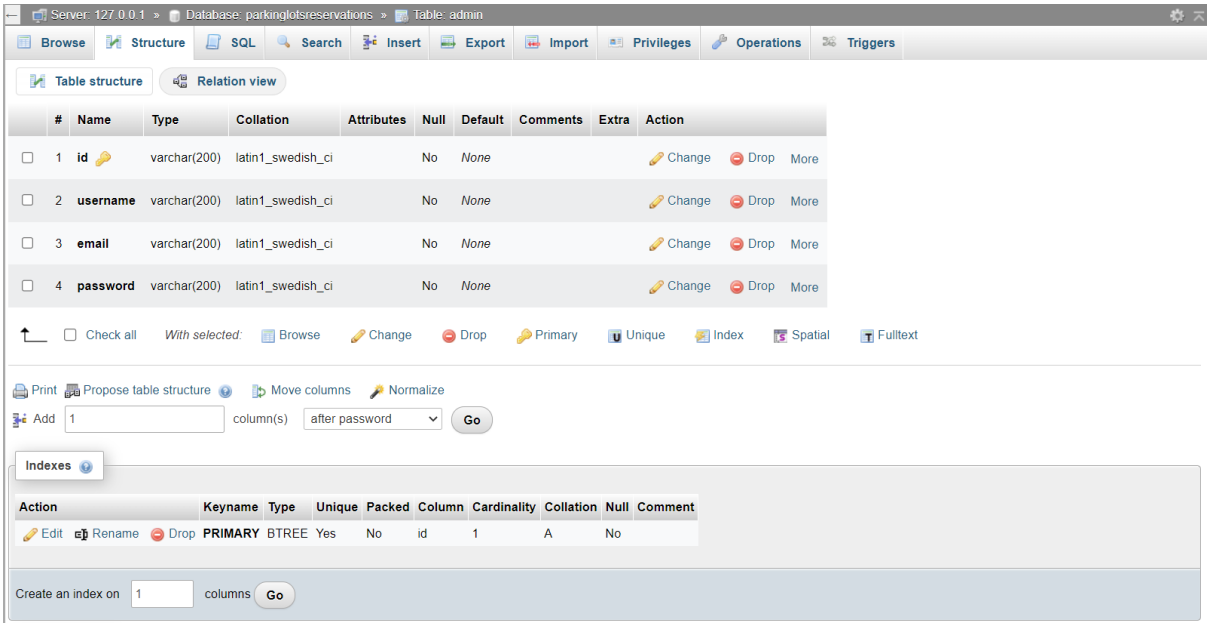

Image Source: (Self Work)

The above image depicts admin table for a smart parking system that would typically contain information related to the administrator accounts and their permissions. This table would typically include the following fields:

Admin ID: A unique identifier for each administrator. It is a primary key.

Username: The username associated with the admin account.

Email: The email address associated with the admin account.

Password: The password associated with the admin account (usually encrypted for security).

The admin database table is crucial for managing the administrative aspects of the smart parking system, such as adding or removing admin accounts, granting or revoking permissions, and monitoring system activity (Sehrawat and Gill, 2019). The data stored in this table can be used to generate reports and analytics that help improve the efficiency and effectiveness of the system.

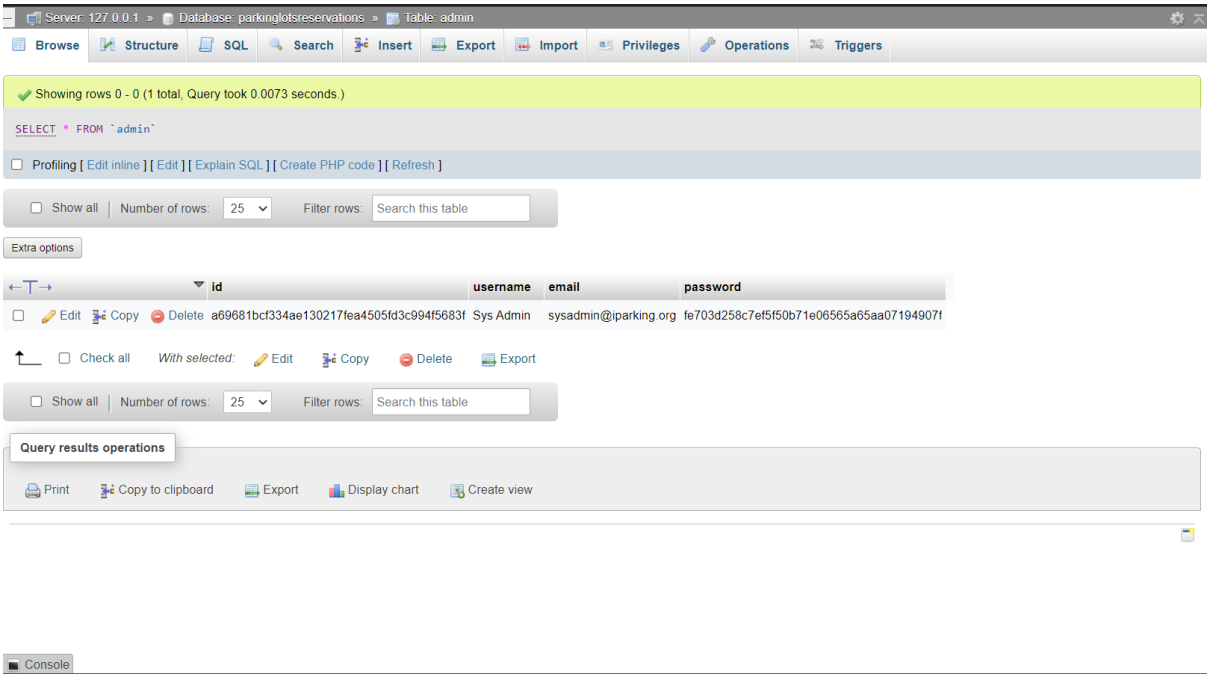

Image Source: (Self Work)

In the above image, the admin table allows the admin to view and manage the details of other administrators in the system. The browse function typically displays a list of all admin accounts in the system, along with their basic information, such as their name, email address, phone number, role, and status.

When the admin selects a specific admin account from the list, the details associated with that account are displayed, including their login credentials, contact information, and permissions (Sieck, Calpin and Almalag, 2020). The browse function also allows the admin to perform various actions on the selected admin account, such as editing their details, changing their permissions, or deleting their account altogether.

The smart parking system's browse for admin table is an important part of the administrative interface since it allows the admin to manage the system's many admin accounts easily. Reports

and analytics based on the information in this table may be used to monitor the system's administrative processes and ensure they're running well.

Client Table

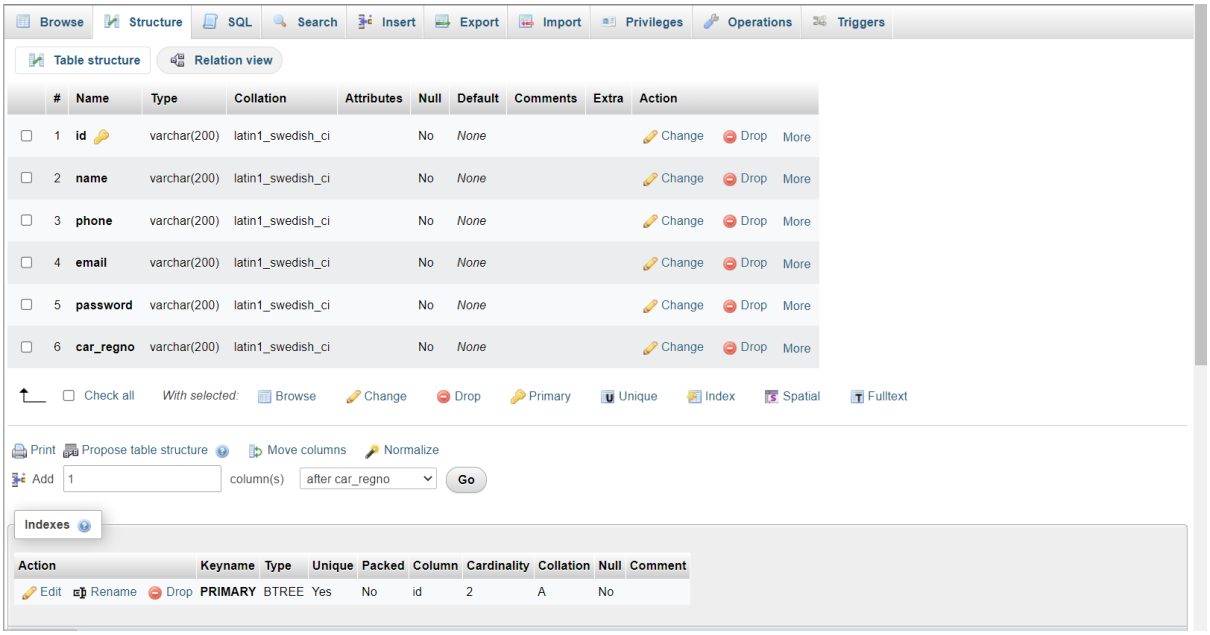

Image Source: (Self Work)

From the above image, the client table for a smart parking system, typically contain information related to the clients who use the system to reserve or access parking spots. This table would typically include the following fields:

Client ID: A unique identifier for each client. It is a primary key.

Username: The username associated with the client account.

Phone: The phone number associated with the client account.

Email: The email address associated with the client account.

Password: The password associated with the client account (usually encrypted for security).

License Plate: The license plate number of the client's vehicle.

The client database table is crucial for managing the client-related aspects of the smart parking system, such as adding or removing client accounts, managing payment methods and balances, and tracking client activity (Singh, Pan and Park, 2021). The data stored in this table can be used to generate reports and analytics that help improve the efficiency and effectiveness of the system, as well as provide insights into client behavior and usage patterns.

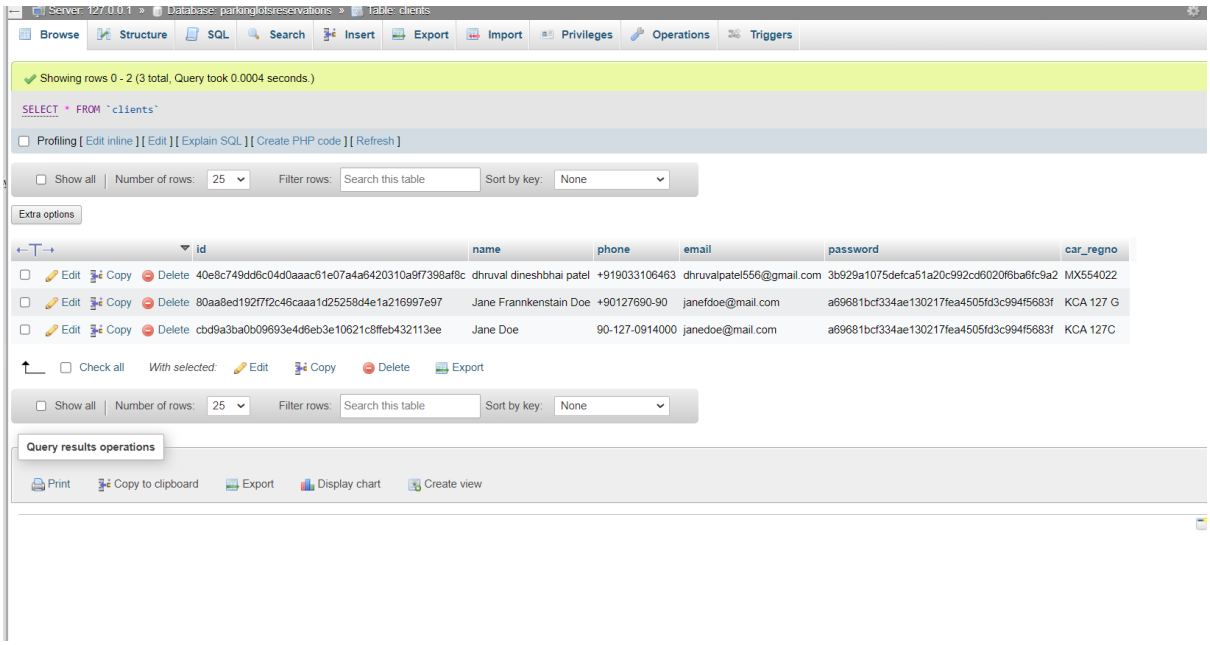

Image Source: (Self Work)

The picture above represents the smart parking system's client table's browse capability, which enables authorised workers to see and manage data about all registered customers. Client accounts in the system, and their names, email addresses, phone numbers, and statuses are normally viewable through the browse feature.

Client account information such as login credentials, contact information, vehicle information, payment method, and balance is presented when the administrator chooses a particular client

account from the list (Sotres et al., 2019). The administrator may change the chosen client's account, such as updating their information or adding a new payment method, using the explore option.

The browse feature for the client table is an integral part of the administration interface of the smart parking system, allowing the administrator or authorised workers to handle the numerous client accounts in the system easily. This table stores information that may be used to analyse and produce reports on how well the system's client-facing features work.

IP camera for camera

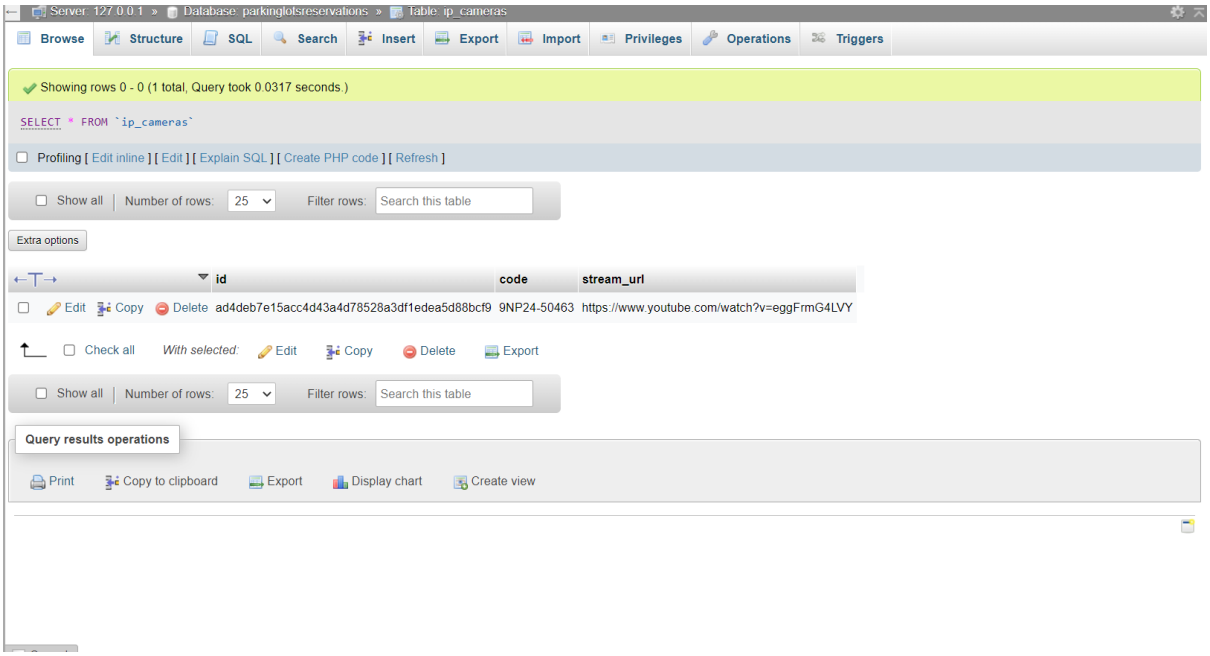

Image Source: (Self Work)

The above picture of browse function for IP camera in a smart parking system allows the administrator or authorized personnel to view and manage the live video feeds and recordings of the installed cameras in the parking lot. The browse function typically displays a list of all the IP

cameras installed in the parking lot, along with their basic information, such as their location and status.

When the administrator selects a specific IP camera from the list, the live video feed from that camera is displayed, allowing them to monitor the parking lot for any suspicious or unauthorized activities (Unterluggauer et al., 2022). The browse function also allows the administrator to view the recorded footage from the selected camera, which can be used as evidence in case of any incidents or disputes.

The browse feature for IP cameras is an integral part of the smart parking system's security and surveillance capabilities, giving the administrator or authorised employees a simple means to watch the parking lot and maintain the safety and security of the automobiles and their owners. This table's data may be used to provide reports and analytics that aid in tracking and improving how well the system's security-related operations work.

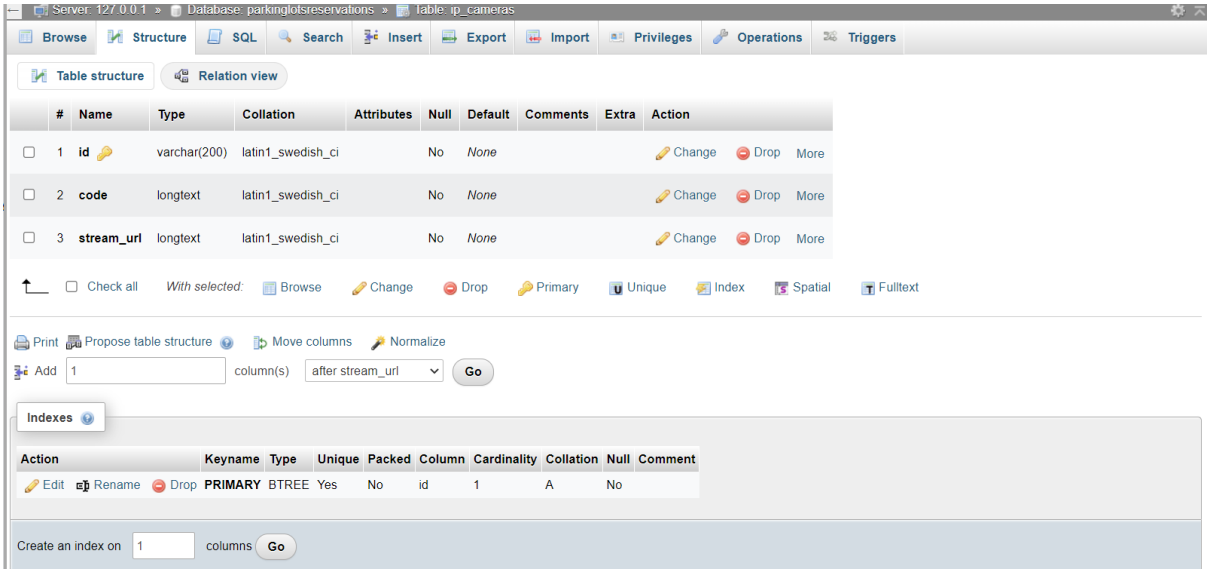

Image Source: (Self Work)

The above IP camera table stores information about the IP cameras installed in the parking lot. This table typically includes fields such as camera ID, code, stream url, location, IP address, status, and recording settings.

The camera ID field is a unique identifier for each camera installed in the parking lot, which can be used to identify and manage the cameras individually. Camera id is chosen as primary key. The location field describes the physical location of the camera in the parking lot, such as the entrance, exit, or specific parking spots.

The IP address field stores the network address of the camera, which allows the smart parking system to communicate with the camera and retrieve the live video feed and recorded footage (WAHYUNI, Saleh and Koriyanti, 2019). The status field indicates whether the camera is currently operational or not, and any relevant error messages or alerts.

The recording settings field stores the configuration details for the camera's recording settings, such as the resolution, frame rate, and storage location for the recorded footage. This information is used to ensure that the cameras are recording the required footage with the appropriate quality and storage capacity.

Parking lots

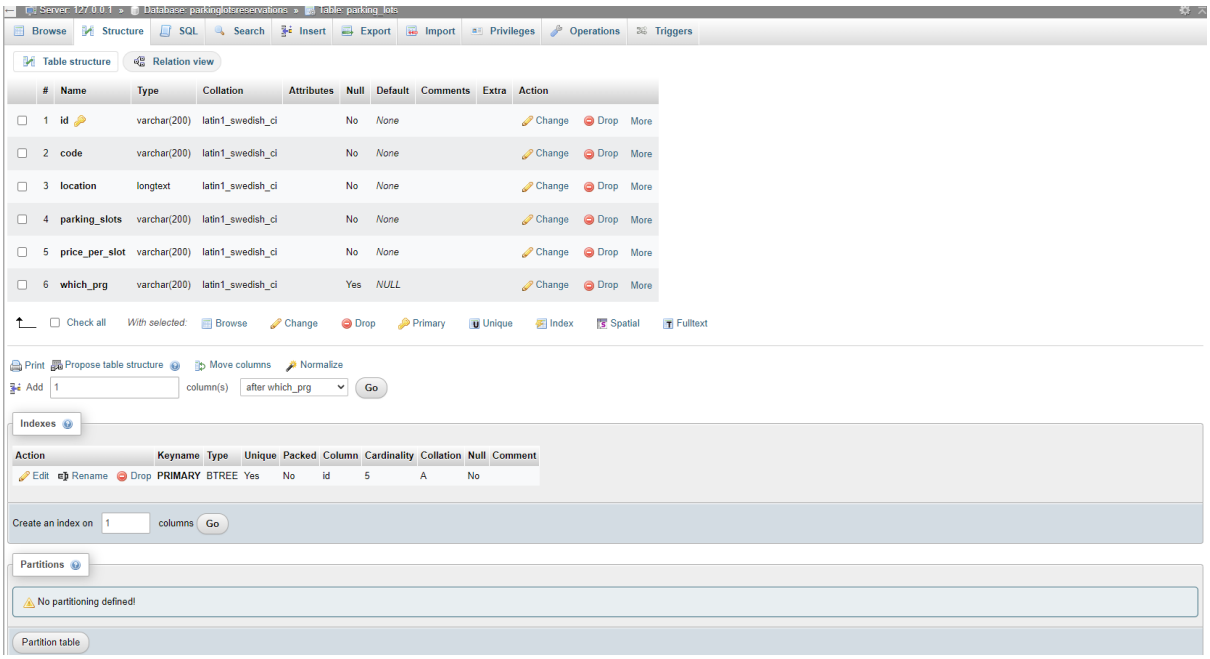

Figure 8: Parking lot system

Image Source: (Self Work)

The above parking lot table stores information about the parking spaces in the lot, including their unique ID, code, location, parking slots, price per slot, type, status, and availability.

The unique ID field is a unique identifier for each parking space in the lot, which can be used to manage and monitor the parking spaces individually. The location field describes the physical location of the parking space in the lot, such as the level, row, and spot number.

The type field indicates the type of parking space, such as regular, handicap-accessible, or reserved for specific vehicles (Wikipedia, 2023). The status field indicates whether the parking space is currently occupied or available, and any relevant error messages or alerts.

The availability field is a binary field that indicates whether the parking space is currently available or occupied, and is typically updated in real-time by the smart parking system's sensors or cameras.

The data stored in this table can be used to generate reports and analytics that help optimize the utilization of the parking spaces, improve the efficiency of the parking operations, and enhance the overall user experience for the drivers.

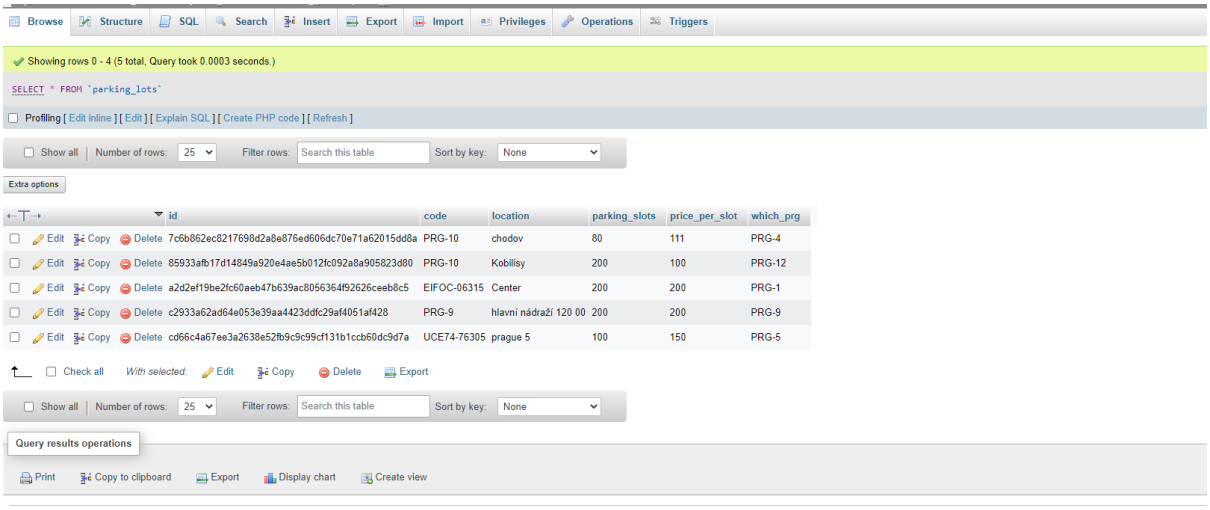

Image Source: (Self Work)

The above image depicts that users may utilise the browse function to look for details on parking areas in a certain area. In most cases, this function displays a list of parking garages that fulfil the user's search parameters, such as their proximity to the user's current location, a certain zip code, the availability of a certain parking space, or the cost of such space.

Details such as the parking lot's name, location, code, contact details, and availability status may be shown to the user. Users may also see up-to-date information on the parking lot's capacity, available parking options, and any alerts or notifications.

The browse function for parking lots in smart parking systems also enables customers to pre-book parking spots using the system's mobile app or online interface (Xiang and Pan, 2022). Customers

may choose a parking garage or lot, select a parking spot, and pay for the reservation in one convenient online transaction.

Payment

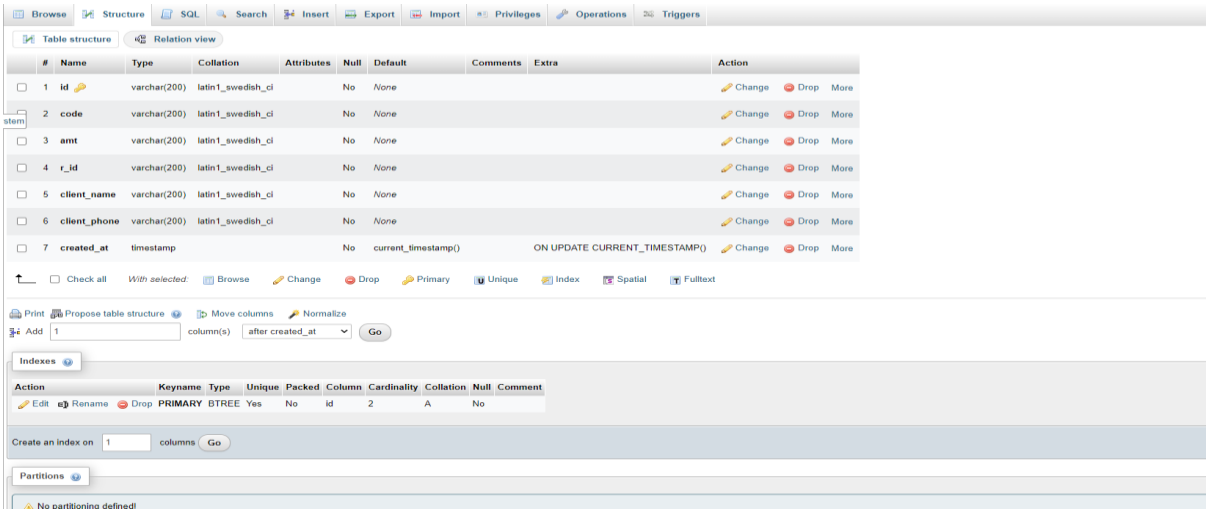

Figure 9: payment module

Image Source: (Self Work)

All parking-related financial transactions are recorded in the above pay table. This table often includes payment information such as ID, code, client name, client number, date of payment, the amount paid, mode of payment, and parking lot or spot for which payment was made.

The payment database table may include billing and invoicing details, such as the customer's billing address, payment due dates, invoice numbers, and standard payment information. As well as managing client accounts and billing information, this data may be utilised to create invoices and monitor payment history.

Refunds, chargebacks, and other payment-related issues are also recorded in the payment database table of intelligent parking systems (Abd Kadir, 2021). This data may be used to keep tabs on and resolve payment disputes and guarantee timely, correct payment processing.

The payment database table is an integral part of the backend architecture of a smart parking system, facilitating the management and tracking of financial transactions in real-time, enhancing billing and invoicing procedures, and providing users with a smooth and safe payment experience.

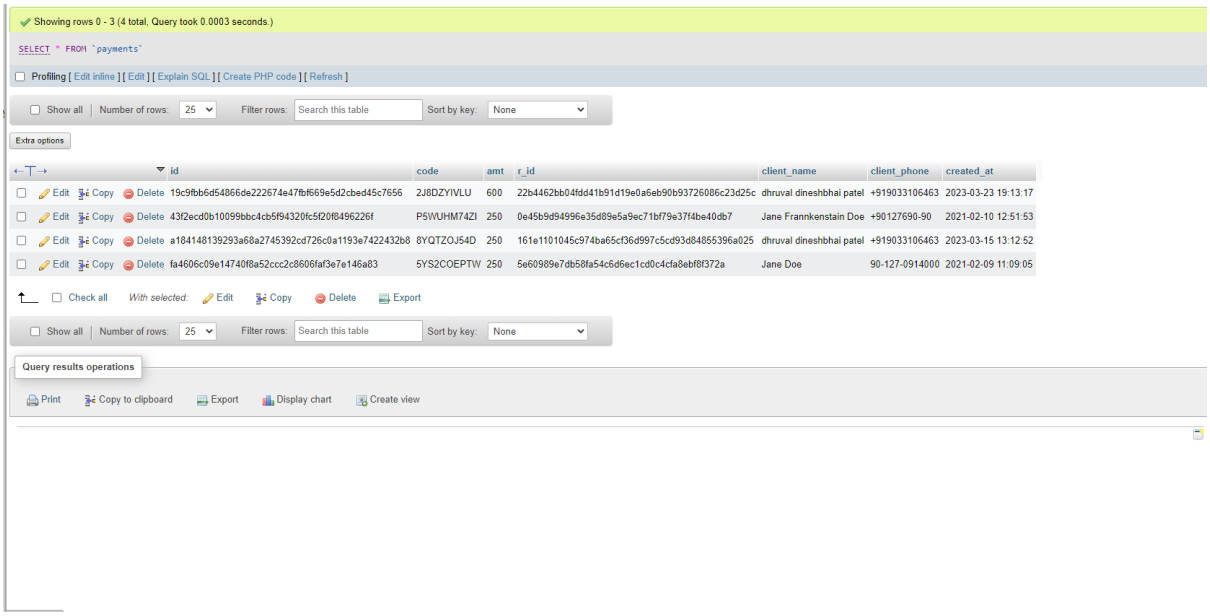

Image Source: (Self Work)

The above image show information such as the ID, code, client name, client number, payment date, payment amount, payment method, and parking lot or spot for which payment was made.

Filtering the list by payment date range, payment type, or parking lot makes it easy for the administrator to find particular payment transactions (Ahad et al., 2022). The list may be filtered based on several criteria, including the total amount owed, the due date, and the parking spot location.

The administrator may be able to do more than see payment records using the browse function, such as issue refunds, change payment amounts, notify customers of upcoming payments, and

generate reports on payment activities. This can enhance customer service, facilitate more efficient payment processing, and guarantee the integrity of all financial records.

Parking description

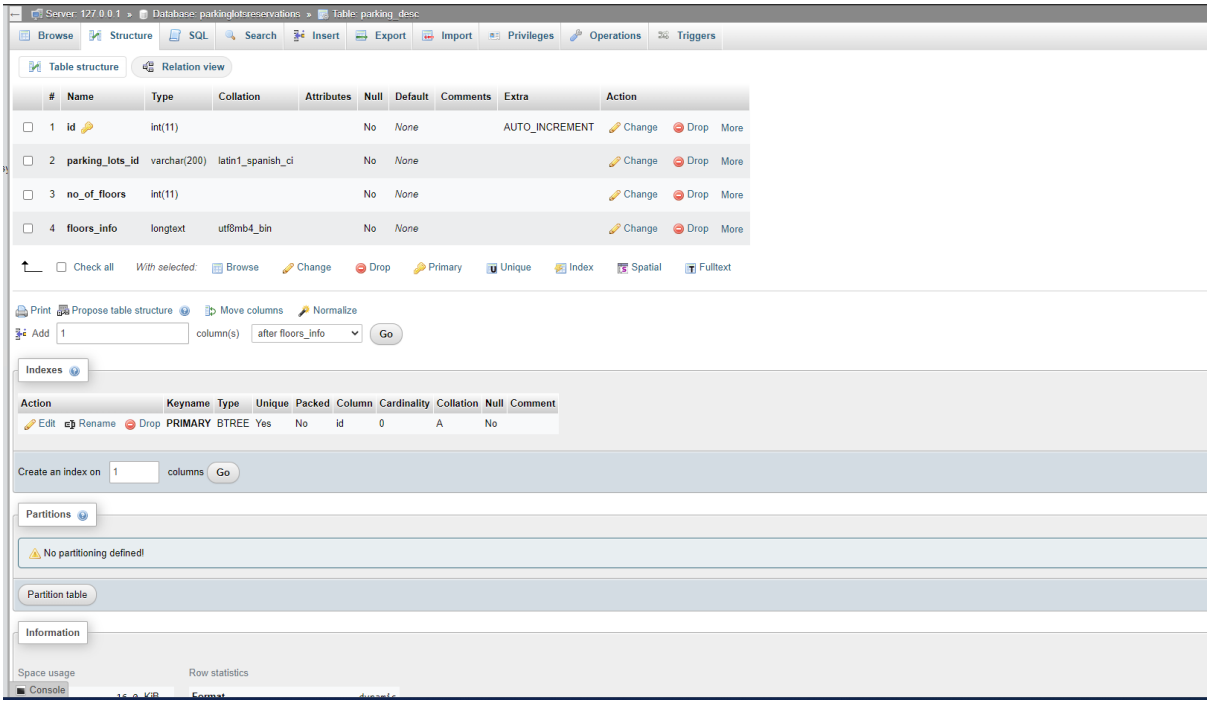

Image Source: (Self Work)

The table hierarchy of the parking system is shown in the graph just presented, which was part of the discussion regarding the parking description. A name, a type, a collection, and characteristics are included inside that (Ahmed et al., 2019). And last but not least, we have the null, default, comment, additional, and action categories. There is an auto-increment at the end of the additional section.

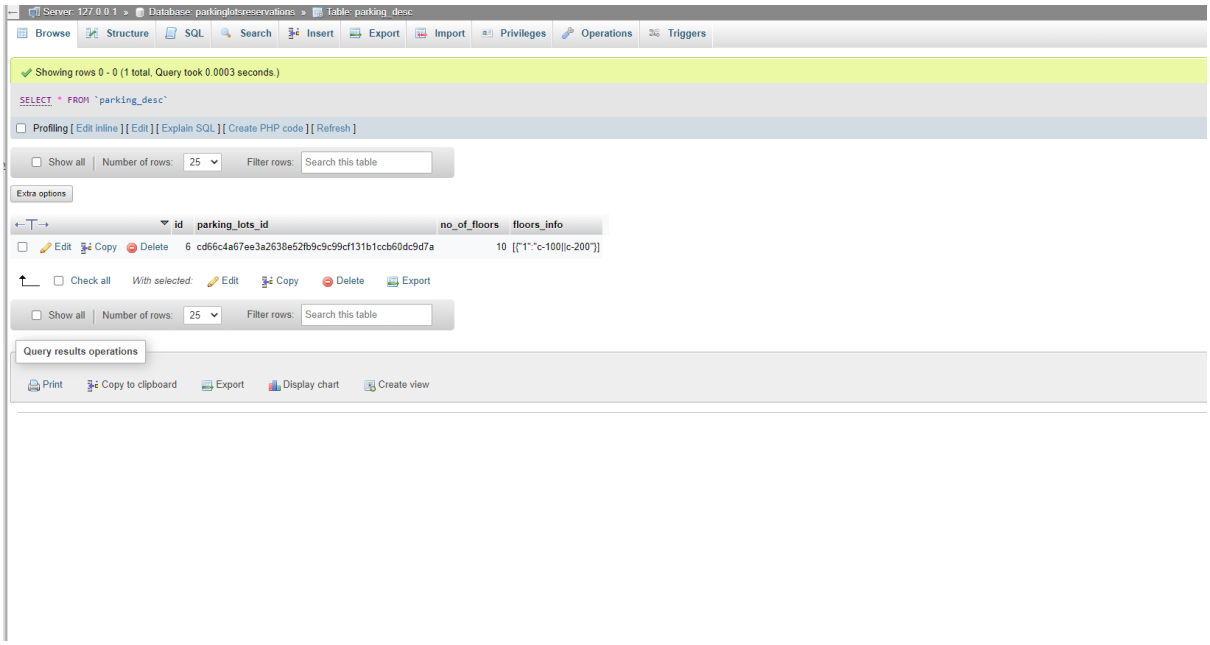

Image Source: (Self Work)

The above chart depicts parking information. Identification numbers for both the parking garage and the lot are shown. After the floor count comes the actual floor information (Al-Turjman and Malekloo, 2019). The number of levels indicates how many levels of parking are available. In addition, the floor information specifies the level the vehicle is parked on.

Reservation

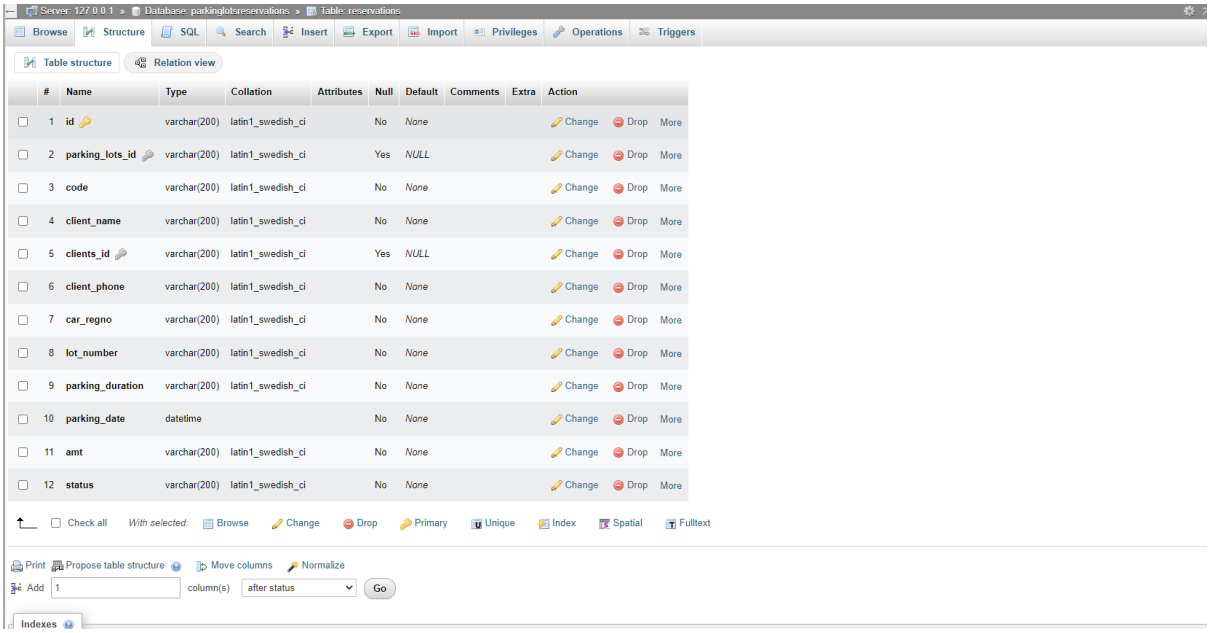

Image Source: (Self Work)

A structure may be seen in the smart parking system graphics that were shown before. In which there is information on the table's format. Below that is a section labelled "Name of the information requested." Following the discussion of the kind of data comes the presentation of the collation, attributes, null, defaults, comments, additional, and action categories.

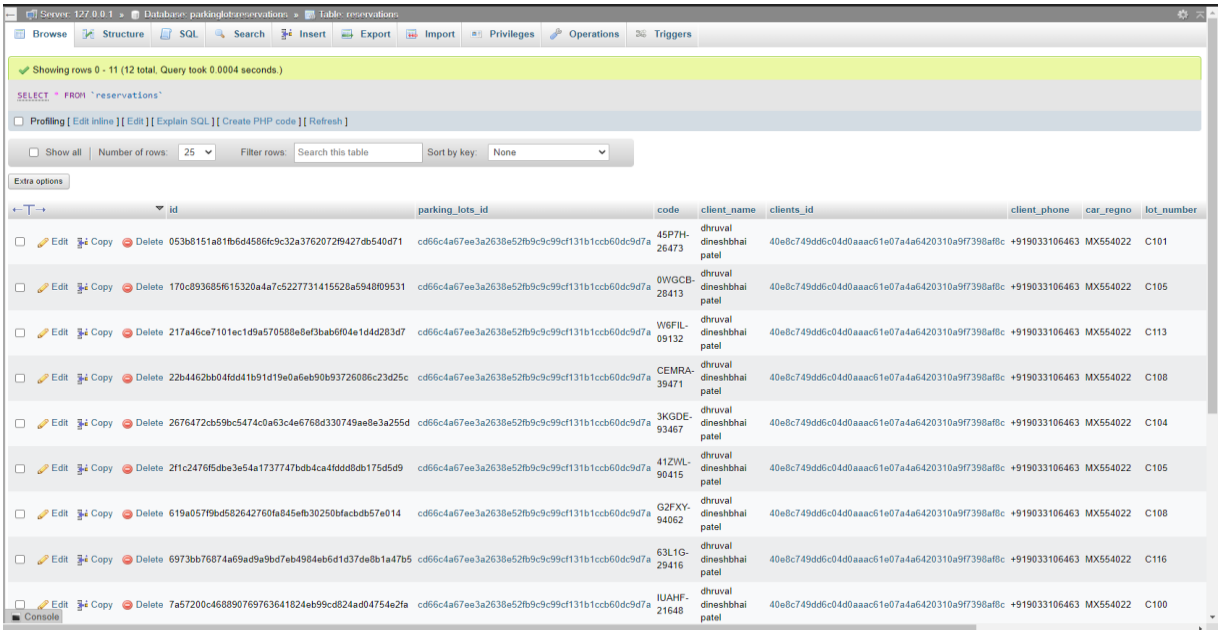

Image Source: (Self Work)

The above diagram depicts storage space in the database. There are 12 inquiries, of which they have decided to see rows 0 through 11 (Ali et al., 2020). The parking lot number, customer name, client identification, phone number, car regno, and client phone number are all included in the excel files used for all the queries.

7. Conclusion

The deployment of a PHP-based online parking management system in Prague has the potential to provide a variety of benefits, including the following:

Improved Productivity: An online parking management system may reduce the amount of time and effort required to manage parking while also simplifying the reservation process. This system can automate the parking reservation, payment processing, and reporting processes, reducing the need for human intervention.

When a parking management system is available online, customers have a simpler time booking parking spaces and making payments. This adds to an increase in the overall quality of their experience. Because of the system's ability to provide real-time updates on parking availability, customers are less likely to suffer discontent and confusion.

Increased Revenue: The use of parking spaces may be maximised with the help of an online parking management system, which can help parking operators generate more money. Moreover, the system may provide data on parking spot use, which can be used to identify opportunities for additional revenue.

With the Assistance of an Online Parking Management System, Traffic Congestion Can Be Reduced and Traffic Flow Can Be Improved The online parking management system can help reduce traffic congestion and improve traffic flow in the city by providing real-time information on parking spot availability. Also, this has the ability to reduce pollutants and improve air quality.

Enhanced Reports The online parking management system may provide accurate and up-to-date reports on parking utilisation, revenue, and other metrics, which may aid parking operators in making data-driven decisions.

Increased Security An online parking management system may offer a secure environment for payment processing and data storage, which may contribute to an improvement in overall security. In addition to these advantages, the system may reduce the possibility of theft and damage, as well as unauthorised access into parking spaces.

Therefore, installing a PHP-based online parking management system in Prague may give significant benefits such as increased productivity, better customer experience, more money, improved traffic flow, improved reporting, and increased safety.

According to studies, using an online parking management system based on PHP may provide a number of major advantages. These advantages include increased efficiency, enhanced customer experience, more income, improved traffic flow, improved reporting, and increased security.

According to the conclusions of a research conducted by the European Parking Association, the deployment of an online parking management system has the potential to boost parking occupancy rates by up to 20%, resulting in greater income for parking operators. According to the study's results, the system has the ability to minimise the amount of parking violations, increase customer satisfaction, and deliver data-driven insights to parking management.

According to the findings of another study conducted by the Institute of Transportation Studies at the University of California, Berkeley, implementing an online parking management system can reduce traffic congestion and improve air quality by reducing the number of vehicles driving around looking for parking spots.

Moreover, since PHP is an open-source technology with a large community of users and developers, using a PHP-based system may be both adaptable and cost-effective. As a result, it is considerably easier to personalise the system to meet the specific needs of parking owners and consumers.

In summary, implementing an online parking management system based on PHP may provide a substantial number of advantages, including increased efficiency, improved customer experience, increased income, improved traffic flow, and the supply of data-driven insights for parking management. It is a cost-effective and adaptable system that can be tailored to fit the specific needs of parking operators as well as users.

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