# A PARKING MANAGEMENT SYSTEM FOR MANAGING PARKING SPACE IN CITIES

## A CASE STUDY OF KAMPALA CITY

**BY GROUP 4**

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**SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY**

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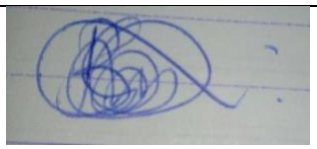
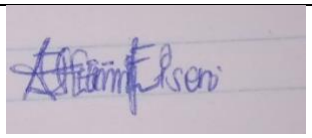
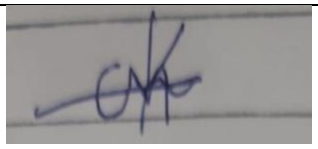
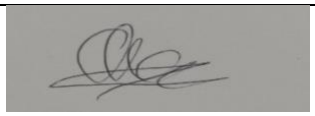
| BABIRYE GEORGIA | 19/U/12835/EVE | babiryegeorgia2019@gmail.com 0754451780 |  |
| ALAYO RHODA | 19/U/13439/EVE | alayorhoda7@gmail.com 0705814186 |  |
| KALANZI MARK | 19/U/12463/EVE | mkalanzi220@gmail.com 0758492182 |  |
| ATIM DOROTHY | 19/U/13568/EVE | atimdorothy1998@gmail.com 0771466879/0741265339 |  |
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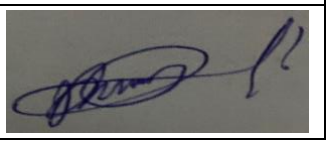
| ECUMAN PETERSON | 19/U/13943/EVE | ecumanpeterson@gmail.com 077966979/0704470906 |  |

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**Dedication**

We dedicate this report to the Almighty God without whom we can do nothing. We further dedicate it to our parents and guardians for their unceasing and selfless support throughout our stay at this University. MAY THE ALMIGHTY GOD BLESS YOU ALL.

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**TABLE OF CONTENTS**

GROUP MEMBERSHIP ..... i

Approval ..... ii

Dedication ..... iii

Acknowledgment ..... iv

TABLE OF CONTENTS ..... v

List of abbreviations ..... ix

List of Tables ..... x

List of Figures ..... xi

Abstract ..... 12

CHAPTER ONE ..... 1

INTRODUCTION ..... 1

1.0 Introduction ..... 1

1.1 Background to the study ..... 1

1.2 Statement of the Problem. ..... 2

1.3 Objectives of the study ..... 2

1.3.1 General objective ..... 2

1.3.2 Specific Objectives ..... 2

1.4 Scope of the study ..... 2

1.4.1 Context scope; ..... 2

1.4.2 Geographical Scope; ..... 2

1.4.3 Time Scope; ..... 3

1.5 Research Significance ..... 3

CHAPTER TWO: ..... 4

LITERATURE REVIEW ..... 4

2.0 Introduction ..... 4

2.1 Categories of Parking Management Systems. 4
2.2 City Navigation and smart parking. 5
2.3 Internet of Things (IoT) and smart parking. 6
2.4 Challenges in transportation and parking. 6
2.5 Advantages of a Parking Management System. 6
2.7 Requirements of the Parking Management System 7
2.8 Existing Parking Management Systems. 8
2.9 Chapter Summary. 9
CHAPTER THREE 11
METHODOLOGY 11
3.0 Introduction 11
3.1 Survey research method. 11
3.2 Data Collection 11
3.3 Study population 11
3.4 Sampling method and sample size. 12
3.5 Data collection instruments. 12
3.5.1 Data Analysis 12
3.5.2 System Analysis 12
3.6 System Design. 12
3.7 System implementation 13
3.8 System testing 13
3.9 Chapter summary 13
CHAPTER FOUR 14
SYSTEM STUDY, ANALYSIS AND DESIGN 14
4.0 Introduction 14
4.1 System Analysis 14

4.1.1 Response Rate ..... 14
4.1.2 Findings for the interviews ..... 14
4.2 Findings for questionnaires and surveys ..... 14
4.2.1 Gender distribution ..... 14
4.3 Requirements Analysis ..... 16
4.3.1 User requirements ..... 17
4.3.2 Functional requirements ..... 17
4.3.3 Non-functional requirements ..... 17
4.3.4 System requirements ..... 18
4.4 System Design ..... 18
4.4.1 Architectural design of the system ..... 18
4.4.2 Process Design ..... 19
4.4.3 Data Modelling ..... 22
4.4.3.1 Modelling relationships between entities ..... 22
4.4.4 Physical Design ..... 24
CHAPTER FIVE ..... 27
SYSTEM IMPLEMENTATION, TESTING, AND VALIDATION ..... 27
5.0 Introduction ..... 27
5.1 The Architecture and system components ..... 27
5.1.1 Three-tier Architecture ..... 27
5.2.1.1 System components ..... 27
5.3 System Testing ..... 32
5.3.1 Functional Testing ..... 32
5.3.2 Compatibility Testing ..... 33
5.3.3 Web Browser Testing ..... 33
5.3.4 Usability Testing ..... 33

5.4 Chapter Summary ..... 36
CHAPTER SIX. ..... 37
DISCUSSION, ACHIEVEMENTS AND FUTUREWORKS, ..... 37
LIMITATIONS, RECOMMENDATIONS AND CONCLUSIONS ..... 37
6.0 Introduction ..... 37
6.1 Discussion ..... 37
6.2 Achievements ..... 38
6.3 Limitations ..... 38
6.4 Recommendations ..... 38
6.5 Future works ..... 39
REFERENCES ..... 41
APPENDICES ..... 45
APPENDIX A: Questionnaire ..... 45
APPENDIX B: INTERVIEW GUIDE ..... 47

## List of abbreviations

| | |
|---|---|
| **$CO_2$** | Carbon-dioxide |
| **CSS** | Cascading Style Sheets |
| **DFDs** | Data Flow Diagrams |
| **ERDs** | Entity Relationship Diagrams |
| **GHG** | Greenhouse Gas |
| **HTML** | Hyper Text Markup Language |
| **IOT** | Internet of Things |
| **MSP** | Megenagna Smart Parking |
| **MySQL** | My Structured Query Language |
| **OBU** | On-Board Unit |
| **PGIS** | Parking Guidance Information Systems |
| **PHP** | Hypertext Preprocessor |
| **PSU** | Parking Side Unit |
| **RFID** | Radio Frequency Identification |
| **RSU** | Road Side Unit |
| **RSUs** | Roadside Units |
| **SPSS** | Statistical Package for the Social Sciences |
| **UML** | Unified Modeling Language |
| **V2R** | vehicle-to-roadside |
| **V2V** | vehicle-to-vehicle |
| **VANET** | Vehicular ad hoc network |

**List of Tables**

Table 1: Comparing the existing systems to our proposed system. ..... 9
Table 2: shows the gender distribution ..... 14
Table 3: Ease with which drivers find parking space in Kampala city ..... 15
Table 4: The time spent by drivers while trying to locate parking space in Kampala city ..... 16
Table 5: Recommendations of the Parking Management System as per the survey ..... 16
Table 6: Attributes in Bookings table ..... 24
Table 7:Attributes in the parking spaces table ..... 24
Table 8:Attributes in the park_administrator table ..... 25
Table 9:Attributes in the roles table ..... 25
Table 10:Attributes in the users table ..... 25
Table 11:Attributes in the vehicles table ..... 26
Table 12: shows the results of the test identifier ..... 32
Table 13: shows the results of test identifier two whose main assessment was to edit users and user profiles. ..... 32
Table 14: shows the ability to modify details on the parking system by the administrator ..... 33
Table 15: shows testing done on available and commonly used web browsers. ..... 33

## List of Figures

Figure 1:shows the gender distribution of participants ..... 15
Figure 2: shows the ease with which drivers find parking space in Kampala city ..... 15
Figure 3: shows recommendations of the Parking Management System as per the survey ..... 16
Figure 4: shows the system architecture ..... 19
Figure 5: Showing the Context diagram (Level zero) ..... 20
Figure 6: shows data flow diagram level one ..... 21
Figure 7: Showing the ERD shows relationships between entities ..... 23
Figure 8: Showing the Login page ..... 28
Figure 9: Showing booking page ..... 29
Figure 10: Showing the driver Adding Vehicle details Page ..... 29
Figure 11: Showing the Park Administrator's Page: ..... 30
Figure 12: Showing the Add Parking Spaces Page ..... 31
Figure 13: The Super Administrator dashboard ..... 31
Figure 14: shows a summary of the results of user-friendliness. ..... 34
Figure 15: shows the functionality of the system ..... 35
Figure 16: Showing the Aesthetics of the system ..... 35
Figure 17: Shows the Acceptability of the system ..... 36

## Abstract

Parking Management System is a parking strategy that combines technology and human innovation in an effort to use as few resources as possible, such as fuel, time and space, to achieve faster, easier and denser parking of vehicles. In Kampala Capital City, drivers find it hard to locate available and secure parking space. The main objective of this study was to develop a Parking Management System which would provide adequate information about available and secure parking space for motorists in Kampala Capital City. A Parking Management System is a system which allows real-time data to be obtained about parking availability, both outside and inside, and regarding traffic and road conditions.

This report is a detailed compilation of all the activities we engaged in while developing the Parking Management System. In this study, we carried out interviews and administered questionnaires about smart parking, we used programming languages like PHP, MySQL, CSS and JavaScript to develop the Parking Management System as well as tools like Visual Studio Code for coding and SPSS to carryout data analysis. The system was developed using agile methods that involved iterative methods of development and testing.

Results show that more than 68% of the people contacted had never heard of a Parking Management System in their area and 84% have been in circumstances where they were late for something because they could not find a parking spot, 84% recommended the development of a Parking Management System and 94% say it would be effective. The Parking Management System is able to show availability of parking spaces in real time and the system is able to generate a unique code for a motorist when he or she books parking space. This code is presented to the Park Administrator during time of payment. Majority of the respondents recommended the Parking Management System and also believed it would be effective.

The Parking Management System was developed mainly for motorists around Kampala Capital City in Uganda, we recommend the Kampala City Council to adopt the developed system to manage street parking, plan to automate street parking in order to reduce on the amount of money lost to parking fees defaulters and improve space utilization, recommend traffic routes, and track down space utilization in real-time to overcome traffic congestion, accidents and pollution.

# CHAPTER ONE

# INTRODUCTION

## 1.0 Introduction

Information systems have been deployed to support business functions. An information system is a set of integrated devices that input, output, process, and store data and information (Prasad, 2021). This study focuses on Parking Management Systems which are a specific category of information systems. A Parking Management System is a system which allows real-time data to be obtained about parking availability (Burbano , 2021). The idea of developing a Parking Management System makes parking easier, faster, with less of a drain on resources which are slowly disappearing. The aim of the Parking Management System proposed in this paper is to assist drivers in alleviating several issues linked to parking (Melnyk , 2019).

## 1.1 Background to the study

When drivers or motorists are searching for parking space, they create congestion, accidents and pollution. Drivers park along the road which brings about insecurity of their vehicles and some drivers do not pay parking fees which is a challenge to the Park Administrators. Parking Management System services are able to significantly ease these problems by guiding a driver directly to a parking space (Editors, 2019). It is through this background that this study seeks to develop a Parking Management System for Kampala Capital City that will help direct drivers to the free parking bays, thus reducing the time they take looking for parking with a long-term goal of improving security, payments, mobility, air quality and services for citizens. In addition, an important goal of the system is to reduce the traffic searching for parking hence reduce energy consumption and carbon emissions (Hongwei Wang, 2011).

Many municipalities around the world are venturing into smart parking. For example, in India, the state government has planned an on-street paid Parking Management System for the entire Bengaluru replicating the pilot system that at present is implemented on 10 roads in the city, essentially banning free and haphazard parking (Bureau, 2020). In addition, China Mobile has implemented two separate NB-IoT Parking Management Systems. Multiplex Uganda Limited, the Company which was contracted by Kampala City Council, to manage street parking, plans to automate street parking in order to reduce on the amount of money lost to parking fees defaulters and improve space utilization, recommend traffic routes, and track down space utilization in real-time (Ntegyereize, 2007).

## 1.2 Statement of the Problem.

Looking for a vacant parking lot in a busy city like Kampala, at a peak hour is a nightmare to drivers. They have to drive around looking for a free parking spot, something that is believed to increase traffic congestion. (Sewagudde, 2016). The driving around not only frustrates drivers but also increases the average consumption of gas and hence the air pollution that affects the environment. It is also believed that, as a driver's attention is partly on looking for a free spot in a busy city, the likelihood of causing an accident is higher. Another challenge is associated with paying for the parking most of the time, the machines from which to get the payment ticket are located some distance from the car, and this becomes a challenge to the drivers (Sewagudde, 2016).

The Parking Management System will be able to direct drivers to the free parking bays, thus reducing the time they take looking for parking, and therefore reducing the carbon emissions as well. Reducing the carbon emissions means reducing the amount of fuel used by vehicles thus resulting into monetary savings. Therefore, there is need to develop a Parking Management System that reduces on the above challenges.

## 1.3 Objectives of the Study

### 1.3.1 General Objective

To develop a Parking Management System that helps provide adequate information about available and secure parking space for motorists in Kampala Capital City.

### 1.3.2 Specific Objectives

The specific objectives of the study were:

1. To examine the adequacy of parking spaces and the traffic challenges faced by drivers in Kampala Capital City in order to derive requirements for the Parking Management System.
2. To design a Parking Management System.
3. To implement the Parking Management System.
4. To test and validate the Parking Management System.

## 1.4 Scope of the study

### 1.4.1 Context scope;

The study concentrated on the implementation of a Parking Management System that helps provide adequate information about available and secure parking space for motorists in Kampala City. The system helps users to book their parking slots online, by monitoring the parking spaces on a real-time basis for their availability.

### 1.4.2 Geographical Scope;

The study was conducted at Wandegeya market basement parking yard that is located in Wandegeya, Kampala, Uganda.

### 1.4.3 Time Scope;

The study considered a study period of five months for data collection and analysis, requirements collection, design, implementation, testing, and validation of the Parking Management System.

## 1.5 Research Significance

- This study's findings were to help ease access to available and secure parking space in Kampala City since the system is intended to make communication easy.
- Traffic congestion was to be reduced since the system was designed to enable the driver know exactly where they need to park.
- In terms of environment conservation, the level of pollution was to be reduced by decreasing vehicle emission in the air (LIPMANPh, 2007)
- The system was meant to ensure safety of vehicles.
- For the car park operators, the information gathered via the implementation of the Parking Management System would be exploited to predict future parking patterns.

# CHAPTER TWO:

# LITERATURE REVIEW

## 2.0 Introduction

In today's world, parking lots have become redundant and need lots of man-power to handle and maintain them. These parking lots are not user friendly and do not provide data regarding availability of free spaces. Many researchers have contributed to this issue and formalized with various methods to better optimize the parking lot to serve the needs of motorists (Shaikh,2015).

The Parking Management Systems were initially implemented in Europe, USA, and Japan but later on as other countries started developing, these Parking Management Systems are being installed in these countries as well. With further advancement in the Parking Management Systems, the problem of finding vacant spaces and all the hustle is going to deprive (Sahni, 2016).

In cities with high vehicle congestion, finding an available parking spot can be a waste of time and resources. In areas such as Los Angeles, vehicles looking for parking spots produced over730 tons of carbon dioxide and burnt 47,000 gallons of gas. The inconvenience created by the need of finding a parking slot causes some drivers to park in unauthorized zones, plus increasing vehicle congestion and carbon emissions. If drivers had an access to a database containing information about parking spots in real-time, there would be more opportunities for selecting an appropriate route to a desired parking slot (Barriga, 2019).

## 2.1 Categories of Parking Management Systems.

### 2.1.1 Parking Guidance Information Systems (PGIS).

PGIS is a parking technology that guides and provides information about the availability of parking spaces located in major cities. Vehicle detectors are installed at entrances, exits and/or individual parking space to collect and calculate the number of occupied and available spaces. Information, ranged from "empty" or "full" lot, to the number of availabilities, or to the exact location of available spaces, are displayed at various spots so that drivers can make better decision.

### 2.1.2 Transit-Based Information Systems

The Transit-Based Information System specifically provides parking space information and public transportation schedules in Park and Ride facilities. The system's main purpose is to encourage commuters to park their vehicles and use buses or trains for their transit. This in turn will reduce traffic congestion, pollution, and fuel consumption. Vehicle detectors are employed similar to PGI. Messages are then displayed on variable message signs along highways leading to park and ride lots.

### 2.1.3 Smart Payment Systems.

Smart payment systems employ advanced technologies to implement payment systems in place of conventional parking meters. The systems allow fast and convenience payment, improving collection rates for fine, and reducing the rate of assaults on parking officials. Technologies employed include contact methods (debit, credit cards), contactless methods (smart cards, RFID cards), and mobile communication devices (mobile phone services). The payment for specific parking space will be used to calculate occupied parking spaces.

### 2.1.4 E-parking

E-parking employs advanced technologies to combine and streamline parking reservation and payment systems. Using this system, a driver could inquire about the availability, reserve for a parking space at a given destination, and pay when leaving. The system is accessed via cell phone, PDA and/or internet. Still conventional detectors are needed to detect approaching vehicles. However, the system must be able to identify customers and/or their vehicles making reservation and allows them the access to reserved space. The identification process at the parking lot may employ confirmation code access that the customer receives on cell phone.

### 2.1.5 Automated Parking

Automatic parking is a computer-controlled mechanical system that allows customers to drive their cars into one of several bays, lock their cars, and let the computer do the rest. To pick up their cars, the customers just punch in their codes and passwords, then the machine will retrieve their cars and ready to leave in just a few minutes. Automatic parking allows for an efficient use of expensive and limited parking spaces. A variety of vehicle detectors are installed in this system (Chinrungrueng, 2007).

## 2.2 City Navigation and smart parking.

Although some online navigation systems, e.g., Google Maps and portable navigators, can help drivers to locate parking garages in their desirable destinations, drivers may still find it hard to get vacant parking space when they arrive, especially in peak hours. Vehicular ad hoc network (VANET) is a particular type of mobile ad hoc network (MANET) where the mobile nodes are vehicles travelling across roads. Each vehicle is equipped with an onboard unit (OBU) to communicate with the nearby vehicles through vehicle-to-vehicle (V2V) communications, and with the roadside units (RSUs) via vehicle-to-roadside (V2R) communications. It is a critical supplement for conventional navigation systems to resist drivers to find vacant parking spots through vehicular communications. In Parking Management System navigation, the OBU on a vehicle is able to send a parking query to the nearby RSUs for parking space discovery in its destination and reach the accessible parking spot following the up-to-date parking information acquired from the RSUs. It has the advantage that drivers can conveniently use OBUs to access real-time parking navigation services and reach accessible parking spaces within short delay and low fuel cost (Ni, 2018).

Security and privacy are preliminary concerns for drivers in VANETs, since the infrastructure may be confronted with various cyber-attacks, including impersonation attacks, forgery attacks and global eavesdropping attacks. To prevent the impersonation attack, it is necessary to authenticate

drivers before accessing services, such that a fabricated or unlicensed driver can be detected if he pretends to be a legal driver to access free services. All messages exchanged between OBUs and RSUs should be signed to prevent the pollution and modification of attackers (Ni, 2018).

Some navigation systems, such as Apple Maps, Google Maps and Baidu Maps, collect drivers' locations and destinations, resulting in the leakage of their trajectory and the exposure of their personal habits. In VANET-based parking navigation, OBUs frequently interact with RSUs to deliver personal queries, including current locations and destinations, to acquire real-time parking information. Thus, it is possible for curious entities to learn the driving patterns of vehicles and determine the drivers' locations at a future time, and even identify personal information about drivers. Further, the exposure of vehicles' locations may bring huge convenience to car thieves, as they might trace the vehicles several days before taking action and prefer to steal cars in quiet places. Thereby, location privacy is critical for the wide acceptance of Parking Management System navigation services to the public. One common method of location privacy preservation is to achieve the anonymity of drivers. Once the drivers are anonymous, no attacker is able to identify the drivers from navigation queries or link several navigation results to reconstruct the trajectory of a specific driver (Ni, 2018).

### 2.3 Internet of Things (IoT) and smart parking.

IoT is based on the smart sensors and the middleware for connecting between clients and terminal devices. It can provide the public with interesting information about various things deployed in our surrounding environment. In particular, the Parking Management System is one of the main projects for IoT (Lee, 2016). The parking lot that uses IoT in its system will allow drivers to see the parking space in real-time via an application or a website. This Parking Management System allows a driver to know if there is space to park the vehicle before getting to the parking lot. The internet of things has reduced the average duration spent looking for parking space by 43%. Another direct benefit of this is the decrease in emitted carbon by these vehicles, as they spend less time moving around. While the IoT has many benefits on the environment, it also increases parking efficiency, with more parking lots getting filled (Phil, 2021).

### 2.4 Challenges in transportation and parking.

On street parking is causing a lot of negative impacts on traffic flow for example it causes traffic congestion, accidents, misuse of pedestrian facilities, restricted movement and others like crippling of businesses since the illegally parked cars block goods on display (Ogenrwot, 2022). In addition, the increased number of vehicles has increased the demand for new parking structures and the rapid increase in urbanization has increased congestion. Kampala Capital City also has confusing parking policies which have been a challenge in transportation and parking.

### 2.5 Advantages of a Parking Management System.

A Parking Management System has a number of advantages some of which include;

**Environment.**

One goal of the Parking Management System is to reduce the time taken and the hustle factor of locating available parking space. Being able to accurately direct a driver to an available space has many environmental benefits; it reduces $CO_2$ emissions, noise and other pollutants.

**Convenience**. It can be frustrating, especially at peak times, driving around town looking for available spaces. The convenience factor is of particular importance for spaces reserved for disabled drivers, public service or emergency vehicles.

**Reduced Traffic.** When a driver knows exactly where they need to go; it reduces idling and unnecessary driving and therefore optimizes traffic flows in built-up areas.

**Reduced costs and overhead**. Traditional on-street parking may have required investments in parking meters or parking inspectors. Parking Management System technology can reduce these overheads by automated processes and providing targeted enforcement activity.

**Safety.** Decreased searching for spaces can reduce accidents by ensuring drivers maintain their attention rather than browsing for spaces.

**Integrated Payments.** Parking Management Systems can include real-time and electronic payment methods via an app or a browser. This makes the parking experience far easier (Hughes, 2019).

### 2.6 Challenges of implementing the Parking Management System.

In Internet of Things, all devices require Internet and it is a major challenge to provide Internet connection at every work place.

Due to lack of interoperability among all Internet of things systems, design of a perfect system with less cost becomes a difficult job.

Knowledge of various domains of engineering is required for implementation of smart parking. The power consumption of all the IoT devices installed leads to an increase in maintenance cost.
The theft of installed equipment is also a major concern (Vakula, 2017).

### 2.7 Requirements of the Parking Management System

The Parking Management System has both functional and non-functional requirements. Functional requirements are capabilities that the product must do to satisfy specific user needs (Kumar, 2006). The Parking Management System is designed with the following functional requirements:

- The admin is able to update data of existing parking areas.
- The admin is able to view the information of all registered parking areas.
- The system allows the user to register his or her information into the system and add his or her vehicle details into the account.

- The system allows a user to see the number of available spots in real time.
- The system allows a user to reserve a parking spot and cancel his or her reservation if a user does not arrive at the reserved spot within 15 minutes after the reservation is made.
- The system is designed to allow a user to reserve only one parking spot at a time.

Non-functional requirements define system attributes such as security, reliability, performance, maintainability, scalability and usability (Kumar, 2006). The Parking Management System has the following non-functional requirements:

- The system doesn't allow booking of parking slots which are occupied.
- The system doesn't allow booking of the same parking slot by multiple users at the same time.
- The user is not allowed to see any data until logged in.
- The user is notified upon unsuccessful booking of a parking slot (HunYahiko, 2020).

## 2.8 Existing Parking Management Systems.

### 2.8.1 Megenagna Parking Management System(MSP)

Megenagna is fully operating since June 2017 in Ethiopia in the city of Addis Ababa, and is considered as a continental first, and is the first Parking Management System facility constructed within this new city's mobility management plan. It connects six road junctures convening from different parts of the capital, and its aim is to alleviate the pressure on the surrounding road network. Megenagna was selected as the pilot location, as it is a central hub for many economic activities, such as markets, mall, shops and hotels, and therefore very prone to traffic and pedestrian congestion
(Shaban, 2017).

This Parking Management System has many benefits. It contributes to GHG emissions reduction and air quality improvement by alleviating traffic congestion, through reducing time drivers need to find a free parking space. Furthermore, it also helped solve parking and traffic flow issues in the area by providing more parking slots, accompanied by policies banning street-parking in highly-congestible areas. Moreover, it presented a job opportunity for 20 people, becoming the leading example for other Parking Management Systems being built across the city. The main challenge of Addis Ababa's Parking Management System revolution is that some of the sites allocated in the city's master plan are situated in low traffic and suburb areas, with low parking demand, or in central areas where it is very difficult to undertake parking construction (Shaban, 2017).

### 2.8.2 ValetEZ

ValetEZ is a Parking Management System and mobility solutions firm in India that designs solutions to manage parking spaces and eliminate the pain that vehicle owners face every day when parking in their city. Its parking platform can be deployed on parking lots of any size and provide a real time view to parking lot owners and users, bringing a high level of efficiency and reliability to the overall experience. With its platform, users, parking space owners, and cities can benefit from; real time view of parking infrastructure, transparency and security in parking charges and

service delivery, flexibility in managing and accessing parking spaces, data analytics on parking utilization. These qualities are enough to make it one of the top Parking Management System companies in India (Dubey, 2021).

### 2.8.3 VersionX

VersionX has numerous products but its Parking Management System solutions have made its name in one of the top Parking Management Systems companies in India. VersionX's Parking Management System is a unique parking management solution. Suitable for all types of parking areas, it digitizes end-to end parking processes including multi-tenant, multi-level parking. It is integrated with visitor management system, FASTag, and access control hardware. Extremely useful for shared parking spaces, the solution automates day-to-day processes such as auto-identifying appropriate parking slots, be it reserved or pay-and-park, auto-generating parking tickets, levying penalties, and many more
(Dubey, 2021).

*Table 1: Comparing the existing systems to our proposed system.*

| **Features of the related existing systems** | Megenagna Parking Management System(MSP) | ValetEZ | VersionX | Parking Management System |
|---|---|---|---|---|
| The system improves the parking performance like saving time , traffic and enhances the safety of vehicles in the parking | Yes | Yes | Yes | Yes |
| The parking system is easier and flexible to the drivers fetching the above said status of the parking slot on the web or Internet view and book the slot from anywhere. | Yes | Yes | Yes | Yes |
| Theft Management | Yes | Yes | Yes | Yes |
| The system shows real time information | Yes | Yes | Yes | Yes |
| The parking slots state is saved in database and the driver can know the parking lot status | Yes | Yes | Yes | Yes |

## 2.9 Chapter Summary.

The services provided by a Parking Management System have become the essence of building smart cities. With the advancements in technologies and rising number of vehicles on road, the

Parking Management System has become a necessity for us. The proposed Parking Management System has several advantages, including detecting parking spaces using the Internet of Things and calculating the time of entry and exit, and calculating the expected cost. Although, there are certain disadvantages in the implementation of this system as described earlier, the advantages far outweigh its disadvantages.

# CHAPTER THREE

# METHODOLOGY

## 3.0 Introduction

This chapter comprises a detailed description of methods, techniques, approaches, and technologies that were used to achieve the objectives of the study. Section 3.1 presents survey research methods, section 3.2 presents the data collection techniques and approaches together with the technologies, section 3.3 presents the study population, section 3.4 presents the sampling method and sample size, section 3.5 presents the data collection instruments, section 3.6 presents the system design, sections 3.7 and 3.8 present system implementation and testing.

## 3.1 Survey research method.

Survey research refers to the collection of information from a sample of individuals through their responses to questions (Check J., 2012). We decided to adopt this method because it is a fast way to get the results that we need, it allows for data to come from multiple sources at once and it offers a straightforward analysis and visualization of the data.

Both primary and secondary data was collected. Primary data was collected through a structured questionnaire and interviews. Self-administered questionnaires were randomly administered to all respondents in the mentioned case study. Interviews were conducted to purposively selected members who had the knowledge and experience in the case study chosen. These interviews were conducted at Wandegeya Market Basement Parking.

## 3.2 Data Collection

The primary data in this research was gathered through semi-structured interviews. During the semi-structured interview, the interviewer may prepare a list of questions but won't necessarily ask them all, or touch on them in any particular order (Doyle, 2022). The common way of collecting qualitative data was by conducting interviews because it enabled us to acquire loads of insightful data in a very short time. A conversational interview method was used because it leads to more correct question interpretations.

We also administered written questionnaires to collect primary data from respondents. The questionnaire consisted of 128 respondents. A questionnaire is a list of questions or items used to gather data from respondents about their attitudes, experiences, or opinions (Bhandari, 2021). The questionnaire had closed-ended questions divided into sections that represent the different variables of the study.

## 3.3 Study population

The target population contains a group of individuals that the intervention intends to conduct research in and draw conclusions from (Barnsbee, 2018) because they will all have significant traits in common. Thus, the target population were the parking attendants and motorists who park their vehicles at Wandegeya market basement parking yard.

### 3.4 Sampling method and sample size.

Simple random sampling was used for the study. Every motorist had an equal chance of being selected from the sample. A total of 20 people comprising of parking attendants and motorists who park their vehicles at Wandegeya basement parking yard were randomly selected. We used a mathematical formula of Tora Yamane (Yamane, 1973) to determine the sample size as illustrated below.

N÷ (1+N € 2)

Where N is the total population size and "E" is the acceptable sampling error. A total population of 20 respondents used a confidence level of 95% or probability of 0.05 thus the sample size was

20÷ (1+20(0.05)2) = 6 respondents

Therefore, out of 20, only 6 respondents were sampled.

### 3.5 Data collection instruments.

Data collection instruments are tools used by researchers to collect data in the research process. Questionnaire, Pens, notebooks and an interview guide were used as our tools for data collection.

#### 3.5.1 Data Analysis

We used the Statistical Package for the Social Sciences (SPSS) software to analyze the data that we obtained. SPSS is a software program used by researchers in various disciplines for quantitative analysis of complex data. Working on data is a complex and time-consuming process, but this software can easily handle and operate information with the help of some techniques. The data collected from an online survey can be exported to SPSS for detailed analysis. SPSS is designed in such a way that it can handle a large set of variable data formats (Noels, 2018).

#### 3.5.2 System Analysis

The collected data and information was systematically analyzed so that requirements needed to develop the Parking Management System could be identified. System analysis is the way towards noticing the system for investigating and improvement purposes (Kumari, 2020). In other words, system analysis involved the detailed look at the current system and what the system was required to do. The basic tool of system analysis was the ability to prove, enquire, observe more and reconcile all what happened in any situation. The information that was gathered was analyzed to identify the components of the system, creating a structure from which the essential requirements were most efficiently met. System analysis always leads to system design which is the development of new system that meets the future requirements (Groves & Little, 2012).

### 3.6 System Design.

The design was at three levels: Conceptual, logical and physical. This was done using a Data Flow Diagram (DFD) for designing the process model of the system, and an Entity Relationship Diagram (ERD) for designing the data model of the system. The model of the system was designed based on the functional and non-functional requirements, which describes the parameters and the data that was incorporated into the system. An ERD was used to identify the data that is captured, stored

and retrieved in order to support the activities performed in discussion processes. Entity Relationship Diagrams are relatively simple, user friendly and provide a unified view of data, which is independent of the data model.

### 3.7 System implementation

During system implementation, we used programming languages like JavaScript, MySQL, PHP and CSS as well as tools like Visual Studio Code for coding.

### 3.8 System testing

Functional tests were carried out based on use cases to determine the success or failure of the system implementation and design, compatibility testing was done to ensure that the web applications were compatible with the available platforms and end users of the application were involved in usability testing.

### 3.9 Chapter summary

Results show that more than 68% of the people contacted had never heard of a Parking Management System in their area and 84% have been in circumstances where they were late for something because they could not find a parking spot, 84% recommended the development of a Parking Management System and 94% say it would be effective. 80% of the potential users indicated that the application was easy to use and learn. They were able to use the system without any prior training. 12% of the respondents assessed the application to be fair to use, meaning it was neither easy nor difficult to learn and use. Majority of the respondents recommended the Parking Management System and also believed it would be effective.

# CHAPTER FOUR

# SYSTEM STUDY, ANALYSIS AND DESIGN

## 4.0 Introduction

This chapter focuses on the results of the study made about the performance of the current system and the identified requirements. It also focuses on the analysis and design of the Parking Management Systems.

## 4.1 System Analysis

The primary data was collected by administering questionnaires to different parties involved mainly the drivers around Kampala Capital City as an online survey. The following are the results of the data analysis.

### 4.1.1 Response Rate

Out of a sample of 128 individuals contacted by our group for the research, 114 provided full data, a response rate of 89.0%, while the rest provided partial data. 45.3% were female while 54.6% were male.

### 4.1.2 Findings for the interviews

We were able to interview a group of 19 people, 12 were motorists and the 7 were park attendants around Wandegeya Market, unfortunately all of them were male. All of these 19 people were unaware of a Parking Management System, 17 recommended the implementation of a Parking Management System. The park attendants claimed they were facing a big challenge of payments and that this new system would solve that problem. The motorists recommended this new system because of the inconvenience they face as they try to locate parking space.

## 4.2 Findings for questionnaires and surveys

A total number of 128 people participated in our survey. Based on questions in the questionnaire, below are graphical representations of the different questions answered by our respondents.

### 4.2.1 Gender distribution

A total of 70 males and 58 females participated in the 128 Parking Management System survey.

*Table 2: shows the gender distribution*

| Gender | Numbers |
|---|---|
| Males | 70 |
| Females | 58 |
| Total | 128 |

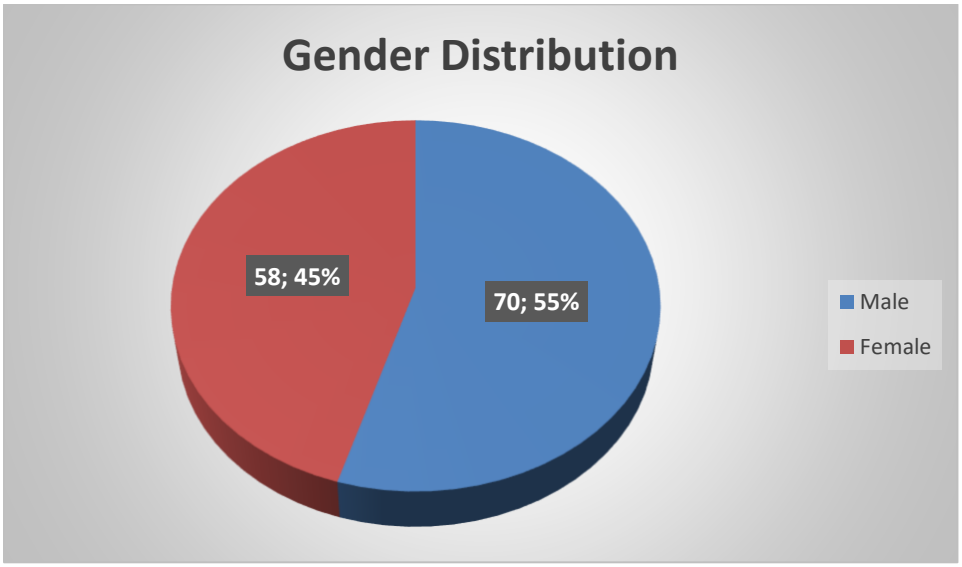



*Figure 1:shows the gender distribution of participants*

*Table 3:* Ease with which drivers find parking space in Kampala city

| **Ratings** | **Number of drivers** |
|---|---|
| Easy | 2 |
| Neutral | 15 |
| Hard | 53 |
| Extremely hard | 53 |
| **Total** | 123 |

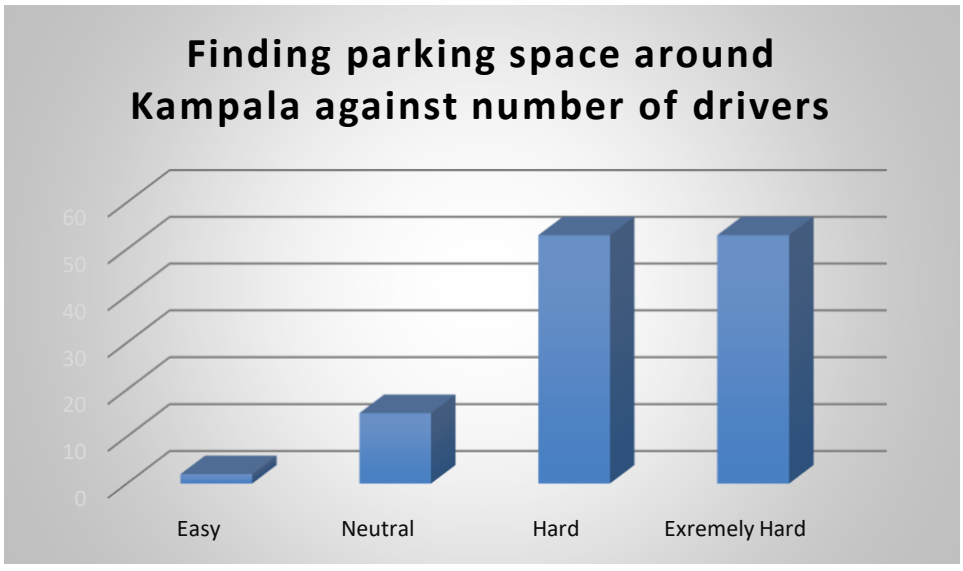



*Figure 2: shows the ease with which drivers find parking space in Kampala city*

*Table 4:* The time spent by drivers while trying to locate parking space in Kampala city

| **Time intervals (minutes)** | **Number of drivers** |
|---|---|
| 0-4 | 12 |
| 5-14 | 24 |
| 15-19 | 44 |
| 20 and above | 35 |
| **Total** | 115 |

*Table 5:* Recommendations of the Parking Management System as per the survey

| **Recommendations** | **Number of suggestions** |
|---|---|
| Strongly recommend | 108 |
| Not sure | 14 |
| Won't recommend | 6 |
| **Total** | 128 |


*Figure 3: shows recommendations of the Parking Management System as per the survey*

### 4.3 Requirements Analysis

The requirements of the system are categorized into user, functional, nonfunctional, software, and hardware requirements.

### 4.3.1 User requirements

We interviewed the intended users of the system and collected first-hand information about what the expected features of the system would be according to recruitment needs to be addressed.

- An application that is easy to learn and use
- An application that is fast, flexible, and convenient.
- An application that restricts access to information to only authorized personnel
- An application that provides attractive interfaces with easy navigation throughout it.

### 4.3.2 Functional requirements

The functional requirements describe what the system is expected to perform or do. They define the intended behavior of the system as it relates to the functionality of the system and they include;

- **Login**; both the administrators and system users are required to login
- **Add drivers;** the park administrators can add drivers to the system or the drivers can perform self-registration.
- **Add Park administrators and Parking Spaces;** The Super administrator adds Park administrators and parking spaces in the system.
- **Delete driver;** The Park administrator deletes drivers.
- **Generate booking code;** Booking code is a code that is generated automatically after a driver books.
- **Search for parking space;** the driver can be able to enter his desired destination and choose a convenient parking area with available parking slots.
- **Payment;** The payments are made in cash on arrival at the parking area.
- **Editing user profiles;** Users are able to make changes to their profiles.
- **Google account login;** Users are able to login using their google accounts.
- **Recovering passwords;** The system is also able to recover passwords for users.

### 4.3.3 Non-functional requirements.

The non-functional requirements are constraints that should be compulsory to the services provided by the system, these include;

- **Performance:** The system works efficiently on almost all major server software (XAMP, WAMP, LAMP)
- **Usability:** The system does not require high-end knowledge of the English language which makes it easy to use.
- **Integrity:** drivers have a unique booking code and with unique identifiers for each table in the database.
- **Security:** The users secure their information with strong passwords.
- **Reliability and availability**: Many users can login and logout of the system concurrently.
- **Scalability**; the system also can store, retrieve and process large amounts of data.

### 4.3.4 System requirements

The system requires compatibility so that it can run and perform its tasks properly as required by users on the available software requirements.

The following were the requirements that were used for the better running of the system.

**Software requirements.**

- WAMP server
- PHP, HTML, JavaScript, CSS as the programming languages
- Wondershare EdrawMax for the UML, DFDS, ERDS
- Visual Studio Code as our development editor
- Operating systems such as windows

**Hardware components**

- computing devices such as laptops
- processor like intel i3, i5, i7

## 4.4 System Design

According to Fabrycky & Benjamin (2010), system design is the process of defining the elements of a system such as the architecture, modules, and components, the different interfaces of those components, and the data that goes through that system. System design focused on how to accomplish the set objectives of the system. This was achieved using both the process and data design techniques.

We modeled the processes of the system using Data Flow Diagrams (DFDs) and performed data modeling using Entity-Relationship Diagrams (ERDs), Use case diagrams, design of user interfaces, physical design, and hardware and software configurations.

### 4.4.1 Architectural design of the system

This was used to describe the conceptual model that defines the structure, behavior, and views of the system.

**System architecture**

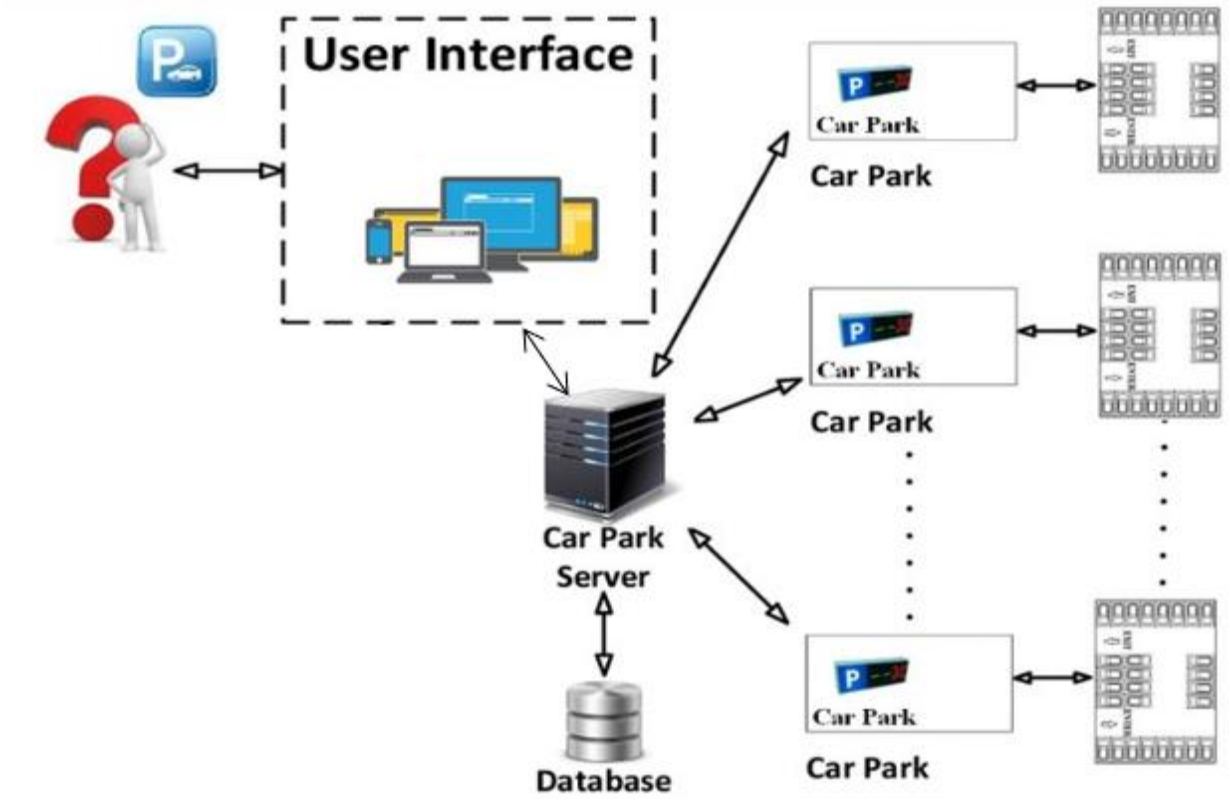


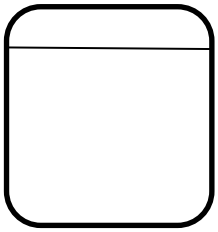

*Figure 4: shows the system architecture*

### 4.4.2 Process Design

The process design should be done carefully with processing productivity (efficiency and effectiveness) as the primary objective. The efficiency with which system resources are used and the effectiveness with which the software is written to achieve this efficiency is one important consideration.

**The symbols used in process modeling are illustrated below;**

**External Entity**



**Process**

**Data Flow**

ID

**Data Store**

**Context diagram (Level zero)**

A context diagram is an overview of the system showing system boundaries, external entities interacting with the system and the major information flows between the entities and the system.

Figure below depicts the system being studied as it relates to other systems and interfaces flowing to and from the external entities.

z

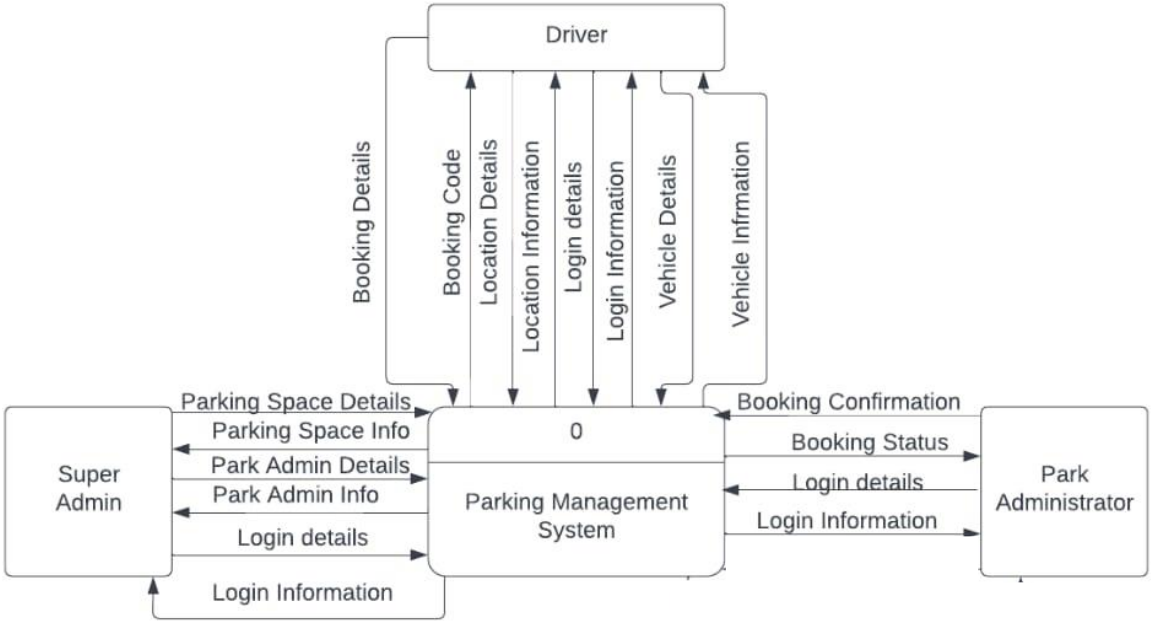



*Figure 5: Showing the Context diagram (Level zero)*

**Data Flow Diagram: Level one**

This data flow diagram shows the interaction between external entities and processes of the system. It also shows what kind of information was to be input and output from the system, data stores, and where data was to come from and go (Burge, 2011).

**External entities of the system include:**

**The park admin**: The system Park administrator's major responsibility is to confirm bookings manage parking space assigned to him by adding, deleting, and changing data.

**The Driver**: Books parking space.

**The Super Admin**: The system administrator's major responsibility is to manage users, adds parking spaces and adds Park administrators in the system.

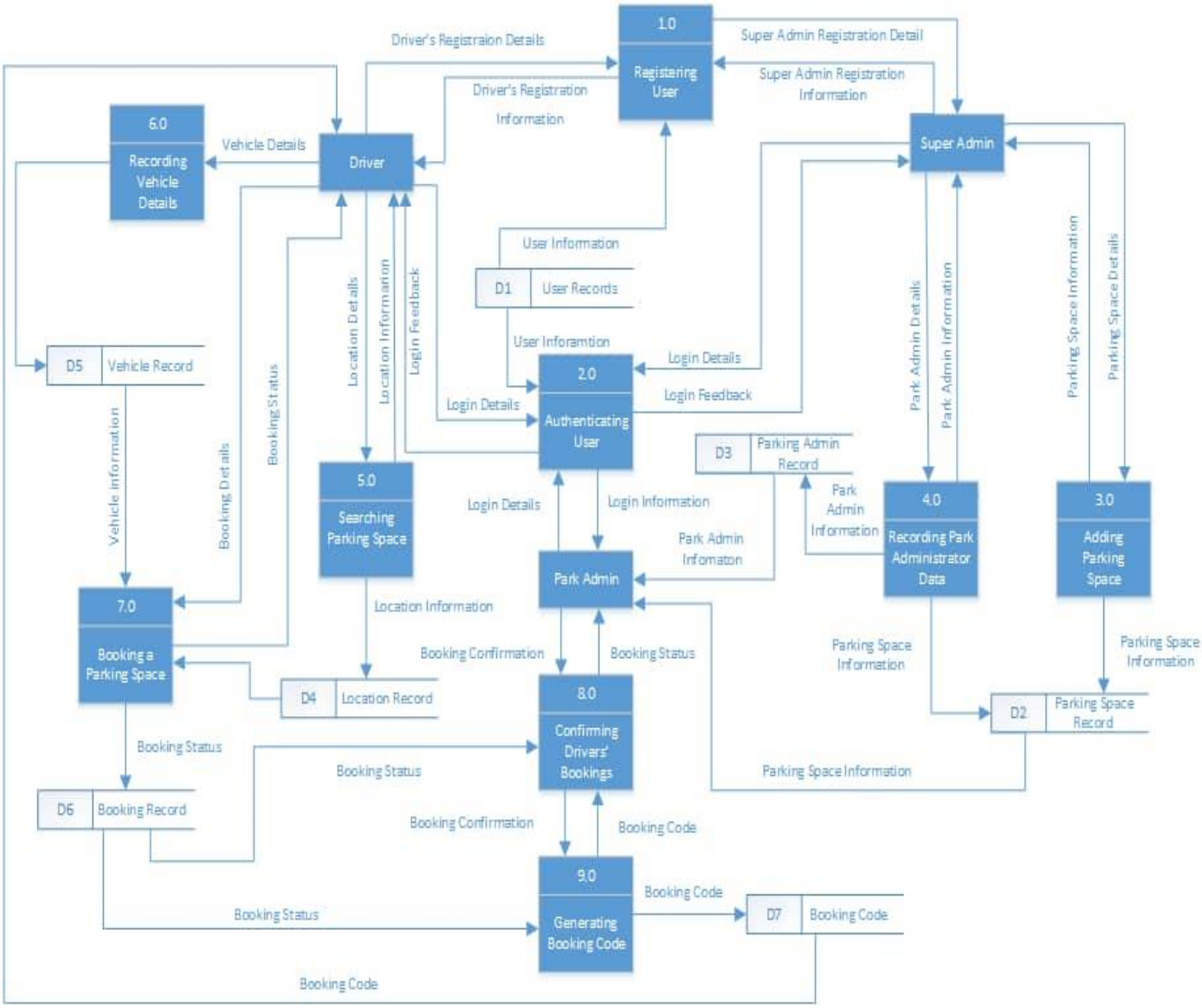



*Figure 6:* shows data flow diagram level one

### 4.4.3 Data Modelling

A data model is a formal way of representing the data that are used and created by a system. It shows the people, places, and things in which data is captured and the relationships among them.

#### 4.4.3.1 Modelling relationships between entities

The illustration below describes the various relationships between the entities together with their respective cardinalities.

- **Relationship between Super administrator and Park administrator.**

The Super administrator adds the Park administrator to the system.

- **Relationship between Super administrator and Parking Spaces.**

The Super administrator registers the Parking space to the system.

- **Relationship between the Park Administrator and Bookings.**

The Park Administrator acknowledges the bookings made by driver in the system.

- **Relationship between Driver and Vehicle details**

The Driver records his Vehicle details in the system.

- **Relationship between Driver and Bookings**

The Driver makes Bookings

**Entity Relationship Diagram.**

We used an ERD to represent the entities and the relationships between them, their occurrence (multiplicities), and attributes.

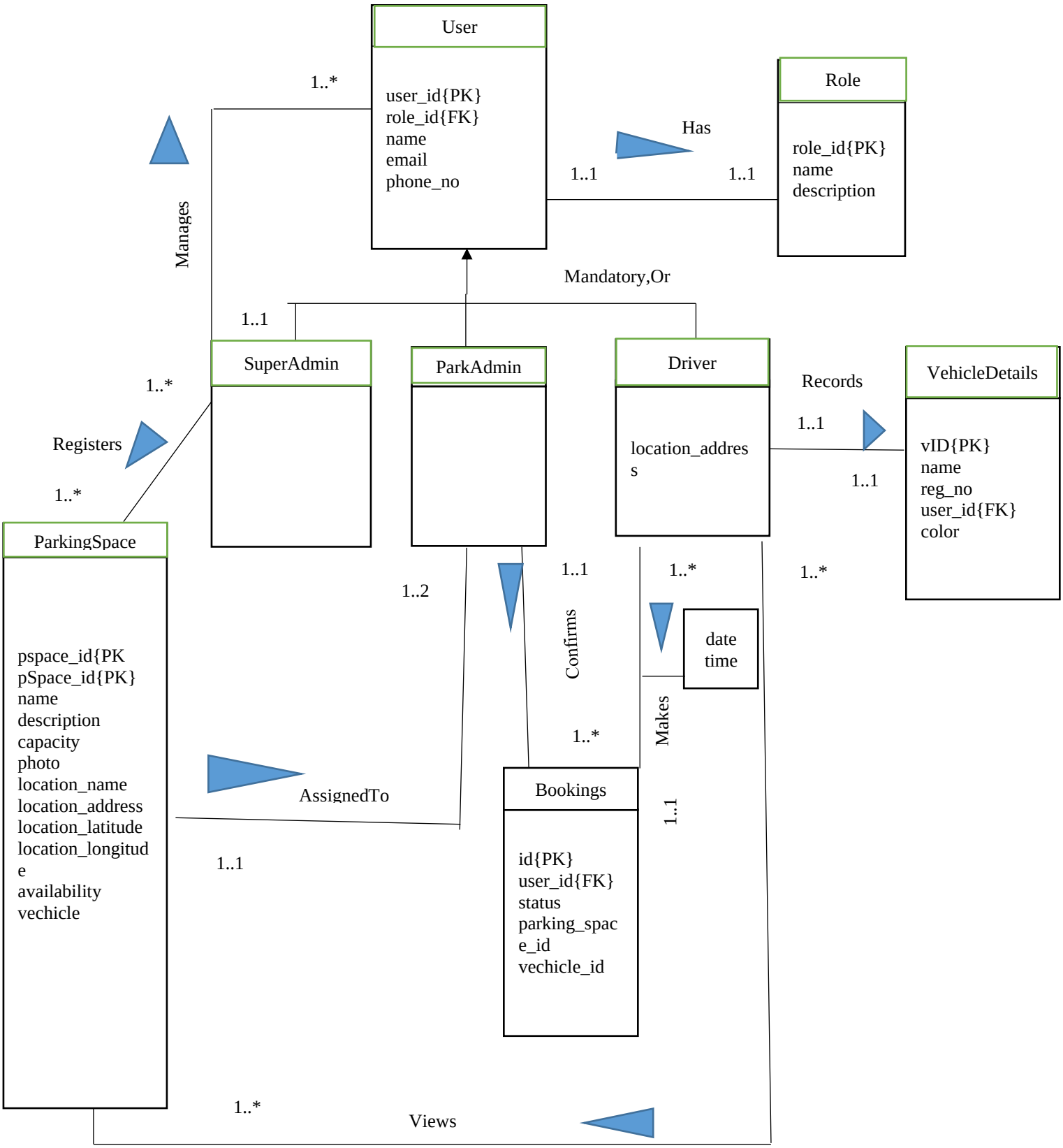



*Figure 7: Showing the ERD shows relationships between entities*

### 4.4.4 Physical Design

This is the final stage where all logical specification of the system is converted into the description in terms of hardware and software (Goodland, 1995). It contains the various tables with their attributes, data type, and constraints.

*Table 6:* Attributes in Bookings table

| Field Name | DataType | Constraint |
|---|---|---|
| booking_id *(Primary key)* | bigint | Not Null |
| user_id{fk} | bigint | Not Null |
| status | varchar(255) | Not Null |
| parking_space_id | bigint | Not Null |
| vehicle_id | bigint | Null |

*Table 7:*Attributes in the parking spaces table

| Field Name | Data Type | Constraint |
|---|---|---|
| space_id *(Primary key)* | bigint | Not Null |
| name | varchar(255) | Not Null |
| description | varchar(255) | *NULL* |
| capacity | bigint | NULL |
| photos | text | Not Null |
| location_name | varchar(255) | *NULL* |
| location_address | varchar(255) | *NULL* |
| location_longitude | varchar(255) | *NULL* |
| location_latitude | varchar(255) | *NULL* |
| availability | varchar(255) | *NULL* |
| provider_id | bigint | *NULL* |

*Table 8:*Attributes in the park_administrator table

| Field Name | Data Type | Constraint |
|---|---|---|
| name | varchar(255) | Not Null |
| phone_no | varchar(255) | *NULL* |
| email | varchar(255) | *NULL* |
| is_verified | bigint | Not Null |

*Table 9:*Attributes in the roles table

| Field Name | Data Type | Constraint |
|---|---|---|
| role_id *(Primary key)* | bigint | Not Null |
| name | varchar(255) | Not Null |
| description | varchar(255) | *NULL* |

*Table 10:*Attributes in the users table

| Field Name | Data Type | Constraint |
|---|---|---|
| user_id *(Primary key)* | bigint | Not Null |
| name | varchar(255) | Not Null |
| email | varchar(255) | Not Null |
| role_id | bigint | Not Null |
| google_id | varchar(255) | *NULL* |
| password | varchar(255) | *NULL* |
| phone_no | varchar(255) | *NULL* |
| nin | varchar(255) | *NULL* |

*Table 11:A*ttributes in the vehicles table

| Field Name | DataType | Constraint |
|---|---|---|
| vehicle_id *(Primary key)* | bigint | Not Null |
| reg_no | varchar(255) | Not Null |
| user_id {FK} | bigint | Not Null |
| name | varchar(256) | *NULL* |
| color | varchar(255) | *NULL* |
| description | varchar(255) | *NULL* |

# CHAPTER FIVE

# SYSTEM IMPLEMENTATION, TESTING, AND VALIDATION

## 5.0 Introduction

This chapter presents the results of implementation, testing and validation of the Parking Management System.

## 5.1 The Architecture and system components

### 5.1.1 Three-tier Architecture

The parking management system has a three-tier architecture which consists of the front-end, the middle-end and the back-end.

The front-end is the presentation layer which is content rendered by the browser and includes the graphical user interfaces from which the System Administrators and Drivers can interact with the system through accessing the Parking Slots. The front-end was implemented using various technologies which make it fully responsive and dynamic. These include Bootstrap, HTML, JavaScript, CSS and PHP, which are all open source and easy to use. The system is fully adaptable to all devices available today, thus, the user can access and use the system using smart mobile phones, tablets, personal computers among others, provided they are connected to the internet.

The middle-end layer was implemented by PHP, an easy-to-use open-source server-side scripting tool. It is the logical layer of the system which creates easy accessibility between the client and the server. Thus, improve interactivity with the users of the system.

The back-end is the database that comprises of data sets and the database management system (DBMS) software that manages and provides access to the data. Information is stored and retrieved from the database. MySQl was used to implement the back-end layer. MySQL is a relational database system that is designed to work with multiple systems. This tool was used to manage information in the database of the system. Therefore, all the data is stored in various tables in the database, for clear purposes.

#### 5.2.1.1 System components

The main system components of administrative users of the Parking Management System are:

**Login page**

This window enables the driver to sign into the system with valid user name and password to start their session after a successful registration. Users for example driver, super administrators and Park administrator must log in using a unique Username and Password to obtain access to the online application system. The user's Username and Password are authenticated for security purposes once they have been issued.

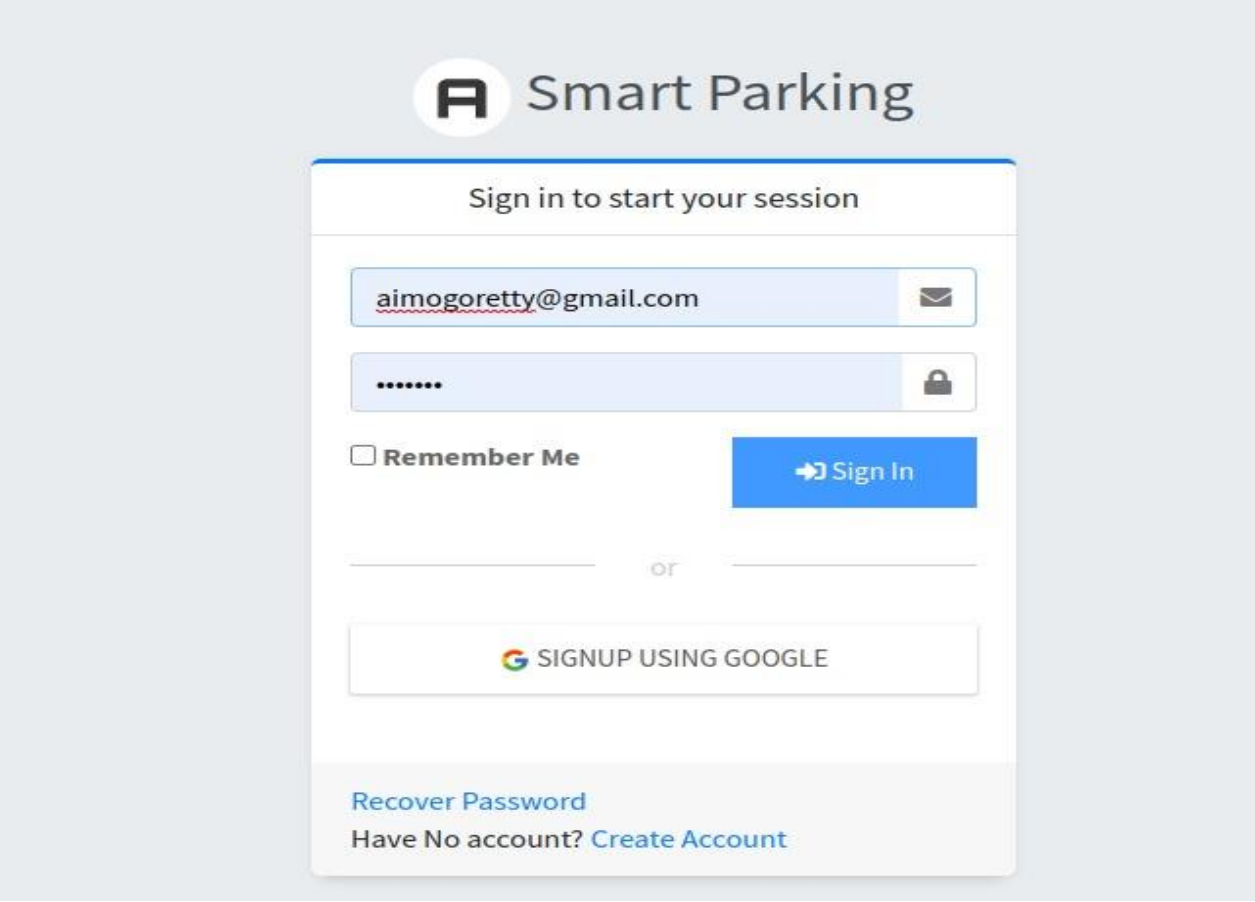



*Figure 8: Showing the Login page*

**Booking page**.

This page enables the driver to search for parking space available around his/her location and then book in Parking Management System

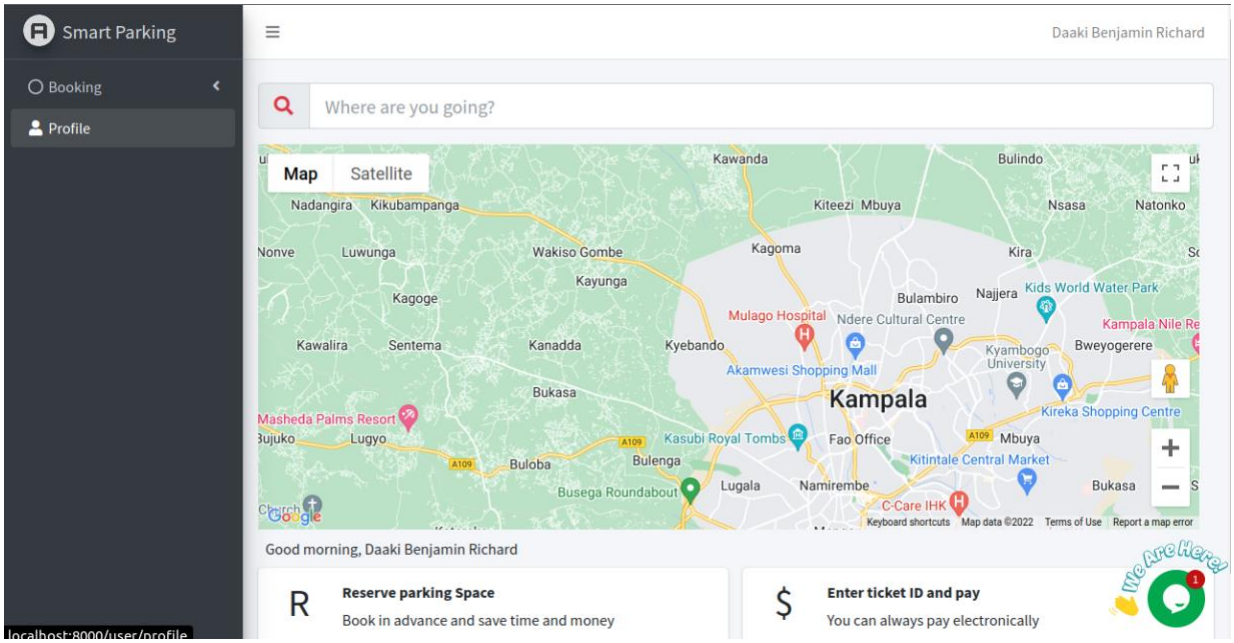
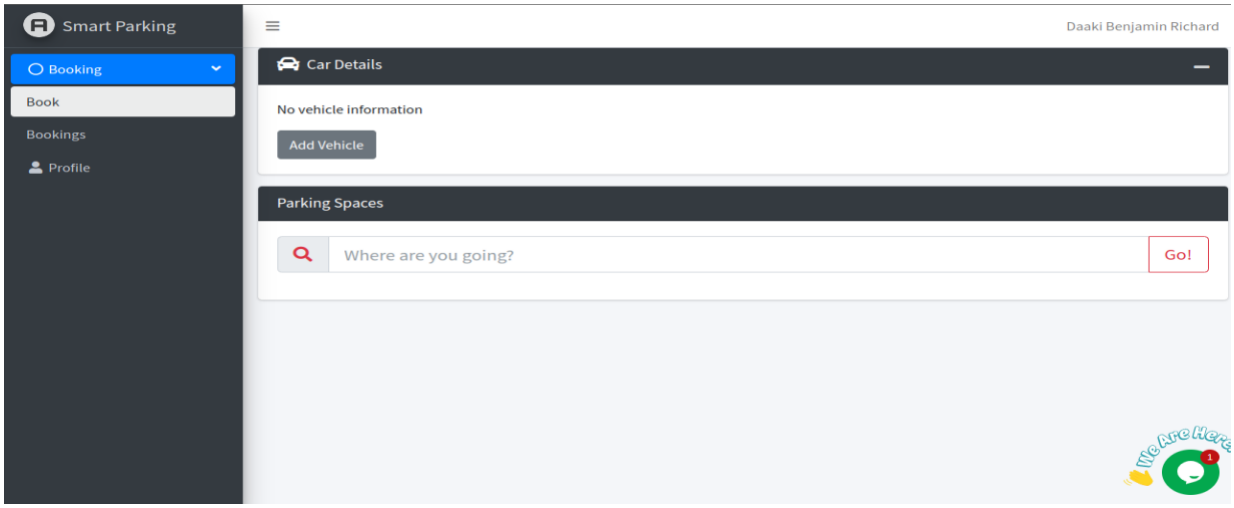



*Figure 9: Showing booking page*

**Vehicle details Page.**

This page enables the driver to enter his /her vehicle details in Parking Management System in order to book for the parking slot.




**Park Administrator's Page**.

*Figure 10: Showing the driver Adding Vehicle details Page*

The page enables the Park Admin to view Total bookings, Pending bookings, available slots and Total Drivers of the parking space assigned to it in Parking Management System and he confirms bookings made by drivers

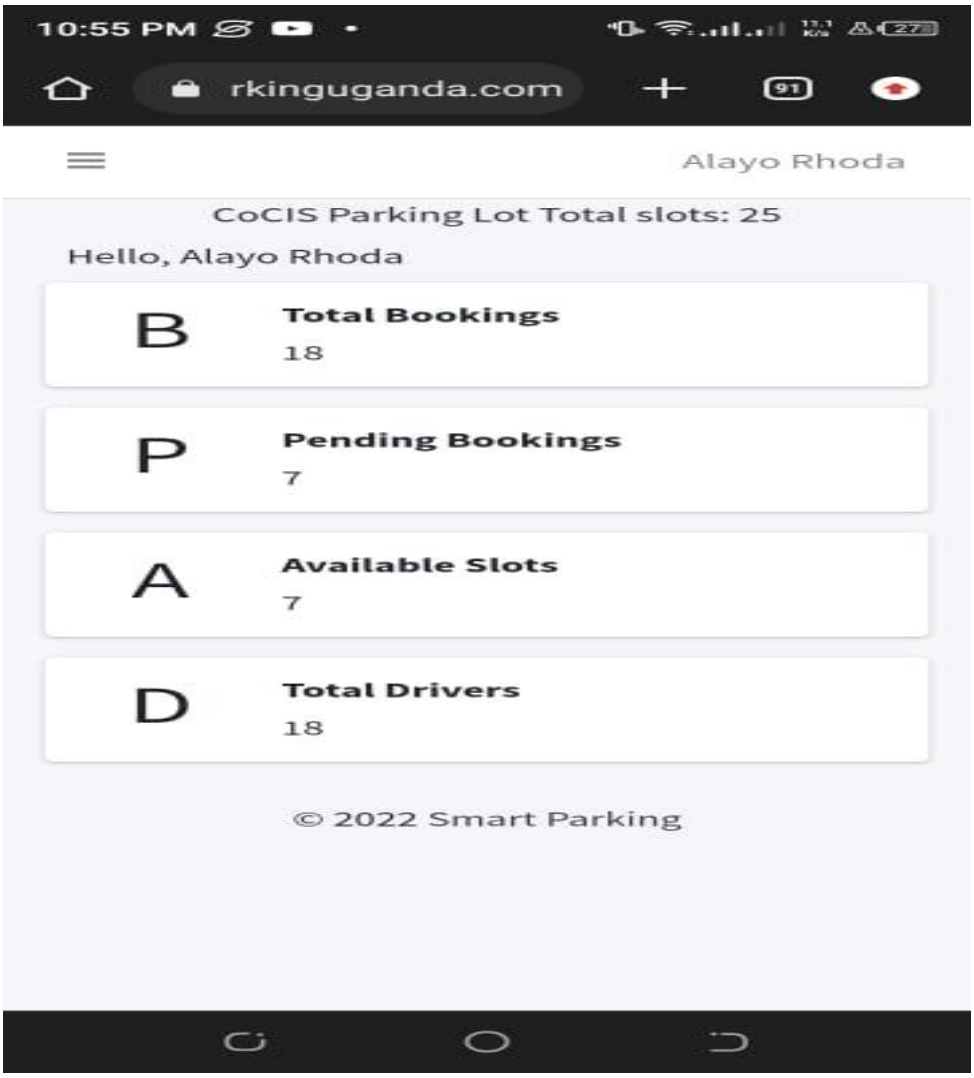



*Figure 11: Showing the Park Administrator's Page:*

**Add Parking Spaces Page.**

This page enables the super Administrator to add parking space to the system.

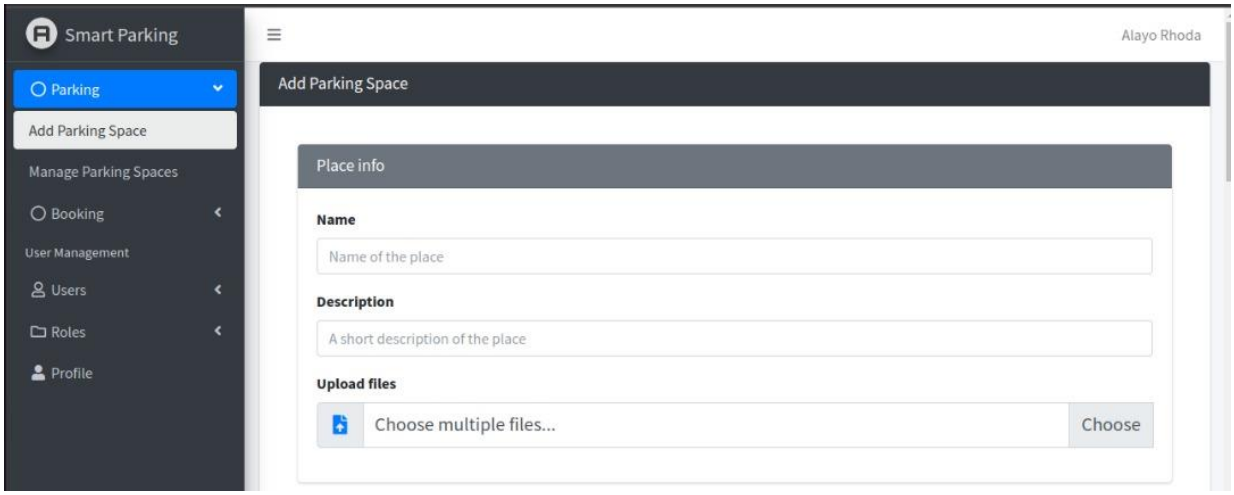



*Figure 12: Showing the Add Parking Spaces Page*

**The Super Administrator dashboard**

The Super Administrator is able to view and manage parking spaces and users in parking management system

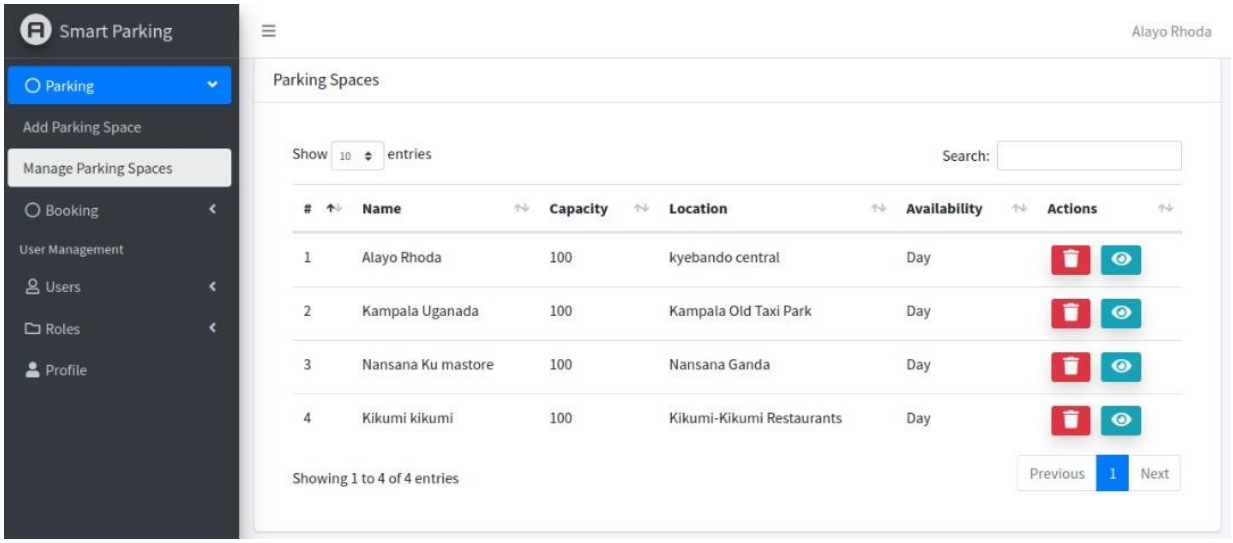



*Figure 13: The Super Administrator dashboard*

### 5.3 System Testing

This section describes tests performed on the web application. Tests were done against the Functional and Non-functional requirements of the application.

#### 5.3.1 Functional Testing

Functional tests were done based on use cases to determine the success or failure of the system implementation and design. The testing measures for each use case were determined, and the findings were classified as successful or failed. Tables detailing some of the primary use cases and their test results can be found below.

##### 5.3.1.1 Test Identifier 1: To log in or Logout

The main focus of the evaluation was to ensure that both mobile and online applications have proper login and logout functionality. The conduct that was observed and that was expected was both consistent. The outcome was declared successful because Test Identifier one passed the trial.

*Table 12: shows the results of the test identifier*

| **Utilized Use Case** | **Logging in or out of the system** |
|---|---|
| **Test Parameters** | Login with the correct username and password pair/Logout |
| **Expected Behavior** | Successful login and access granted/ Successful logout |
| **Observed Behavior** | Successful login and access granted / Successful logout |
| **Test Outcome** | Pass |

##### 5.3.1.2 Test identifier 2: To Edit Users and User profiles

Observed and expected behavior was consistent. Test Identifier two passed the trial and the outcome was deemed successful.

*Table 13: shows the results of test identifier two whose main assessment was to edit users and user profiles.*

| | |
|---|---|
| **Test Parameter** | Edit user profiles by users |
| **Expected behavior** | Successful modification of the user profile |
| **Observed behavior** | Successfully modified user profiles |
| **Test Outcome** | Pass |

***Test identifier 3: The ability to modify details on the parking management the Super Administrator.***

The table shows the results of test identifier 3 whose primary goal was to see if an administrator could change the details of the Parking spaces,user's details. Observed and expected behavior was consistent. Test Identifier 3 passed the trial and the outcome was deemed successful.

*Table 14: shows the ability to modify details on the parking system by the administrator*

| Utilized Use Case | Modify total parking spaces, bookings and users |
|---|---|
| **Test parameter** | Total parking spaces, bookings and users' details can only be modified by the admin only |
| **Expected behavior** | Successful modification of the total parking spaces, bookings and users' details |
| **Observed behavior** | Total parking spaces, bookings and users' details details can be successfully edited by the admin |
| **Test Outcome** | Pass |

### 5.3.2 Compatibility Testing

Compatibility was done to ensure that the Parking Management System were compatible with the available platforms. The Parking Management System was tested against available web browsers.

### 5.3.3 Web Browser Testing

*Table 15: shows testing done on available and commonly used web browsers.*

| | |
|---|---|
| **Internet Explorer (versions 4 and above)** | YES |
| **Firefox (version 8 and above)** | YES |
| **Chrome (all versions)** | YES |

### 5.3.4 Usability Testing

End-users of the application were involved in usability testing. This group defined the target population available to use the system. A total 15 respondents carried out the user testing practice giving appropriate feedback for the research. 15respondents were used as these were the only individuals who created time to visit a stand and participate in the process of registration, sign up into the system to book a parking slot and the respondents recommended the Parking Management System and also believed it would be effective.

**User testing was done to achieve the following objectives:**

i) User-friendliness
ii) Functionality
iii) Aesthetics
iv) Acceptance

**User-friendliness**

This chapter focused on each of the mentioned objectives in detail. The findings are presented graphically for an elaborative visual presentation. 80% of the potential users indicated that the application was easy to use and learn. They were able to use the system without any prior training. 12% of respondents assessed the application to be fair to use, meaning it was neither easy nor difficult to learn and use; in some situations, they needed the assistance of a trainer to ensure that what they were doing was correct. That application was challenging to use for 10% of the responders.

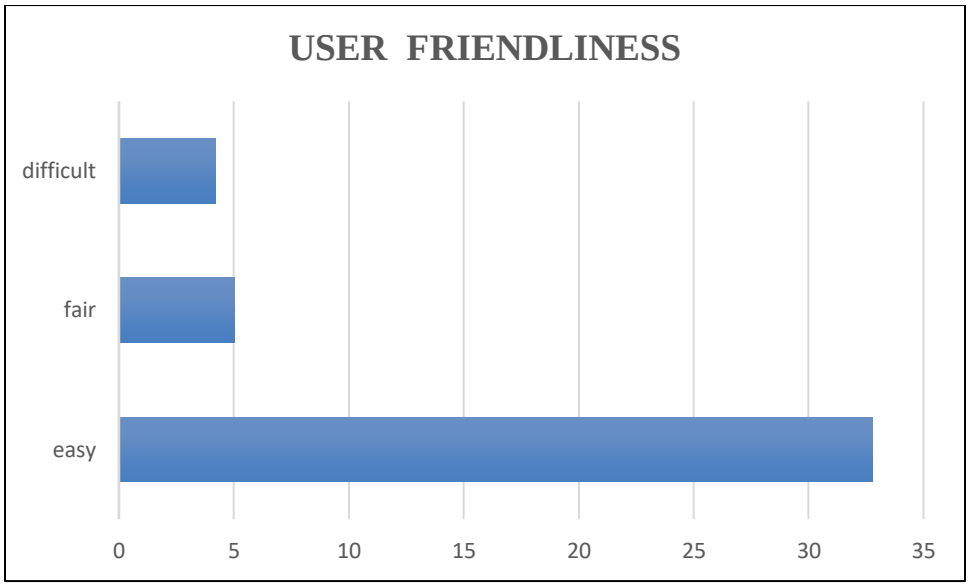



*Figure 14: shows a summary of the results of user-friendliness.*

**Functionality**

The application's users tested the system's functionality to see if it met their expectations. The application's functionality was praised by 75% of the respondents. 15 percent of respondents said the application's functionality was mediocre, implying that some features of the program were not up to par. The functionality of the system did not meet the desired aim, according to 10% of the respondents. The overall results were utilized to fine-tune the application until it was ready for acceptance.

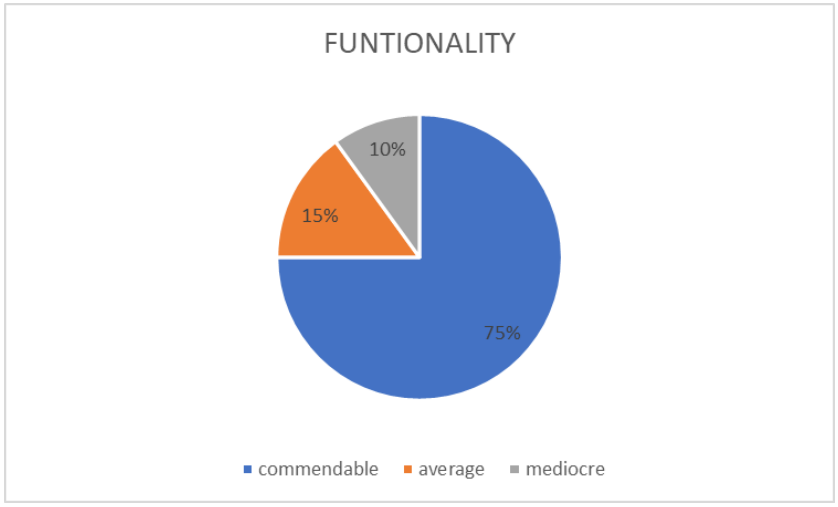



*Figure 15: shows the functionality of the system*

**Aesthetics**

The look and feel of an application's design and flow to its users define user interface aesthetics. The application has an attractive presentation, according to 84 percent of respondents. The application was deemed acceptable by 14% of respondents, while the rest amount stated that it was unappealing to the eye. The graphic below gives a summary of the findings.

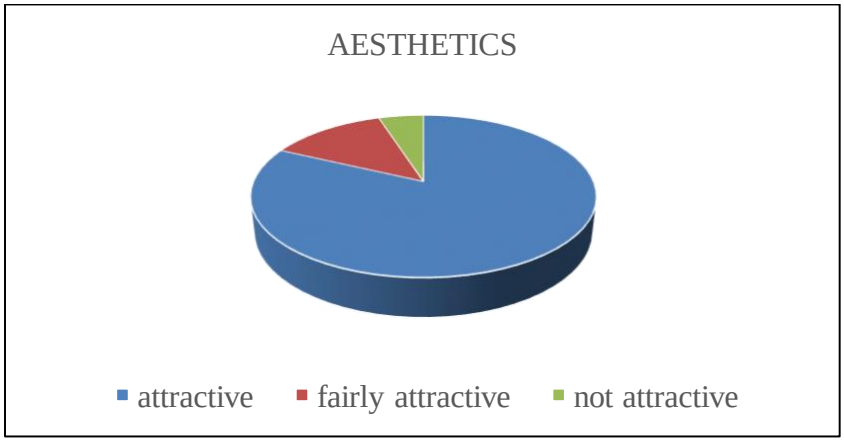



*Figure 16: Showing the Aesthetics of the system*

**Acceptance**

The acceptance test was carried out to see if the application could be integrated for use by the intended users. The application was deemed beneficial by 88 percent of those polled. Only 6% of the respondents were hesitant to accept the application, while the remaining 5% said they would not use it. The graphic below shows a summary of the findings.

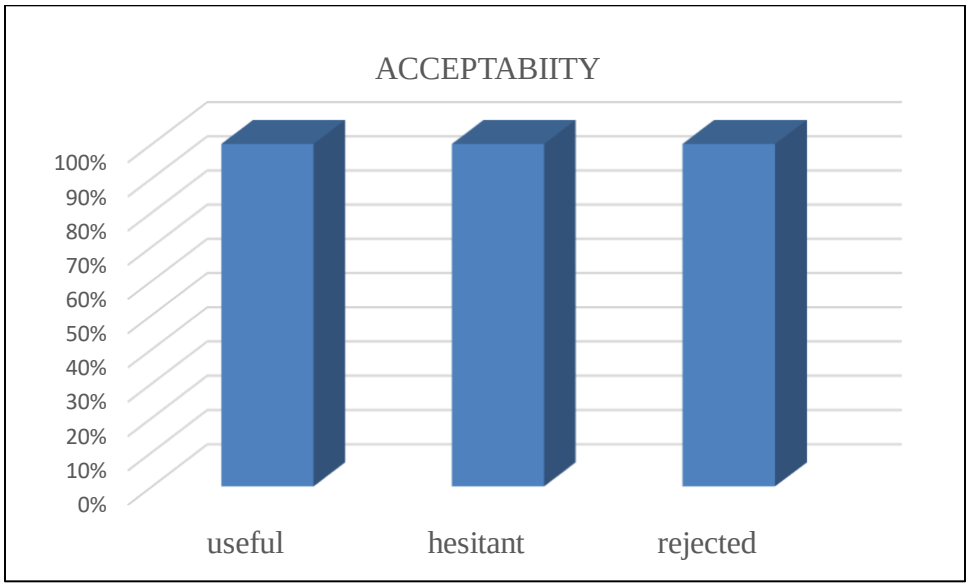



*Figure 17: Shows the Acceptability of the system*

### 5.3.5 System Validation

System validation is the process of testing a regulated computerized system to ensure that it does exactly what it is designed to do in a consistent and reproducible manner. The Parking Management System was presented to the public to receive feedback about its performance. The feedback was analyzed and incorporated to refine or redesign the Parking Management System.

## 5.4 Chapter Summary

System requirements generated during the requirements collecting and analysis stage provided fundamental information utilized in the system implementation step. To ensure that the system was created to meet user needs specified by targeted users, research objectives and questions were also taken into account. A majority of the specified objectives were met by the whole project. The research was conducted in plenty of time for application testing and feedback. The web-based application was developed solely for the park administrator to manage users using the application, update data of existing parking areas, view the information of all existing parking areas, allow the user to see the number of available slots in real time, allow the user to reserve a parking slot and notify the user upon successful or unsuccessful booking of a parking slot.

The system was tested in three stages: User Testing; was done to test User Friendliness, Application Functionality, Interface Aesthetics, and User Acceptance of the prototype; Compatibility Testing; was done to test the web-based application to web browsers; and User Testing; was done to test the prototype's User Friendliness, Application Functionality, Interface Aesthetics, and User Acceptance.

# CHAPTER SIX.

# DISCUSSION, ACHIEVEMENTS AND FUTUREWORKS,

# LIMITATIONS, RECOMMENDATIONS AND CONCLUSIONS

## 6.0 Introduction

This chapter highlights the summary and conclusions Parking Management System as well as the recommendations about what needs to be improved in the project by other researchers in future.

## 6.1 Discussion

This sub-section highlights the summary about how the objectives of the study were addressed during the different stages of project implementation, which include preliminary investigation about the performance of the current system and data analysis, system analysis and design, system development, system testing and validation.

The implemented system has the following functions;
Users are able to monitor available and unavailable parking slots. The goal is to automate and decrease time spent manually searching for parking space.

With this new system, there is better payment. Drivers cannot leave the parking lots without finishing the payments.

Low risk of insecurity. There is low risk of insecurity since the cars are no longer parked along the roads.

The objective of preliminary study was achieved by using both primary and secondary data collection methods. These include; interviews, and questionnaires. Using an interview guide, we posed face-to-face questions to 19 respondents and answers were not biased. We also administered questionnaires to the respondents in order to collect first hand data about the ways through which they were accessing parking slots around Kampala capital city. The collected data was analyzed using SPSS tool, excel spreadsheet, which was easy to use.

For system analysis and design of the system, we identified the requirement specifications from the first phase and designed the system using data flow diagrams (DFDs) for process modeling and the entity relationship diagram (ERDs) for data modeling.
The system was developed using software technologies; bootstrap framework, HTML, PHP, CSS, JavaScript and MySQL. This open source and easy to use technologies made the system fully responsive and dynamic. And thus, we were able complete the implementation process in the allocated critical time.

The system was tested by using the method of benchmarking, were units of the application were run and tested independently in order to identify and debug syntax errors among others. The different modules of the system were also integrated and tested as a whole while for system validation, the prototype version of the system was given to the users to use in order to prove whether it meets their user requirements or not.

### 6.2 Achievements

The greatest achievement of this project was the successful development of the Parking Management System. The system helps to direct drivers to the free parking bays, thus reducing the time they take looking for parking with a long term goal of improving security, payments, mobility, air quality and services for the citizens. In addition, an important goal of the system was to reduce the traffic searching for parking, hence reduce energy consumption.
The Parking Management System was successfully developed, tested, and found to be working as expected. The system was developed using software technologies; HTML, CSS. JavaScript, PHP and MySQL, among others.

There was no proof that a Parking Management System existed in Uganda. The respondents who claimed that they had heard of a Parking Management System knew about it from other countries like China. Majority of the respondents recommended the Parking Management System and also believed it would be effective. The system served its intended function well. According to the results of the usability testing, 78% of respondents said the program was user-friendly in the sense that it was simple to learn and use. Its functionality was deemed commendable by 75% of respondents. Finally, 88% of respondents judged the application to be useful and acceptable.

### 6.3 Limitations

Given the design objectives of Parking Management Systems that requires the coordination among multiple parties, we summarize the main design considerations as follows:

Trade-off between Benefits to Drivers and Service Providers: Multiple parties (drivers and service providers) are involved in the parking system operation. The state of the system depends on their interaction with each other. To balance the needs of involved parties, we use parking price as the control signal to coordinate the involved parties.

Differentiated Service for Large Scale Autonomous Drivers: Thousands of drivers make parking decision autonomously. They have different needs and budgets for parking and their interpretation of parking information is different. Providing differentiated service for drivers is important to satisfy individual users. In this sense, the service quality is determined by parking price.

### 6.4 Recommendations

We recommend;

The Kampala City Council to adopt the developed system to manage street parking, plan to automate street parking in order to reduce on the amount of money lost to parking fees defaulters and improve space utilization, recommend traffic routes, and track down space utilization in real-time to overcome traffic congestion, accidents and pollution.
The system users mainly the motorists be sensitized extensively about the system used to make their tasks easy. The Parking Management System was developed mainly for motorcyclists around Kampala Capital City in Uganda, we recommend policymakers like Ministry of works and Transport Uganda and Kampala Capital City Authority to use the system because we believe that the system provides adequate information about available and secure parking space for motorists to overcome traffic congestion, pollution and accidents.

### 6.5 Future works

In the future work we will propose a dynamic Parking Management System architecture based on multi agent systems.

Our system will be divided into different processes:

Communication module: it will concern the request send by the driver to the system.

Coordination module: at this level we find agents which have the role of displaying information to the user in a suitable manner taking into account constraints of the device.

Processing module: the main role of this module is the processing of different queries sent by the user e.g.: reservation, payment, check-in, check-out, etc.

Data module: it contains data of the parking saved on real time.

The contribution of our system will concern the data analysis process which is the node of our system. For that reason, we will use different modern techniques such as expert systems.
We should integrate the two different technologies together in order to achieve a system which is the most efficient, reliable, secure and inexpensive.
Expert systems have a lot of attractive features; increased availability, reduced cost, reduced danger, permanence, increased reliability, explanation, fast and complete response at all times, intelligent database, multiple expertise

### 6.6 Conclusions

This report, we define the concept of the Parking Management System, their Types and the classification of different technologies. After we give a survey of different parking systems which was implemented by many researchers to resolve the growing problem of traffic congestion, wasted time, wasting money, and help provide better public service and reduce car emissions and pollution. As a future work we will propose a dynamic architecture based on multi-agent systems and expert systems for Parking Management System management.
The greatest achievement of this project was the successful development of Parking Management System. The system enables the drivers to easily access available and secure parking space in Kampala City since the system makes communication easy.

During the entire project period, we were introduced to different aspects of Information Technology. This helped us to appreciate the practicability of the theory covered in the course. Thus, the report presented reviews that were done during the project development: background to the problem, statement of the problem, objectives, scope, significance, literature review, methodology, system design, and implementation.

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## APPENDICES

### APPENDIX A: Questionnaire

**PARKING MANAGEMENT SYSTEM**
**SURVEY**

This survey is carried out to help us understand how effective the Parking Management System would be if implemented

* Required

1. Are you a student, staff or not a university member? *

*Mark only one oval.*

- Student
- Staff

2. What is your gender? *

*Mark only one oval.*

- Male
- Female

3. Have you ever heard of a Parking Management System in your area? *

*Mark only one oval.*

- Yes
- No

4. Do you have a vehicle? *

*Mark only one oval.*

- Yes
- No

5. If yes, how many days a week do you normally drive around Kampala City?

*Mark only one oval.*

- 1 - 2 days
- 2 - 4 days
- 4 - 7 days
- No, l don't drive to school

6. How easy is it to find a parking space around Kampala?

*Mark only one oval.*

- Easy
- Neutral
- Hard
- Extremely Hard

7. How much time do you spend looking for a parking spot?

*Mark only one oval.*

- 0-4 ıtes

- 5-15 minutes
- 16-20 minutes
- More than 20 minutes

8. Have you ever been late for something because you could not find a spot? *Mark only one oval.*
- Yes
- No

9. How would you rate the current parking system? *
*Mark only one oval.*
- Good
- Average
- Poor

10. How strongly would you recommend a Parking Management System which * would let you know about the available parking slots around Kampala City *Mark only one oval.*
- Won't recommend
- Not sure
- Strongly recommend

11. Do you think this Parking Management System would be effective? *
*Mark only one oval.*
- Yes
- No

## APPENDIX B: INTERVIEW GUIDE

Dear Respondent, we are a group of BIST students from CoCIS – Makerere University, and we are conducting research on implementation of a Parking Management System. We kindly request you to spare some time and answer the questions so that we can accomplish this task. We will keep this data confidential and use it strictly for academic purposes only.

1. What experience do you have in parking Field?
2. How many slots can your parking accommodate?
3. Have you faced any challenges regarding parking?
4. What are those challenges?
5. Have you heard of a parking management system in your area?
6. We are designing a Parking Management System to enable drivers to access the Parking Slots around town; do you think this could improve the current way of accessing the secure parking lot?
7. According to your observation, do most of the drivers that you always chat/interact with own smart phones or computers?
8. The proposed prototype involves only three main stakeholders (Super administrator, Park administrator and Driver). What other stakeholders do you think should be involved?
9. How strongly would you recommend a parking management system which would show availability of parking slots?
10. Any other comments, suggestions or challenges?

**We are grateful for your assistance**