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Development of a Global Positioning System (GPS) for Managing Parking

(A Case Study of Tanzania Parking Management Systems Dar es salaam City Center)

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Abstract*—The main purpose of the study was to design and Develop a Global Positioning System (GPS) in National Parking System. The research design used in the study was Quantitative and Qualitative Research design. The study covered the total population of 3000 respondents from National Parking System (NPS) Dar es Salaam where 2300 were drivers and parking attendants who charge these drivers for parking and auxiliary staffs were 700. The researcher arrived at this sample size with the aid of (Slovenes' formula). Research instrument used closed ended questions. The scale was given to the cross section of respondents; such as staff members and drivers, and that made easy to gather data from the field. Data analysis was done with the the help of Statistical Package for Social Science (SPSS) was used during data manipulation. It was found that system non-functional requirements were the time required for someone with basic computer skills to learn it should not be more than 24 hours, it should make use of forms for entering data, it should be easy to use and it should be developed using recognized DBMS (Database Management System). The system should be easily networked to monitor and control any number of different parking facilities. In many instances developing a new system creates an opportunity to redefine how the organization conducts its business leading to higher levels of productivity and performance. It was also found out that the system should be able to redesign a structure, scope, power, relationships, workflows and services that maximize and utilize faults that might occur on the system.*

The researcher therefore recommended that further studies need to be conducted on GPS to improve on the efficiency in case the system users differ from the one for which this project has been developed for.

***Keywords*—** *Global Positioning System (GPS), Development, Managing, Parking, Real, Time, Tracking, Parking Slots.*

I. INTRODUCTION

1.0 Overview

This chapter presents the background of the study, statement of the problem, objectives of the study, research questions, significance of the study, scope of the study, limitations of the study and definition of key terms.

1.1 Background of the Study

Parking facilities are a major expense to society and parking conflicts are among the most common problems facing infrastructure planners. These problems can be most often described either in terms of supply or in terms of management. Parking management describes the process of optimizing the use of parking systems while making use of systems and programs that are applicable to parking (Jun, 2010).

A well-thought out parking strategy often helps reduce the number of parking spots required in a particular situation and provides a variety of socio-economical and environmental benefits. When all factors are taken into consideration, improved management is often the best solution to parking problems. Management solutions tend to be significantly more optimum (Jun, 2010).

Parking guidance is an optimization control problem which provides driving route suggestion and slot status by using computer technology, mechanics of communication, and control technique for the purpose of guiding drivers to the expected parking place. The result of such methods is to guide the customer to the expected parking place by driving on planned route (Jun, 2010).

The problem of parking and parking systems in big cities emerged first in the city of New York in the United Stated during the early 1940s following a boom in motor vehicle production. As the number of motor vehicles increased, the roads became more congested, hence leading to the problem of parking systems (de Wit, 2006).

Therefore, in these densely populated urban areas, a certain amount of traffic congestion and delay are due to parking. Recent study shows, in a business district of Los Angeles, vehicles looking for parking burn 47,000 gallons of gasoline and produced 730 tons of carbon dioxide, which is equivalent of 38 trips around the world (de Wit, 2006).

Hunting for a vacant parking spot in a metropolitan/suburban area is a daily source of anxiety for most drivers and it is time-consuming in the USA. It generally results in more traffic congestion. For instance, a recent survey (White, 2007) shows that during rush hours in most big cities such as New York, London, Tokyo and Berlin the traffic generated by cars searching for parking spots takes up to 40% of the total traffic. However, using effective parking strategies, many European cities have transformed parking situation into an economic opportunity (de Wit, 2006).

Parking emerged to be a serious problem in Asia in 1950s, in Japan from the mid-1960, in Hong Kong and Singapore in the early 1970s and in the Republic of Korea, Malaysia and Thailand in the late 1970s and 1980s. In Malaysia, (Balcombe and York 2003) examined parking behavior in eight sites that experienced parking problems in the early 2000s. All sites

reported that at least 10% of the car owners normally are parked more than 50 m from their home with this being above 30%. The constraint on availability of parking spaces discourages people from purchasing new cars.

In Africa, the problem of parking and parking slots is more common in the most populous cities. The city of Lagos in Nigeria is the populous city in Nigeria with a population of 16 million people with 7 million of them commuting on a daily basis, hence leading to long traffic jams and shortage of parking spaces. Johannesburg of South Africa is another African city which has been plagued by the problem of shortage of parking spaces in Africa. These problems are contributed by lack of technological know-how on parking management system. This is typical of poor and developing countries which lack the resources to invest in parking systems (Olomode, 2012).

Urban public transport for the city of Kampala, Uganda is among the cities which are facing the problem of parking management. About 90% of the people in the city use public transport buses. The buses cause traffic jams which make it difficult for cars to find parking space. Moreover, the city has a severe shortage of parking spaces (Kumar et al, 2008).

In Dar Es Salaam, parking is the notable problem that is exacerbated by few designed parking spaces proven to be inadequate. Unauthorized and indiscriminate parking along the street within the urban core is a serious barrier to smooth urban mobility and is an indicative of inadequacy management and system enforcement in the aspects of transport (RAC Foundation, 2004).

In city centers it is not surprising to see parking attendants collecting small cash payments from motorists parked along the footways or double parked meanwhile, basement parking lots of many buildings along the street are half empty (KMC, 2012).

These parking lots charge a modest fee for parking aim to recoup some incurring costs during the construction and these fees are slightly higher than that charged in the streets which accelerates to the on-street parking. Municipal regulations require these parking spaces to be provided as one of the main condition during the application of building permit (KMC, 2012)

In general, people complain of lack of parking spots when actual counts show that only 60 to 75 percent of spots are occupied (Tumlin et al., 2004). A typical automobile is parked 23 hours each day, and uses several parking spots each week (Local Motion, 2006). As the number of car owners increases, the need for parking spaces also increases, and this necessitates the need for efficient parking systems. The National Parking System (NPS) is composed of Directors, Managers, Supervisors, Administration, Technical and Production departments. Its short term objectives are to provide employment and beautify the city. Long term objectives of NPS is to provide parking management and parking services for the city.

The services covers Kariakoo, Samora, Lumumba and Chang'ombe. The current parking situation in Dar es salaam poses difficulty to the city dwellers although in other areas such as residences, it is reasonably and recommendable. Vacuum parking, meter parking and ad hoc parking have been previously used in Tanzania. Inspite of lack of efficient parking management system NPS (National Parking System) eases mobility and provides short time car storage.

By increasing the number of parking attendants, clampers, radiocalls, breakdown vehicles, the NPS will be able to meet its short term plans. The long-term plans will solve the long term problems by providing on and off street parking, establishing parking lots, new constructed buildings with parking yards.

1.2 Statement of the Problem

Currently in Tanzania, there is no system that automates the process of finding an empty parking lot. As a result the process of locating parking in the city is done in ad-hoc manner whereby the driver has to physically locate parking lot. This causes wasting of working time, insecurity for the cars because sometime one has to park far away from his/her destiny, stress and confusion to the drivers and sometimes accidents might occur. That's why the researcher intends to develop a GPS parking management system for Dar es salaam, that will guide driver of vehicles and cars to locate free parking slots. Drivers will benefit from using this new system.

1.3 Objectives of the Study

1.3.1 Main objective

The main objective of the study was to design a Global Positioning System (GPS) for managing parking system.

1.3.2 Specific objectives

i. To identify system requirements of parking management systems in Dar Es Salaam
ii. To develop a system that facilitates real-time tracking of parking slots
iii. To adopt a parking management system that maximizes utilization of available parking slots

1.4 Research Questions

The study was guided by the following research questions;

i. What are requirements for a GPS (Global Positioning System) for managing parking system in Dar es Salaam?
ii. What system can be designed to facilitate tracking of parking slots?
iii. What system can be designed to maximize utilization of parking slots?

1.5 Scope of the Study

Geographical scope

The study was conducted in Dar Es Salaam city centre. The area was chosen as the geographical scope because it is where there is the largest number of cars hence, there is the largest demand for parking and it is also where there are commercial parking slots.

Content scope

Specifically, the study focused on how the GPS (Global Positioning System) – for managing parking was designed and implemented so as to ease the problem of parking within the city centre. The study also looked at how a GPS-for managing parking that helped to simplify the task of finding a free

parking slot among drivers and in doing so maximize the utilization of parking spaces.

Theoretical Scope

The theoretical scope of the study focused on the Technology Acceptance Model (TAM), theoretical framework developed by Davis (1989). According to the TAM model, the adoption of a new technology is determined by the perceived convenience of use, cost of acquisition, level of awareness and accessibility of the technology.

II. Literature Review

2.0 Introduction

This chapter provides an overview of the opinions and ideas of experts on the research topic, system requirements of parking systems, facilities of real-time tracking of parking slots, utilization of parking slots, theoretical model used in the study, related studies similar to this study and the research gap identified by the researcher.

2.1 Opinions, Ideas of Experts and Authors

The parking lots industry is an $8.2bn industry in the United States, with predicted annual growth of 4.2% over the next 5 years (Andrews, 2011). Techniques to improve parking lots efficiency primarily focus on very simplistic methods dealing with parking lot construction and other physical attributes heuristics. The usage of software to simulate various parking lots conditions and study their behavior is not yet being used widely. While improving reservation efficiency is a well-documented topic for the airline industry and hotel industry, despite the similarities the parking industry shares with the aforementioned market sectors, not much research has been conducted for the latter.

2.1.1 Global positioning system and parking system

A GPS parking system works by reading GPS (Global Positioning System) positions in NMEA (National Marine Electronics Association) format from a GPS (Global Positioning System) unit using an onboard computer, extracting position data (latitude, longitude, and altitude) from the NMEA (National Marine Electronics Association) sentences, then converting the data into the local coordinates. The system increases the GPS (Global Positioning System) accuracy by using signal correction received from a differential base station using a radio signal.

Once the system solves for the vehicle location, the system calculates the position of the truck with respect to other trucks by broadcasting its GPS (Global Positioning System) location to those other vehicles using a wireless network. The computer keeps track of vehicle proximity based on distance resulting from each of the GPS (Global Positioning System) vehicle locations and the proximity distance, Wilson (2009)

In today's fast paced working environment, people greatly depend on auto mobiles to commute to their destinations. Automobiles include: motor vehicles, motor bikes, trucks to mention but a few. The use of these auto mobiles has increasingly posed a demand for infrastructure to manage the parking, (Shoup, 2009).

2.1.2 System requirements of parking systems

According to Klappenecker et al., (2010) in order to provide quick parking solutions to the patrons, having the ability to determine which parking spots are empty and can be used by the incoming patron can be immensely helpful. This problem has been studied in a number of ways by different researchers. One approach uses prediction of number of free parking spots in the parking lot.

In this method the parking lot regularly communicates the number of occupied spots, capacity, arrival and parking rate through a vehicular ad-hoc network. The navigation system in the car will compute the probability of getting a free space using all this data. There is one method in which a user is upraised of the existence of parking spots while on the move (Delot et al., 2009).

In this a vehicle ad-hoc network is used, in which drivers can receive information from a central server about the empty spots while driving. There have also been systems where drivers (not individually) are navigated through the parking lot with lit up arrows, indicating the presence of vacant spots in that direction as implemented (Charette, 2007).

When the spots get filled up, the number of vacant spots is updated, and if a particular section gets filled up completely, there will be no more arrows directing drivers to that section. A parking lot system based on wireless sensor networks has been studied (Tang et al, 2006). It finds a closest spot and guides a car to that spot.

2.1.3 Facilities of real-time tracking of parking slots

According to (Basu et al., 2004), tracking of car positions within the parking lot is a relatively new field and still is in the nascent form of research. A method of networked parking spots with architecture and applications is studied in which a multi-hop wireless parking meter network is coupled with a GPS (Global Positioning System) receiver to allow a user to locate and navigate to an empty parking space.

The method uses wireless radio frequency transceivers and auxiliary hardware and software. Another scheme employs parking lot Road Side Units [RSU's] to survey and manage the whole parking lot (Lu, 2010). It is enabled by communication between vehicles and RSU's.

Moreover the system is also used to provide antitheft protection and parking information dissemination using the concept of VANET's (Vehicle Ad-hoc Networks). Another navigational method has several info-stations that are set up across the parking lot and whenever users with mobile devices/PDA's come in the vicinity of the Info-Station, it will receive information from that Info-station about the availability of parking spots there (Ganchev et.al. , 2008).

If the mobile device is a smart-phone, then the user will also receive a graphical representation of the layout of the parking lot that will navigate the user to the parking space. A parking guidance system based on Wireless Sensor networks was suggested in which a driver is guided to an available parking lot (Yoo et al. 2008).

2.1.4 Utilization of parking slots

In order to study the process of optimizing reservations to obtain better 'parking', it is prudent to study the different methods of reservation systems that exist today. A parking

system was proposed in which the system is designed to be compatible with aspects that allow drivers to reserve a parking spot through the internet when the space is available (Inaba et.al, 2001).

One method for defragmenting memory occurs after the usage of the buddy algorithm (Defoe et al, 2005). Knuth's buddy system is an attractive algorithm for managing storage allocation, and it can be made to operate in real-time. The paper investigates the issue of defragmentation for heaps that are managed by the buddy system.

In literatures there are several theoretical studies about road pricing and road space than those of parking pricing and supply management. Although road pricing can be used to influence a wider range of trips characteristics than parking systems can; such as trip length, time of driving, route of choice and type of vehicle used (Verhoef et al., 2005).

Despite the disadvantages (Verhoef et al., 2005) noted under the right conditions, parking systems can be used to reduce the congestion problems as stated in the study conducted by Calthrop, et al., 2002). In most cases however, the right conditions where everyone pays the true cost for their parking do not exist (Shoup, 2005).

Parking system at best is an opaque balance between revenue raising activities to local authorities and desire to avoid discouraging visitors, to maintain the urban vitality and capacity to handle the increase of transport demand. There are literatures investigating the challenges of parking supply and management, as well as empirical studies which hypothesized parking (Bates et al., 2007).

Shoup (2005, 2009) reviewed to some extent the challenges of parking and stated that the parking systems have and will continue to exacerbate the sprawl by requiring the over provision of parking spaces, lowering the resultant density of commercial and residential development and encouraging further car use.

It is argued that the good design of the parking systems in various ways contributes to smooth the transportation networks, lowering emissions, high densities and better more of urban mobility (IHT, 2005) while poor design of parking systems tends to act otherwise. Shoup (2005) conducted a study in 11 international cities.

A recent research organized by the RAC Foundation (2004) found that 48% of respondents acknowledged that have parked illegally. Residential areas in parts of many cities are overwhelmed with parking cars. Litman (2011) conceptualized the parking problem in terms of a paradigm shift which describes a fundamental change in the perception of the problem.

Parking problems and solutions can be viewed in terms of a shift from the old paradigm to the new one. The old paradigm assumes that parking should be abundant and free at the destinations. It attempts to maximize supply and maximize the price (Willson and Shoup, 2009). The paradigm also assumes that parking lots should almost never be filled.

The old parking paradigm asserts that parking requirements should be applied rigidly without exception or variations and that parking management should be considered as a last resort to be used only if increasing supply is infeasible. Feeney (1989) identified several features that simplified parking particularly determination of elasticity.

For example, in shopping malls and airports, some control points are automated whereby users can do a self service in the use of the parking space while others are manned by control personnel. On the other hand, parking attendants have been employed in physically controlled parking bays to direct drivers where parking is empty (Willson and Shoup, 2009).

Users of automobiles spend a lot of time in the parking bays trying to locate where to park. In today's ever busy working environment, drivers hardly have time to spend in parking bays looking for where to park. In many places, especially in city centres finding parking has been noted as one of the major causes of stress (Wilson and Shoup, 2009).

Wilson and Shoup (2009) argued that the traditional method of finding parking by the naked eye has a number of irritating situations. In situations where a driver is walking towards a car or is in the car, the other drivers waiting to find parking often make signs, or whistle or try to do something intending to ask the other whether they are pulling out.

In busy towns and cities, parking management still poses a challenge that keeps growing more complex. The need for efficient parking management systems can't be emphasized enough for such cities. This study thus seeks to provide a solution to the issues above using the latest technology (Wilson and Shoup, 2009).

Recently the car navigation systems have been widely installed in many vehicles. Generally the car navigation system uses navigation information obtained from GPS (Global Positioning System) satellite signal because GPS provides good navigation information to user when GPS signal is available (sea) or not .However GPS does not work well in an underground parking area, tunnel and urban areas due to signal blockage or attenuation. The GPS and DR (Dead Reckoning) sensor integration can be one of the solutions. GPS shows a long-term error performance, on the other hand, DR sensor shows a good performance in short-term, (Jun, 2010).

The DR sensor which is generally used in car navigation is low-cost and has large noise. Thus the DR sensor navigation solution dramatically diverges without GPS even in short term blockage. In GPS/INS (Global Positioning System/Inertial Navigation System) Integration system, car aiding measurements are used to solve this problem. The odometer and gyroscope are used as DR sensors and a distributed filter approach is employed for the GPS (Global Positioning System) integration. To improve the performance of the integrated GPS navigation system, Car movement is additionally used. Gyro and odometer data was analyzed to determine the current car movement, (Jun, 2010).

2.2 Theoretical Framework

This study was guided by the Technology Acceptance Model (TAM) is an information systems theory that models how users come to accept and use a technology. The model suggests that when users are presented with a new technology, two specific factors influence their decision about how and when they will use it (Davis, 1989).

TAM (Technology Acceptance Model) has proven to be a useful theoretical model in helping to understand and explain use behavior in the information system implementation. It has been tested in many empirical researches and the tools used with the model have proven to be of quality and to yield statistically reliable results. However, parsimony has been one of TAM's (Technology Acceptance Model's) strengths but also major weakness, (Mbogo, 2012).

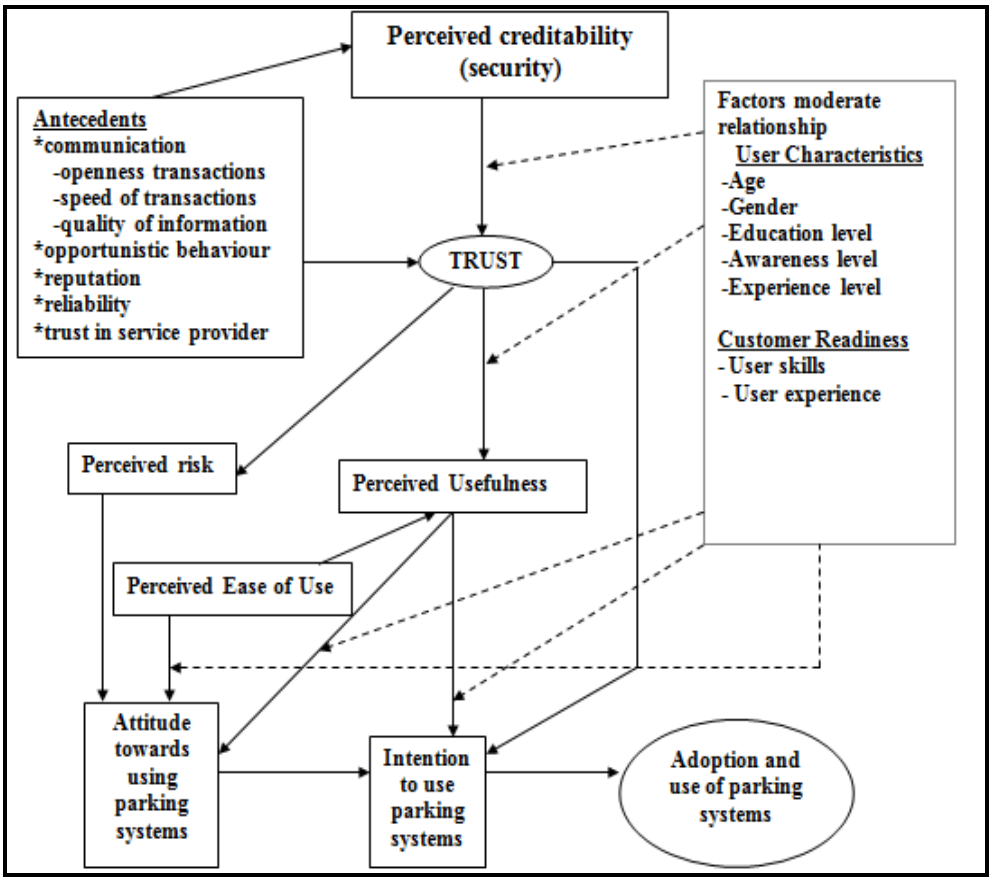

Fig. 2.1. Technology acceptance model (TAM).

Adopted from (Mbogo, 2012).

As a result of the shortcomings, many authors have extended TAM with additional constructs. Mbogo (2010) for instance, employed TAM and extended it to include other factors such as perceived ease of accessibility, perceived low cost, perceived security, perceived convenience, perceived satisfaction and usefulness of the technology.

2.3 Related Studies

Past studies, related to the navigation of vehicles to the parking lots, can be elaborated from the following two aspects: industrial solutions and research solutions. The industrial solutions include commercial systems, which use traditional (e.g. mobile phone) and satellite-based communication devices (e.g. GPS).

The existing commercial systems have been designed mainly for reserving the space in parking stations and they are not suitable to be used for street parking lots. There have also been several works by the academic and/or research community to improve the GPS (Global Positioning System) - based vehicle navigation systems (Cerreo, 2004).

Some of the works related to the street parking are as follows. Cerreo (2004), performed a theoretical study on the street parking. The yearlong study focused on various issues related to on-street parking such as policy, planning, management and operations. The author provided various approaches and adopted different cities to demonstrate these issues.

In other work, Arnott and Rowse (2005) have modeled parking into four modules. These are: spatial structure, trip generation technology, technology of parking and travel, stationary-state conditions. The main drawback of this modeling is that they have ignored traffic congestion. Also, the vehicle speed has been assumed to be independent of the flow of vehicles on the road.

A location-based system NAPA (Nearest Available Parking lot Application) has been presented by Chon et al. (2006) which has been developed as a part of the digital campus project at the New York University. Their system assists users in locating the parking lots on a campus (or in the areas like an airport), yet it does not provide the information about their availability.

The study focuses on using GPS (Global Positioning System)-based technologies to provide the availability of parking lots on streets within a specified distance from the

destination. The existing systems provide the availability of a parking lot at the current time instant, but they do not guarantee that the parking lot will remain available at the time when the vehicle actually arrives at the destination.

To overcome this problem, the proposed algorithm uses the current availability information and the past occupancy information of a parking lot in order to determine the probability of getting it at the time instant when the vehicle reaches the destination and stores the real time data about the availability of the parking lots in the GPS-device installed in the vehicle, (Jun, 2010).

2.4 Research Gap

From the literature reviewed in this study, it is clear that many studies have been conducted on the issue of GPS-based parking systems in various countries around the world. However, no academic study has been conducted on the design and implementation of a GPS-for managing parking in Tanzania, particularly in Dar es Salaam. Hence, there is a research gap.

Also, majority of the studies covered in this literature review focused mainly on parking systems management and GPS-for managing parking in Tanzania. No study focused on developing an actual parking system management. A well-thought out parking strategy often helps reduce the number of parking spots required in a particular situation and provides a variety of socio-economical and environmental benefits. When all factors are taken into consideration, improved management is often the best solution to parking problems. Management solutions tend to be significantly more optimum (Jun, 2010).

Hence, there is a knowledge gap that needs to be addressed. It is the objective of this study to develop and implement a GPS-for managing parking.

III. RESEARCH METHODOLOGY

3.0 Overview

This chapter provides a detailed description of research design, research procedure, target population, sample of the study, sample population, data collection, limitation of the study and the research instruments used in the study in order to accomplish the research objectives.

3.1 Research Design

The study was conducted through Quantitative and Qualitative Research design where the researcher used to interview the National Parking System (NPS) staffs, driver and parking attendants.

Quantitative aspect aimed at measuring the number of individuals agreeing with some factors defined in the research tools, which implied the degree of acceptance.

Qualitative aspect was concerned with aspects that cannot be quantified such as the level of satisfaction.

3.2 Research Population

The study covered the total of 3000 respondents from National Parking System (NPS) Dar es Salaam where 2300 were drivers and parking attendants who charge these drivers for parking and auxiliary staffs were 700 as summarized in the table below.

TABLE 3.1. Categories of respondents.

Categories	Gender	Overall Population	Sample Size
Drivers:	Male	1600	188
	Female	700	82
NPS Staff:	Male	250	29
	Female	450	53
Total	**252**	**3000**	**352**

Source: researcher (2016)

3.2.1 Sample size

The sample size comprised of 352 respondents from the selected departments. The researcher arrived at this sample size with the aid of (Slovin's formula) of:

$$n = \frac{N}{1+N\,(e)2}$$

where n = sample size, N = sampled population and e = level of significance at 0.05.

Calculation of the sample size:

N, sampled population = 3000

e = 0.05

$$n = \frac{3000}{1+3000(0.05)^2}$$

n = 352

TABLE 3.2. Categories of respondents sampling.

Categories	Sample size	Respondents %
Drivers(Male & Female)	270	76.7%
NPS Staffs(Male & Female)	82	23.3%
Total	**352**	**100%**

Source: researcher (2016)

3.2.2 Sampling procedures

During this study, cluster and stratified sampling method were used to obtain respondents. Both stratified and cluster sampling method was used to select from a pool of staffs and parking attendants who made up all the respondents of a sub-group to form a sample population. Stratified sampling was used because it groups population into homogenous subsets that share the same characteristics and clustered sampling was used because it selects groups rather than individual members because a sampling frame cannot be constructed.

3.3 Research Instrument

The research instruments adopted for this research project was Questionnaires. Closed ended questions with like scale were given to the cross section of respondents, the parking attendants which made it easy to gather data from the field. Questionnaires were used to collect data on users' view of the system and their experience of traffic congestion in the city. The questions spanned across the various applications testing such as functionality, usability, performance, compatibility and interface tests. The researcher adopted this type of questionnaires because questions asked in it are easy to complete, analyze quantitatively and responses obtained through the use of this kind of questionnaire can be compared easily to different items hence making it easy for the researcher to detect a trend just by glancing at the responses.

3.4 Validity and Reliability of the Instrument

Validity

The validity of the instrument was ensured by content and faces validity methods. The intention was to examine the correctness of the items in the instrument. Reliability of the instruments reflects its stability and consistency within the given context.

The researcher did this repeatedly in the research fields.

Reliability

Reliability was implemented by using a test-retest technique used for checking reliability of this chosen research instrument that researcher used during the collection of the required data, where the data were collected in different time interval from the same respondents and after calculating the results the outcome became closely similar with slightly coefficient differences of 0.17 which ensures the reliability of this method and to be adopted in this study for data collection.

3.5 Data Gathering Procedures

As a prior stage of the researcher in this phase, before going to the field to seek respondents for collection of the data, the researcher started by getting the recommendation as authenticity and authority from National Parking System (NPS). This introduced interviewer as a researcher trying to carry out academic research, thereafter the researcher went to the field to collect data by using the research instruments chosen for the study in data collection.

The researcher began with briefly explaining the background, objectives and nature of the study before carrying out the study. The researcher supplied questionnaires to the respondents in time and researcher gave them plenty of time to fill it before collecting them back. The aim of this was also to enable the respondents understand the study subject and having a vast idea of what to be filled in it.

3.6 Data Analysis

Data processing and data analysis were guided by the research objectives for the study. It involved the establishment of categories, the application of the categories to the raw data through coding, tabulation; which leads to drawing statistical inferences.

The statistical data analysis tool, Statistical Package for Social Science 16.0 (SPSS 16.0) was used in processing data. SPSS 16.0 was used to analyze the quantitative data collected from the questionnaires. This software package is widely accepted and used by researchers in different disciplines, thus, this tool has been used to screen the data of this research study. SPSS in addition was also applied to perform descriptive statistics such as frequencies, percentages, mean values, and charts. These analyses were performed for each variable separately and to summarize the demographic profile of the respondents in order to get preliminary information and the feel of the data. It was also used to analyze users' experience of the functionality, usability, performance, compatibility and interface tests.

Also in this case, data processing was guided by the objectives of the study and conceptual framework of the research.

The response mode, scoring and interpretation of data followed the point system where the advanced analysis was used for analysis of each research objective.

Interpretation for questions on Objective 1 was done as follows 0.5 – 1 = Strong Agreed, 1.5 – 2 = Agreed, 2.5 – 3 = Strong Disagreed 3.5 – 4 = Disagreed.

These means were gotten from the mean of questions on ease method of into the system.

Interpretation for questions on the objective 2 was scaled as follows, Yes = 0.5 – 1, No = 1.5 – 2, and Neutral = 2.5 – 3.

3.7 Ethical Considerations

The researcher made sure that no reputation and integrity is damaged by obeying and complying with various ethical principles for stances the principle of voluntary participation that requires people not be coerced into participating in research was adhered. Participants were given freedom to participate in the study and it was assured that in case they feel like drawing from the study still no negative action plans were administered them. Informed consent – all research participants were requested to authorized their participation in the study. Confidentiality and anonymity were ensured where the researcher made sure that information obtained from the respondents were not used for any other reasons and this was even guaranteed by not allowing them to show their identity for stance on the filled questionnaires.

3.8 Limitations of the Study

Some respondents refused to respond to some questions fearing that management may victimize them. However this was lessened by assuring respondents confidentiality and signing an agreement or an oath indicating that in case the researcher leaks the information on a respondent then he should use the courts of laws for legal actions. Difficulty in accessing the respondents due to their busy schedules; however the researcher used multiple skills like call backs, re-arranging appointments and extensive mapping.

3.9 Work Flow

The proposed project

The below diagram is of the proposed project flow which shows various steps which were followed in the project execution.

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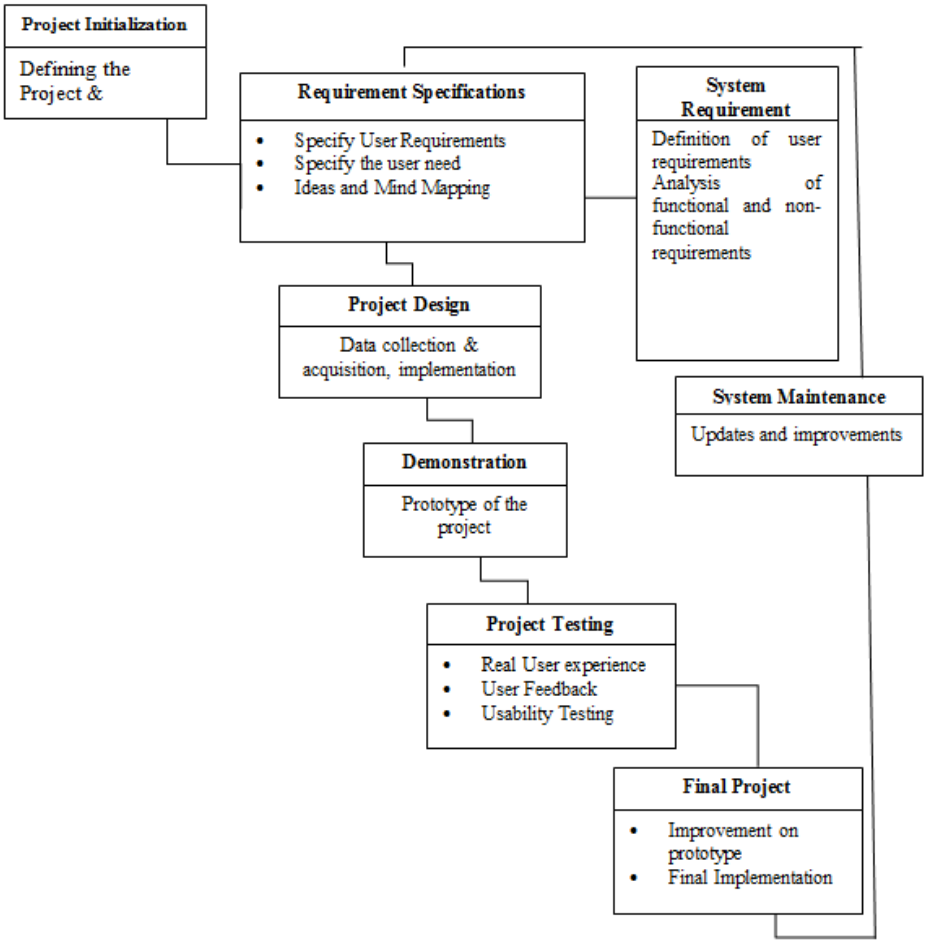

Fig. 3.1. Proposed project work flow.

Once the project definition was completed, user requirements were gathered as the next task. Figure 3.1 shows all the steps and procedures used in the project development. Starting with conceptualization of the project, user requirements were collected to determine what the users would expect the system to fulfill. To deliver an application that satisfies users, inputs from the members of the community and even by use of online social media sites like face book were used. The design part involved data collection and acquisition from motor owners in transport industry in Dar es Salaam. After the design, a prototype application was developed and preliminary testing done. From the user feedback, an improved demonstration version was used to come up with the final version. Since the online version to be hosted requires updates, system maintenance was done to ensure the system remains up to date and address user needs as much as possible.

3.9.1 Application testing

Application testing with real users is the most fundamental usability method since it offers a chance to gather the users experience for a website or an application. User testing is sometimes irreplaceable since it gives information about how people used the product and the problems they encountered while using a product. In this application, several aspects of usability testing were considered in the light of the application developed.

Usability testing assists in understanding how real users experience the application. A well designed user test measures actual performance of the application with respect to goal-critical tasks.

For the purpose of this research, the application will be tested with the real users in Dar es Salaam. The testing was looking for user experience in view of the functionality, design and user interface of the application made.

IV. System Analysis, Design, Testing and Implementation

4.1 Overview

This chapter covered the system design, system requirements and models, logical and physical design, system testing and evaluation, system implementation and maintenance of the proposed GPS for managing parking. The new system is expected to provide an easy way of allocating parking spot to drivers. Drivers are required to carry their mobile phones (smart phones) or Laptops in order for the system to work effectively.

4.2 System Analysis

Systems analysis is the analysis of a problem that the organization will try to solve with an information system. It

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consists of defining the problem, identifying its causes, specifying the solution, and identifying the information requirements that must be met by a new or improved system. The systems analysis includes a feasibility study to determine whether the solution is feasible, or achievable, from a financial, technical, and organizational standpoint. Normally, the systems analysis process identifies several alternative solutions that the organization can pursue.

4.3 Feasibility Study

In this study, the researcher started with feasibility study and focused on current system of delivering global position system (GPS) to NPS (National Parking System) Dar es salaam. By focusing on the current system staffs at NPS (National Parking System) has come with solution of developing the system which will help to cover gap missed in current system of manual system. Furthermore, global position system (GPS) is achievable and helpful to both drivers and staffs who can retrieve all queries pulled from internet and can be accessed through server and this reduces using manual work where by parking attendants had to go and find drivers and issue a parking tickets. Global Position System process was established to involve both drivers and staffs who prepare and coordinate to make it feasible.

4.4 Technical Feasibility Study

A GPS parking system is a system that uses the Global Positioning System (GPS) to determine the precise location of a vehicle relative to a parking lot to which it is attached and to record the position of the asset at regular intervals. The recorded location data is transmitted to a central location database, or internet-connected computer, using a cellular (GPRS), radio, or satellite modem embedded in the unit.

The basic assumption in GPS navigation is that the positions of the GPS satellites are known at any given instant of time (by the GPS control segment) and that the timing and SV orbit/clock information can be transmitted to the user GPS receiver. The GPS Control Segment is responsible for monitoring the satellite signals and uploading the relevant information to satellites. A GPS parking system uses the GNSS (Global Navigation Satellite System) network.

This network incorporates a range of satellites that use microwave signals which are transmitted to GPS devices to give information on location, vehicle speed, time and direction. So, a GPS parking system can potentially give both real-time and historic navigation data on any kind of journey. A GPS parking system can work in various ways. From a commercial perspective, GPS devices are generally used to record the position of vehicles as they make their journeys.

Some systems will store the data within the GPS parking system itself (known as passive parking) and some send the information to a centralized database or system via a modem within the GPS system unit. A passive GPS Parking System will monitor location and will store its data on journeys based on certain types of events. So, for example, this kind of GPS system may log data such as turning the ignition on or off or opening and closing doors.

The data stored on this kind of GPS parking system is usually stored in internal memory which can then be downloaded to a computer. An active GPS Parking System is also known as a real-time system as this method automatically sends the information on the GPS system to a central computer or system in real-time as it happens. This kind of system is usually a better option for commercial purposes such as fleet parking and individual vehicle parking as it allows the company to know exactly where their vehicles are.

4.5 Organizational Feasibility

NPS (National Parking System) staffs and drivers were likely to have a positive attitude towards the system because paper based work system was giving a lot of problems like time consuming and cost of printing parking tickets. Therefore, using this implemented system will reduce and eliminates the printing ticket papers and cost. And drivers would be taught on how to use this system.

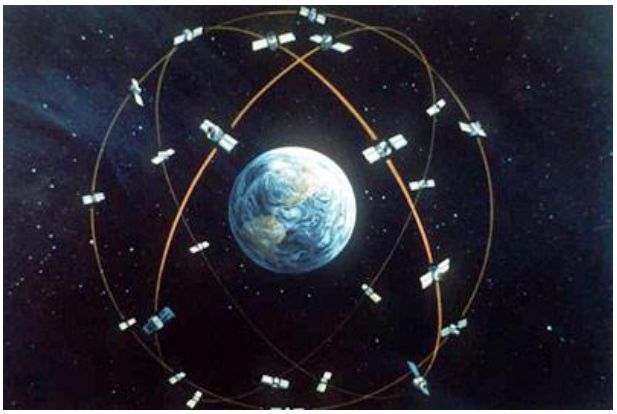


Fig. 4.1. Photo of satellites in the orbit.
Source (Researcher, 2016)

GPS is gets internet connectivity through the satellite which is shown below. GPS is relaying on a server and the drivers gets parking information location from GPS antennae through the server.

4.6 System Requirement Specification

In order for a GPS-based parking management system to function, the following requirements are needed;

a) An SMS-enabled mobile device (mobile phone, tablet, etc)
b) A transactional SMS short code e.g. 15555
c) A server
d) A PC connected to a server through the internet
e) A parking system software installed in the PC
f) A GPS satellite
g) A GPS receiver which communicates with the server via satellite
h) Bluetooth-enabled sensors which can communicate with GPS antenna

4.7 Functional Requirements

The GPS parking management system works as follows; as a driver approaches a parking lot, he or she sends an SMS request to a specified SMS short code designated by the parking management company (E.g. the driver sends an SMS

with the word "PARKING MLIMANI CITY" to 15555). The SMS is received by the parking management company through a PC with installed parking management software.

Once the SMS requesting for parking is received, the software on the PC communicates with a server to ask whether an empty parking slot is available in the particular location mentioned by the driver (e.g. MLIMANI CITY). After receiving the request, the server communicates with GPS antenna (GPS receiver at the parking slot) stationed at the specified location through satellite.

The GPS antennae sends signal back to the server whether or not there are empty parking spaces at the specified parking lot. The server then communicates back to the parking management software installed in the PC at the parking management company.

The software then sends feedback through SMS to the driver for further action

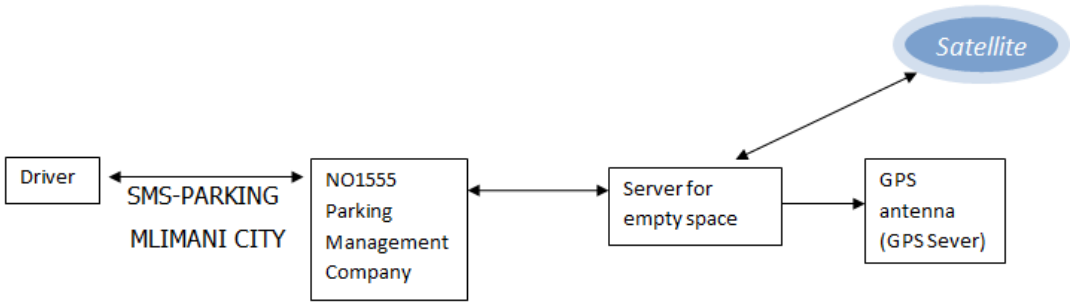


Fig. 4.2. Physical diagram.

Source (researcher, 2016)

If parking space is available, the software send an SMS to the driver to authorize the transaction which is made through airtime (this is made through arrangements with TCRA and mobile phone operators in which the deducted airtime is converted into currency which can be cashed-in. If parking space is not available, the software sends on SMS to the driver suggesting alternative parking slots available nearby.

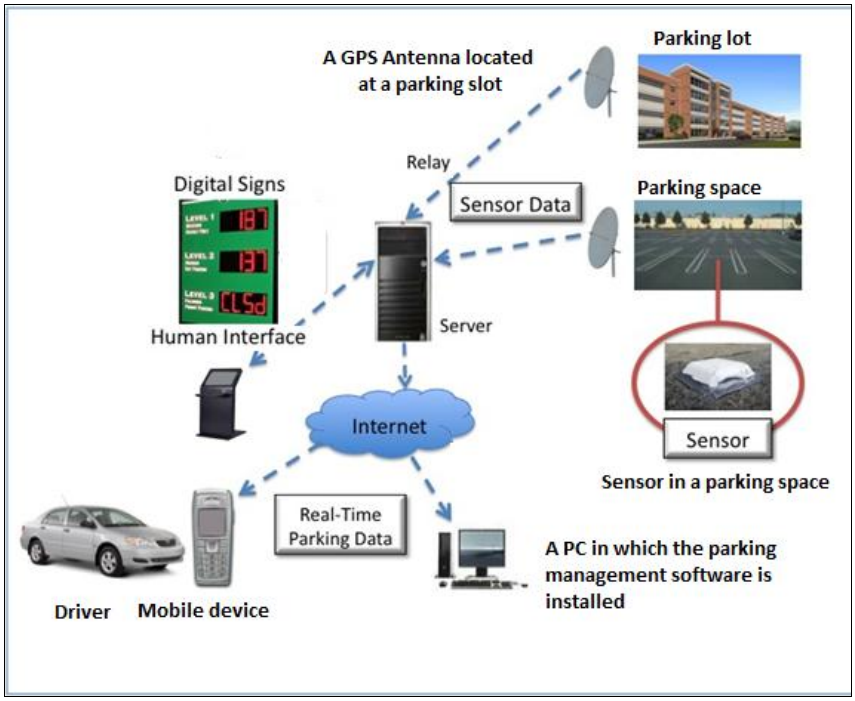


Fig. 4.3. A typical GPS based parking system.

Source (Researcher, 2016)

The parking space sensors are essential to the System. The System requires these sensors to track whether a vehicle occupies the current space.

The wireless network is an essential change to the current system. Without the wireless network the system could not communicate with the parking space sensors. The computer server and database is essential to the System. The computer server and database communicates with the sensors to track parking space status. Additionally, the server communicates with the user interfaces to report empty parking spaces to the user of the system. The server and database will store parking statistical data to be used for future system optimization.

The user interface is an essential feature of the System. The users of the system must have a method to interface with the System to be informed of empty parking spaces.

At each parking slot, there will be digital signs showing the total number of parking spaces, number of parking spaces available and the number of parking spaces occupied. The human interface will also show the time of occupancy left for each occupied parking slot. Once, the time of occupancy is finished, the sensors will alert the parking attendant for further action.

The human interface is an indirect component to the parking management system which displays the number of parking spaces available, the number of parking spaces occupied and for how long each parking space has been occupied. Since the system has an automated digital display a driver has an option either to use an automated system to direct the driver where to park or use the parking attendant to direct the driver where to park in case the system is not working.

When the driver parks the car in the parking lot, the sensor detects the action and sends information to the human interface. The human interface communicates with the antenna to indicate unavailability of the parking space. The antenna communicates with the server that the space has been occupied so that when the software makes a request, the server turns down the request.

When a driver leaves a parking lot, the sensor detects the action and sends information to the human interface. The human interface communicates with the antenna to indicate availability of the parking space. The antenna communicates with the server that the space is now available so that when the software makes a request to the server, the server accepts the request.

4. 8 Non-Functional Requirements

The following are non-functional requirements which many hinder the performance of the parking management system;

a) The parking management system cannot function if there is no mobile phone connectivity since the driver will not be able to communicate with the parking management software.
b) The parking management system cannot function if there is no internet connectivity since the parking system software installed in the PC will not be able to communicate with the server.
c) There parking management system cannot function if there is no electricity since the GPS antenna will not be able to communicate with the server or sensors.
d) The parking management system cannot function if there is no Bluetooth connectivity since the sensors will not be able to communicate with antenna.

4.8.1 System requirements
4.8.1.1 Hardware requirements
Hardware interface 1:

Processor	Intel or Pentium (III, IV), AMD Athlon, 266MHz or higher
Memory (RAM)	256 MB RAM or higher
Hard disk space	40 GB or higher
Monitor (PC) required	VGA 800x600 or higher resolution
Mouse	Any compatible
Keyboard	Any compatible
UPS	1000VA/600W capacity
Printer	Any compatible

Hardware interface 2: The system should be embedded in the PC/Laptop

4.8.1.2 Software requirements

In terms of software requirements, the system operates on window based machines.

Front End – Microsoft Visual Basic Studio was used in the development of the system.

Back End – The Database was created using Microsoft Access and connected to the forms using ADODC connection.

4.9 System Design

4.9.1 System design
4.9.1.1 Use case model

Use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram defined by and created from a Use-case analysis. The use case model shows the interaction between the actors and the system and the functionality provided by a system in terms of actors, their goals (represented as the use cases), and any dependencies between those use cases. It shows how drivers, interact with the system as shown in figure 4.4.

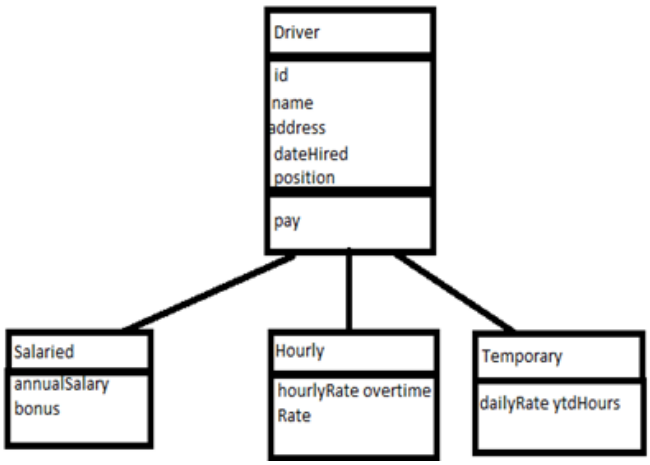


Fig. 4.4. A Class diagram.
Source (Researcher, 2016)

The main purpose of the use case diagram is to show how the system functions are performed. Roles in the system can be depicted. Use case diagrams are formally included in two modeling languages defined by the OMG: the unified modeling language (UML) and the Systems Modeling Language (SysML).

4.9.1.2 Actors

There are one type of actor in the system namely driver. The actor has access via the interface of the system which requires authorization.

4.9.1.3 Use cases

As can be seen from the diagram actor has access to different Use Case, but some of them overlap.

The administrator is able to manage such resources as data entry and handlers allocation, drivers information and report generation.

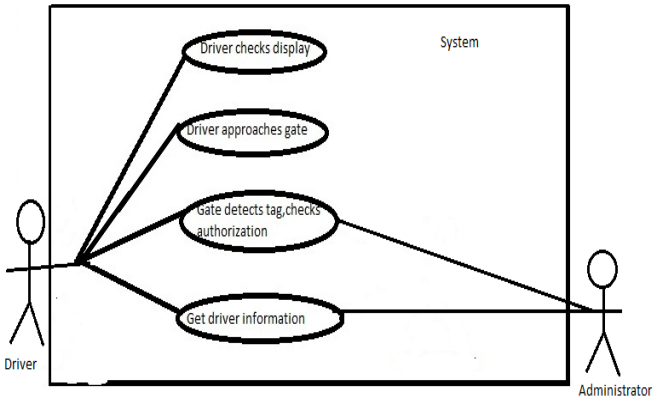


Fig. 4.5. A use case diagram.
Source (Researcher, 2016)

As it is shown on the diagram, there are two actors who perform different tasks. There is a driver who is using his/her mobile phones (smart phones) to see whether there is parking spot available. Another actor is an Administrator who authorizes when the car approaches the parking space.

4.9.2 Conceptual design

4.9.2.1 Class diagram

At the conceptual design, all the classes, attributes, operations and methods are reflected as shown in Figure 4.6. The user can either be an Administrator who administers and manages the execution and activities of the system and a driver who is using that system. They are both identified by their user_id in the system. If unrecognized, the user is prompted to see the administrator for clarifications. An administrator has a username and a password. Each driver has a driver ID, first name, and last name, address and position.

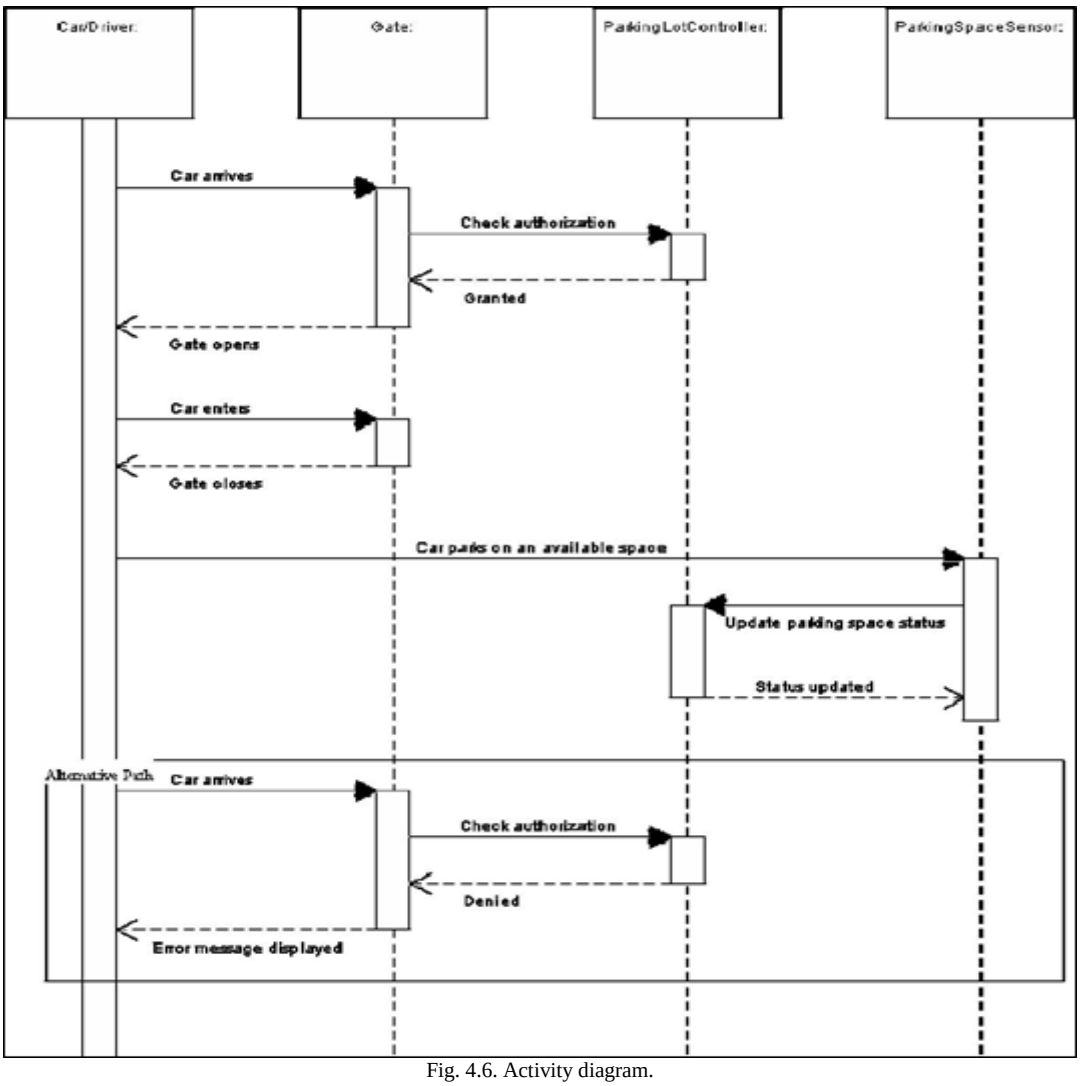


Fig. 4.6. Activity diagram.
Source (Researcher, 2016)

4.9.2.2 Car arriving system use narration

The program shows how GPS (Global Positioning System) is interacting with mobile phones (smart phones) and Laptops. Vehicle arrives at the closet destination, the driver switches on the program, then if space is available it will trigger an alert and a red light start blinking. If there is no space available the blinking light will go off, and the driver will receive an alert message telling him/her no space available at the moment.

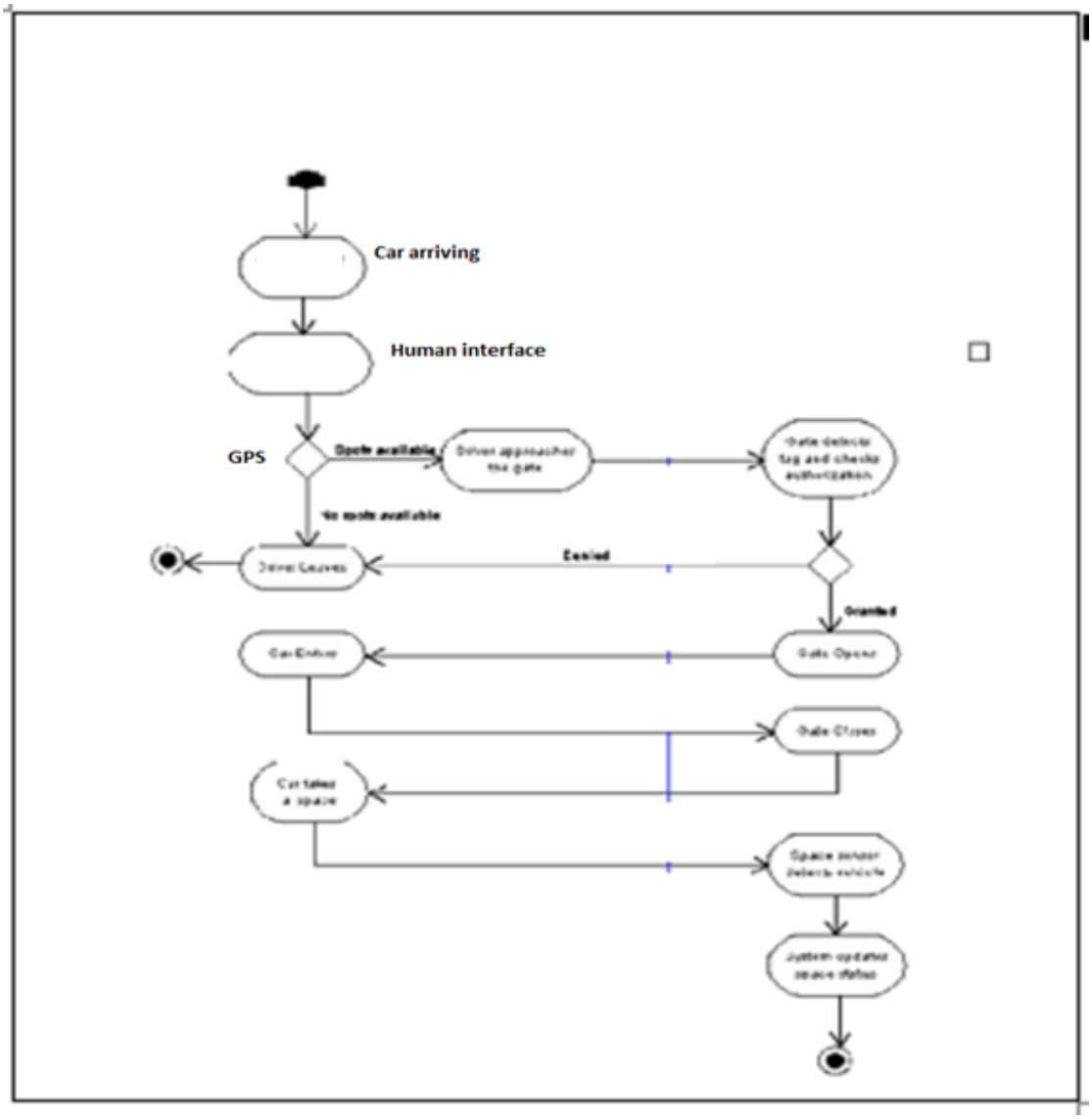


Fig. 4.7. GPS system car arrival.

Source (Researcher 2016)

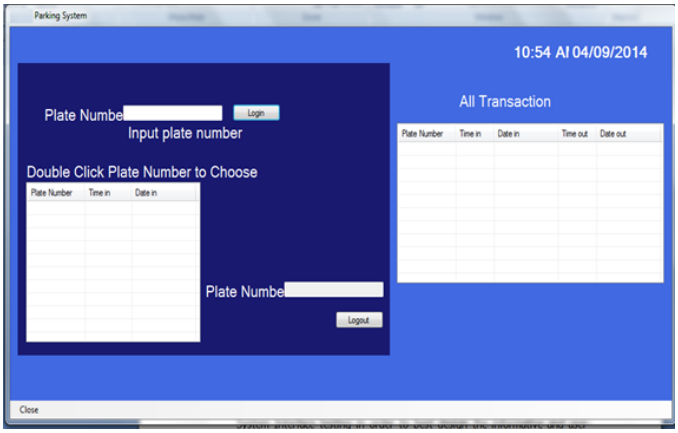
Use Name	Car Leaving
Primary Actor	Car and Driver
Other Actors	None
Description	This use case describes the event of the system tracking when a car leaves the parking lot.
Assumption	Parking Lot is open
Precondition	Car must have a GPS system installed
Initiation/Trigger	The use case is initiated when the car approaches the gate

Step 1: Car approaches gate.
Step 2: The system detects the car tag and checks with may database for authorization.
Step 3: The car is authorized and the system responds by opening the gate.
Step 4: The car drives
Step 5: The system closes the gate once the car is through.
Step 6: The car parks in an available space.

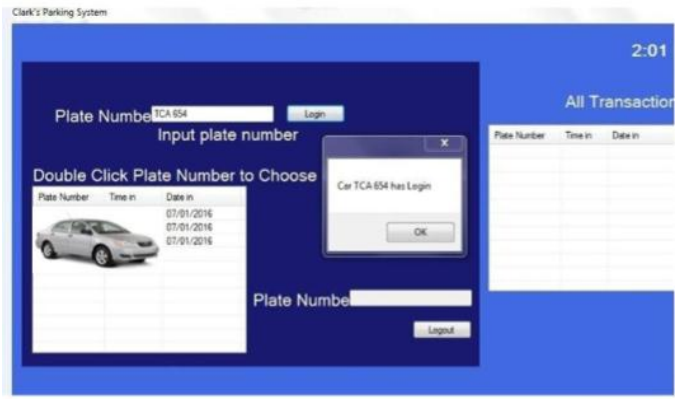
Conclusion: This use case concludes when the parking space status is updated.

4.9.3 Physical Design of the system

The physical design of the parking management software is showed in the diagram below. The diagram was taken from a snapshot of the actual parking management software installed in a PC.



Source (Researcher, 2016)



Source (Researcher, 2016)
Fig. 4.9. Home page of the parking management software.

This system shows that a driver enters into the parking lot and his information is being recorded on a system. His plate number, time and date is recorded for future use. The system is capable of showing how long will the driver be. This system gives an actual test output report.

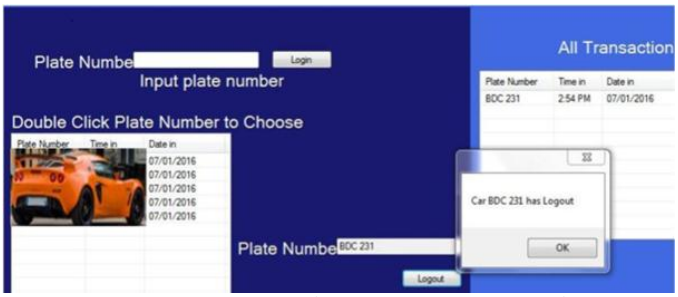


Fig. 4.10. Prototype log out of the parking management software.
Source (Researcher, 2016)

This system shows a driver leaving from the parking area and a system has time and date that shows when exactly is the driver leaving. In other words a driver is login out.

4.9.4 System Testing

System testing is the testing of the whole system based on its specification. It is a comprehensive testing and verification of the system against the requirement specification.

4.9.5 Unit testing

Unit testing involved testing of the equipment to see if they function and communicate properly with each other. Unit testing involved the following activities;

a) Testing whether the mobile device is functioning
b) Testing whether the transactional SMS short code functions properly
c) Testing whether the server functions properly
d) Testing whether the PC functions properly
e) Testing whether the parking management software is installed properly
f) Testing whether there is internet connectivity
g) Testing whether the PC communicates properly with the server
h) Testing whether the server communicates with the GPS satellite
i) Testing whether the GPS antenna communicates with the satellite
j) Testing whether the GPS antennae communicates with sensors

The system interface was reviewed to ensure that all use-cases are accommodated.

The design model for a driver global positioning system results system and allocation system was reviewed to uncover errors in presentation and navigation mechanics.

Selected functional components were unit tested one by one and met the user requirements.

Navigation throughout the entire system architecture was tested and it conformed to the requirements specified.

The computer global positioning system results system was developed and implemented in a server and trying to access through a different devices and was tested for compatibility with different devices.

Security tests were also conducted in an attempt to exploit vulnerabilities in the system environment.

Performance tests were conducted, and controlled under the guidance of end users; the results of their interaction with the system were evaluated for the content and navigation errors, usability concerns, compatibility and performance.

Because many drivers global positioning system results system evolve continuously, system testing is an ongoing activity conducted by system support staff that monitors system's performance basing on test results obtained by the designer. The forms and report designs were evaluated to see if they were easy to use and were compliant to the end user needs.

This diagram shows the availability of parking Lot. When the driver launch a program from his/her mobile phone(smart phone) automatic the program starts.

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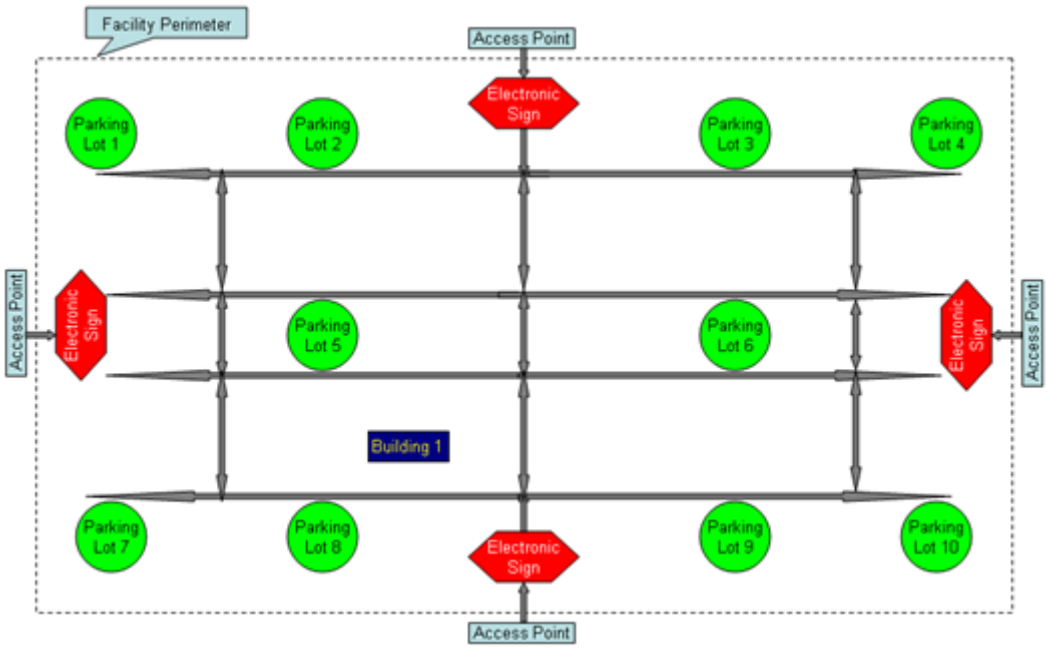

Fig. 4.11. Availability of parking lot.

Source (Researcher, 2016)

4.9.6 Integration testing

Integration testing will involve teasing whether all equipment and software function properly together. The researcher will perform all the outlined functions as described above and find out whether the feedback is positive. Feedback is positive if the equipment and software operate smoothly and enables the driver to allocate a parking space.

4.9.7 Validation and acceptance of testing

The study will validate all the assumptions, equipment and software function properly as expected. Once the parking management system is validated, the system can be accepted for use.

4.10 System Implementation and Conversion

4.10.1 System implementation

The system can be implemented through formulation of a parking management company. The parking management system can also be implemented by being sold to existing parking management companies.

4.10.2 System conversion

Once validated, tested and accepted, the system can be converted to be used for various purposes including commercial and non-commercial purposes. For commercial purposes the system can be used in parking management companies. For non-commercial purposes, the system can be used for residential parking management system or campus parking management systems.

V. Findings, Conclusion and Recommendation

5.1 Overview

This chapter presents the findings as per research objective, conclusion to the research problem and recommendations of the study.

5.2 Findings of the Study

In the study on software requirements it was established that functional requirements of the system are; enabling drivers and NPS (National Parking System) staffs to use GPS (Global Positioning System), through navigable interfaces basing on needs.

Objective 1: To identify system requirements of parking management systems in Dar es Salaam

In the study on software requirements by Whitten, Bentley and Dittman (2005), it was established that functional requirements of the system are; enabling entry of information into the system through navigable user interfaces basing on customer needs.

However, as per research question one in this study; the following were identified as functional requirement of the software; The system should allow users to input data via a graphical user interface, the system should allow the user to navigate through the server, the system should allow the user to pass information from the GPS antenna through satellite, the system should allow searching for a particular parking slot. It was also found out that the system should have a login interface where user should provide username and password in order to use the system. The findings from the study showed that the system should print out reports of available parking slots as required.

In conjunction with research question one.

In this study the researcher found out that National Parking System (NPS) was using an old system which was developed by Legend Technologies Co.Ltd. This system runs under old version of OS (Operating System). National Parking System (NPS) uses Windows 2000 Server. The system prints out tickets for drivers and then National Parking System (NPS) staffs handed those tickets to parking attendants. National

Parking System (NPS) staffs complain that parking attendant delay to collect money from drivers.

It was found that system non-functional requirements include: The time required for someone with basic computer skills to learn it should not be more than 24 hours, it should make use of forms for entering data, it should be easy to use and it should be developed using recognized DBMS.

It was found that NPS (National Parking System) staffs faced many challenges like how to use the new system and whether it would be beneficial and effective to their organization. The new system should allocate drivers where parking space is available. The new system should run through drivers mobile phones. This new system operates on window based machines. The new system is considered to be reliable and cost effective.

Objective 2: To develop a system that facilitates real-time tracking of parking slots

According to objective two, The system that facilitate real time tracking of parking slots should be applied to a number of different parking environments, large parking slots, underground parking facilities.

The system should be easily networked to monitor and control any number of different parking facilities.

In many instances developing a new system creates an opportunity to redefine how the organization conducts its business leading to higher levels of productivity and performance and in this study according to research question two, prototyping was found to be the most appropriate software development methodology. This generated a working model that handled GPS problems.

Objective 3: To use a parking management system that maximizes utilization of available parking slots

According to objective three it was found that the system should be able to redesign a structure, scope, power, relationships, workflows and services that maximizes utilization of available parking slots

The systems should be developed and well managed; ensuring all sensors and system itself performing according to drivers need. It was found that it is very necessary to have power through out for the system to maximizes its utilization in case of power failure, System Administrator should be equipped with inverter and generator so as to help to maximize and utilize faults that might occur on the system.

Content model for the system should be reviewed to uncover errors, system interface used to uncover errors in navigation mechanics. Functional components should be tested one by one to meet the user requirements. Navigation throughout the entire system architecture should be done to make sure the system conform to requirements specified. The system should be implemented in different environment configurations to check compatibility. Security tests should be conducted to exploit vulnerabilities in the system environment. Performance tests should be conducted, and controlled under the guidance of end users; the results of their interaction with the system should be evaluated for the content and navigation errors, usability concerns, compatibility and performance.

5.3 Recommendation

In line with objective one, GPS system should be developed to support city drivers to locate the nearest parking slots within the city center. This should be done after interacting with the system users to know what the system should do and possess as its features in order to meet the user needs. The administrator should consider implementing the system to help city drivers and car owners to achieve their target. This system is in no way an end on its own it is just a means to the end, thus users must not be lured into searching the parking slots within the city center,They should always use the knowledge of GPS and experience to handle the parking process by using the designed system.

According to objective two, the researcher suggests that the developed prototype be implemented and incremented into the functional GPS for the city. Furthermore, the system should be used as a virtual expert instead of users straining their heads for a few logical comparison of the availability of city parking slots. However, its effective use will require the users' understanding of the different components

The System should meet the objectives of the organization. It should address all of the managerial, organizational and technological components of the system solutions. An effective system for NPS (National Parking System), should fulfill its requirements within specific set of technical, organizational, financial and time constraints to meet its goals.

New information systems enable organizations to re design their structure scope, power, relationship workflows, products and services. In many instances developing a new system creates an opportunity to redefine how the organization conducts its business, leading to higher leads of productivity and performance.

IT enables organizations' opportunities to lower their transaction and agency costs and to harness the power of new information technologies that appear regularly to develop unique products, services, processes and hence increase new efficiencies and services. Therefore we conclude and strongly recommend that in order to realize new business opportunities one has to make substantial investments in IT to realize new business opportunities.

IT is one avenue for achieving these advantages along with changes in business practices and management. However a string of short-lived competitive advantages is a foundation for long term advantage in business. IT provides power to provide solutions to challenges and problems in business environment.

5.4 Conclusion

IT Technology global business today is one of the most important tool in executing organizations' objectives; and achieving organizations goals. Information Technology refers to the entire computer based information systems used by organizations and their underlying technologies.

Briefly information technologies and systems are revolutionizing the operation of firms, industries and markets. Managers and business invest in information technology and systems because they provide real economic value to business.

The decision to develop or maintain an information system assume that the return on this investments.

These returns will be expressed as increases in productivity as increases in revenue. Management challenges in developing and using information systems in obtaining business value from information systems. Provides an appropriate complementary asset to use information technology effectively. However understanding the system requirements.

Management challenges in developing and using information systems in obtaining business value from information systems; provides appropriate complementary assets to use information technology effectively. However understanding the system requirements of a Global business environment will create an information technology infrastructure that is flexible enough to support changing organizational goals and designing systems that people can control, understand and use in a socially and ethical manner.

The Information Technology has become the largest component of capital investment. Therefore NPS has a made a wise decisions about which IT Information system they would like to invest. Developing a new information system is a form of planned organizational change that involves many different people in an organization. Information Systems are socio-technical entities.

The system is designed to execute short term, and long term objectives, and thus attain NPS business goals. Automated Parking System of NPS will execute various activities in this system such as system analysis, system design, programming testing, conversion, and maintenance.

Areas for Further Research

Further studies should be conducted on GPS to improve on the efficiency. It should further be researched on for approaches that are different from prototyping that was used during this study.

In case GPS is to be done for the city center of Dar es salaam, more studies should be conducted to increase efficiency in resource utilization.

This study further suggests for more research on the mobile based applications and client to server communication managements systems that could be there and are different from what was used during this, this study further suggests that more research should be done on the features the system should have to perform its intended tasks.

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