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# Mobile Application for Long Distance Vehicles Booking of Passengers in Kenya

Chemutai Nancy

Submitted in Partial Fulfilment of the Requirements for the Award of Master of Science in  
Computer Based Information System

Faculty of Information Technology

Strathmore University

Nairobi, Kenya

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June 2019

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## **Abstract**

Making a booking for a journey has been one of the challenges affecting passengers who travel for long distances. Public transport is one field that is facing extreme pressures with customers demanding higher service levels at an affordable prices. Over years, public transport is supposed to facilitate movement of people from one location to next conveniently and in a cheaper way but this is not the case in Kenya where there are a lot of inconveniences affecting passengers using public service vehicles. To ensure a passenger makes a booking in advance, they are required to visit the booking office prior to their travel date and pay for the journey in form of cash causing inconvenience and thus making the passenger to incur an extra cost in order to make a booking in advance. Thus, this study aims at developing a mobile application that would assist passengers in making a booking at their own convenience by indicating their pick-up location so that they do not have to visit the booking office thus saving them time and travelling cost and reduced queues in booking offices and the number of staff employed leading to increased revenues. In addition, the passenger would be in a position to make payment via M-PESA or Credit Card. A simple web page is provided to add some booking details to the database to be used by the mobile application and at the same time to make a booking for few passengers who would visit the office to make a booking and for viewing reports. Data collection was achieved through questionnaires and review of existing data sources. The study was carried out in line with the ethical practices as specified by the University's rules and regulations.



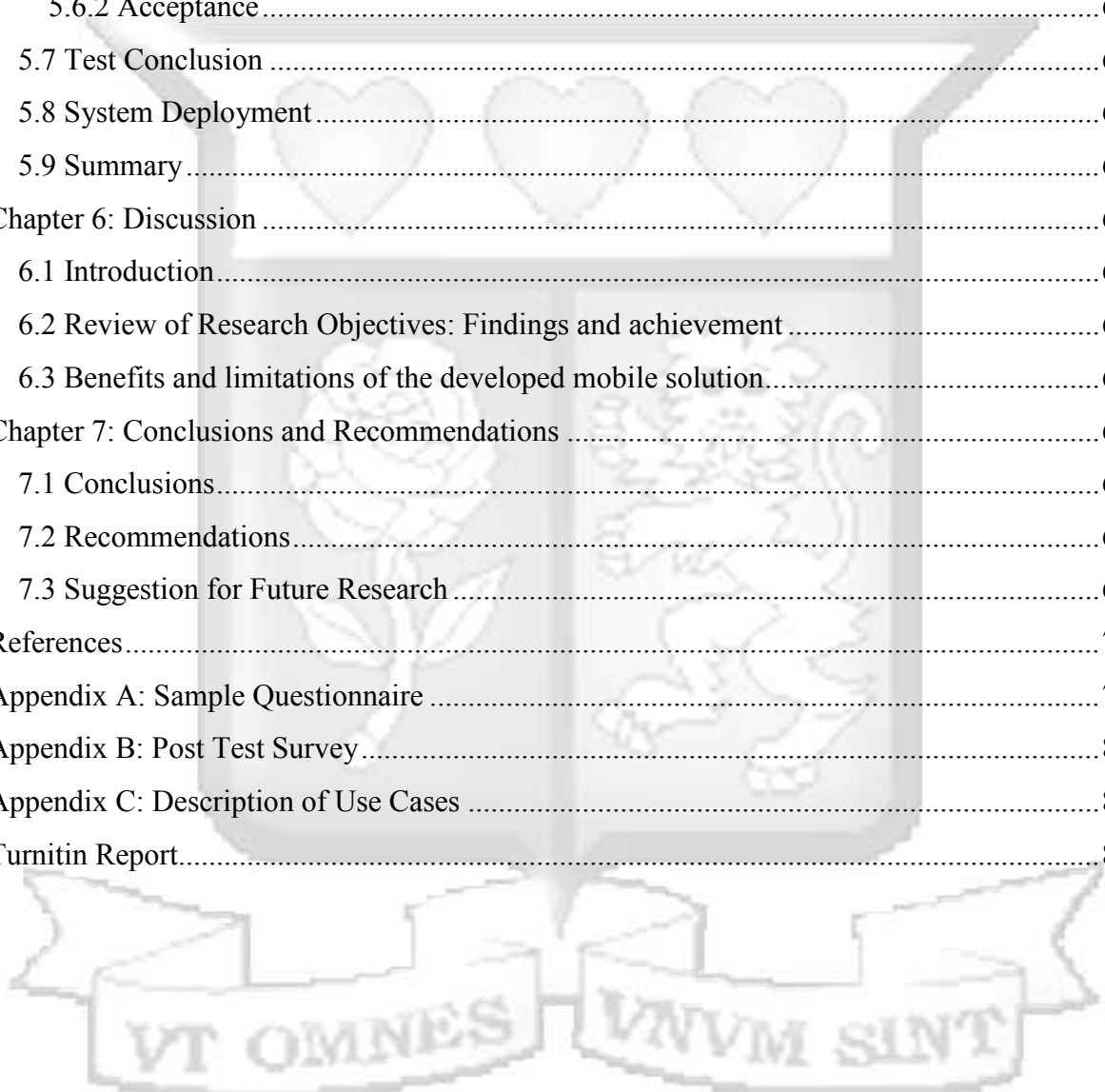
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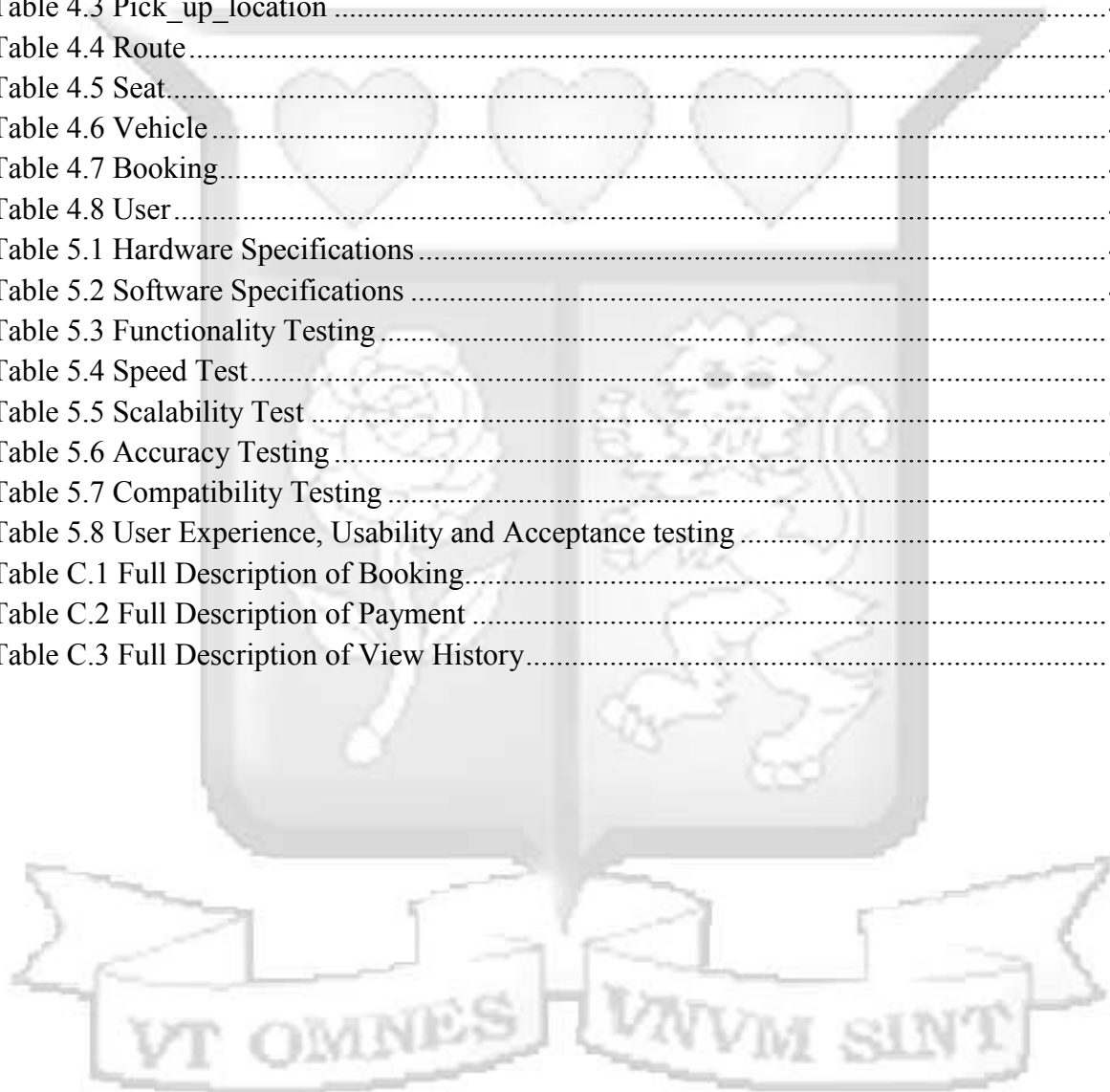
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## Abbreviations /Acronyms

PIN	-	Personal Identification Number
SMS	-	Short Messaging System
API	-	Application Programming Interface
AWS	-	Amazon Web Services
CSS	-	Cascading Style Sheets
ETA	-	Estimated Time of Arrival
FM	-	Frequency Modulation
GDP	-	Gross Domestic Product
HTML	-	Hypertext Mark-up Language
ICT	-	Information and Communication Technology
OS	-	Operating System
CVC	-	Card Verification Code
PHP	-	Hypertext Pre-processor
MMS	-	Multimedia Messaging Service
PSV	-	Public Service Vehicles
SACCO	-	Savings and Credit Cooperative
USSD	-	Unstructured Supplementary Service Data
OTP	-	One Time Password
WAP	-	Wireless Application Protocol
MP	-	Mobile Payment
QR	-	Quick Response
NFC	-	Near Field Communication

- SDLC - Software Development Life Cycle
- SPSS - Statistical Package for Social Sciences



## Acknowledgements

I thank the almighty God for his special grace and protection during the entire period of my research.

I would like to express my gratitude to my supervisor Prof. Ismail Ateya for his tireless support, sincere guidance, understanding and suggestions throughout the dissertation process.



## Dedication

Dedicated to my family and friends for the sacrifice they have made for me to complete this dissertation. Their love, care, encouragement and understanding inspired me to achieve this goal.



# **Chapter 1: Introduction**

## **1.1 Background**

The Kenyan Government has contributed towards acceleration of quick growth of economy and renewal, reduction of poverty levels and creation of wealth in the transport sector, while focusing on improving, upholding and supporting well-organized, reasonable and operational transportation systems providing a favourable surroundings for stimulation of productive tasks and enabling of economic growth and development in Kenya and the whole East African Region at large. The Public Transport in Kenya has 635 registered numbers of Savings and Credit Cooperatives (SACCOs) and over 100,000 PSVs spread across the country, National Transport and Safety Authority (2015). Vehicles also known as “Matatus” in an informal name provides services to many people on a daily basis and are fundamentally the pillar of the Kenyan transport system (Graeff, 2009).

According to new global survey, Kenya has managed to be placed at the second position in Africa among other countries that have significantly adopted cashless payment systems (Kariuki, 2013). In his report, 27 percent of Kenyans have fully adopted cashless payment systems for payment of various goods and services with the number of adoption rising gradually due to reliable mobile phone transactions. Governments and business institutions globally have made slow and steady steps towards the goal of having a society transacting without cash (Moody, 2010). The cashless payment system is thus being seen as a more convenient method of payment in business and government institutions.

The use of technology has promoted the transport sector through better responsiveness to promptly changing customer requests and insecurity, costs reduction through optimization of transport operations and enhanced safety. Small taxi operators such as Uber and Little cabs have consequent significant benefits from technology usage as they are in a position to implement more sophisticated ICT applications than their counterparts.

## **1.2 Problem Statement**

Public transport is supposed to facilitate movement of general public from one destination to the next conveniently and in a cheaper way. However this is not the case in Kenya, where there are a lot of inconveniences affecting passengers using long distance public service vehicles. This transport sector accounts for 5 percent of Kenya’s GDP (Nyasetia, 2013)

and hires at least 300,000 Kenyans as both drivers and conductors among other roles (Leis & Baghudana, 2015), where it has been challenging to standardise and systemize. The challenges that affect the long distance public transport system include for example when the passenger wants to travel to different parts of the country especially for long distances, they are forced to go to visit the booking office in order to make their bookings which makes them incur an extra travelling cost and time wastage due to long queues in the booking offices. It is for these reasons that the mobile application would help passengers make their bookings at their own convenience, pay for the journey and board a vehicle at a designated pick-up location (Iles, 2016).

There are three booking models used in transport industry. One of them being the Single Pay-as-You-Go model where a contactless card or device is used at the beginning of the journey with an already defined cost of transportation or fares for different routes, majorly for buses and trams. The second is the aggregated Single Pay-as-You-Go model is used in a situation where a contactless card or device is used multiple times and the fare combined for several journey routes in to one charge at the end of each day for multi-mode operators and lastly is the pre-purchase model which involves the use of contactless card or device associated with the advanced tickets used as a form of identity to travel. The proposed solution would implement the use of pre-purchase model since the bus company would ensure that the passenger makes a booking prior to travel date.

### **1.3 Research Objectives**

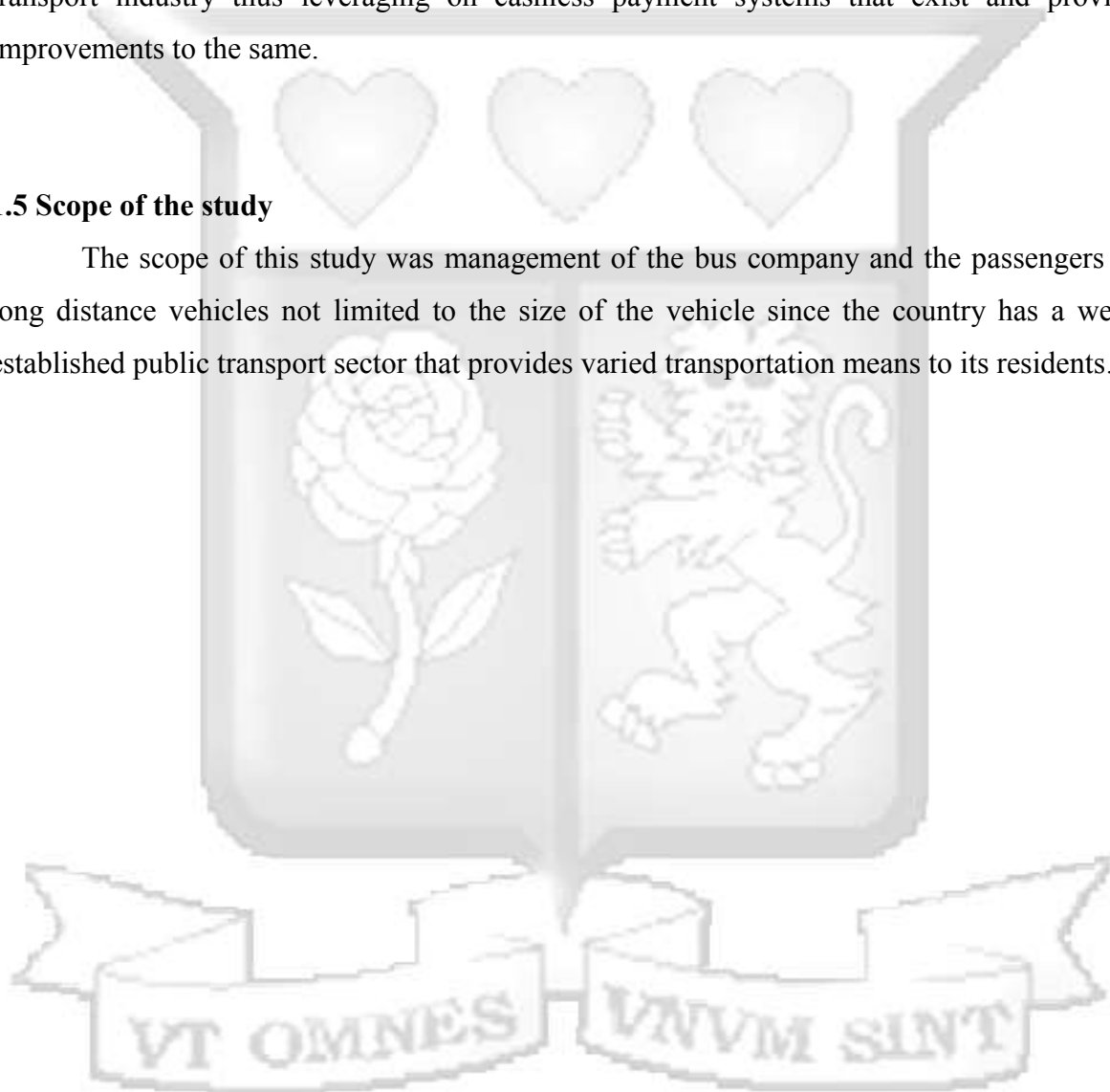
- i. To analyse the relevant information related to booking in long distance public service vehicles.
- ii. To review the challenges affecting the adoption of mobile technology in public service vehicles.
- iii. To review the existing models and architecture for booking.
- iv. To develop a mobile application to aid in improving of PSV booking operations.
- v. To test the developed application.

#### **1.4 Justification of the study**

This study suggests a mobile application that would facilitate an efficient way through which passengers can make bookings for their journey. The application aims at ensuring that the passenger makes booking and payment at their own convenience and board the vehicle at their designated area of choice. The application would make the experience of a commuter much better and safeguard the interest of passengers by enhancing the operations of public transport industry thus leveraging on cashless payment systems that exist and provide improvements to the same.

#### **1.5 Scope of the study**

The scope of this study was management of the bus company and the passengers of long distance vehicles not limited to the size of the vehicle since the country has a well-established public transport sector that provides varied transportation means to its residents.



## Chapter 2: Literature Review

### 2.1 Introduction

Public transport is the main means of transportation in many African countries. In Kenya, they go by the informal name “matatus” whose mode provides most of the public transport in Kenya which are owned by SACCOs operated by private individuals who must pay SACCOs a fixed daily rate (McCormick et al., 2013). The management complained of long queues in their offices where passengers visited in order to make a booking for their journey causing inconveniences to the passengers (Kiwanuka, 2016). According to FinScope survey 2016, several countries have tried to introduce cashless payment systems in the transport industry among them Rwanda where Tap&Go (NFC) cashless payment system was introduced to pay for the transit service which later expanded similar services to Cameroon, Singapore which introduced interoperable, contactless Visa payment options and aims at achieving cash free payments by 2020 in the transport industry and Nigeria which utilizes NFC technology to pay for fare transactions.

In Kenya, the introduction of cashless payment systems failed due to the government’s effort to force matatu operators to use separate private companies to process their transaction as compared to Rwanda who took a different approach through partnership between private and public operators. However, Kenya has implemented mobile applications used for booking where Taxi operators are making use of them. They include Uber which is a US-based company and Safaricom’s Little Cabs available in Nairobi, Kisumu and Mombasa cities, Easy Taxi a Brazilian-based company whose functionality are quite similar. The difference between the proposed solution and the taxi application is that for taxis, they ferry individuals to their designated destinations but for the proposed application, it is aimed at ferrying multiple passengers thus the passenger will be required to choose a specified seat for reservation. Thus the proposed solution aims at developing a mobile application to be used by long distance vehicles within Kenya.

## **2.2 Challenges Affecting the Adoption of Mobile Technology in Public Service Vehicles**

### **2.2.1 Complexity**

The negative effect on adoption of technology has been associated with connection amongst difficulty of a specific technology and invention (Thong, 1999; Corrocher, 2011; Tornatzky & Klein, 1982). Rogers (1983) defined complexity as the extent to which an invention is observed as reasonably problematic to comprehend and use. The apparent simplicity of use is described as the amount of simplicity to use, learning and understanding of technology by potential users. The higher information technology is perceived positively in terms of simplicity of use, the higher the acceptance rate in transport industry. The lower the perceived ease of use will lead to resistance by not only the passengers but also the public service stakeholders. Uber gained its popularity due to the teething troubles people faced while requesting for a taxis (Rogers, 2015). Past research's on impact of app-based dispatch keeps pointing out on whether the facilities respond either as another mode of changeover for public transport or just to counterpart the present means of transport systems. Experimental studies was done to identify most frequented locations by cabs operators as variables and establish that all these localities had other existing means of transport (train and bus) which led to a conclusion established from the result that minicabs compliment public transport (Veloso et al., 2011).

### **2.2.2 Attitude and Behaviour**

Ajzen (1991) defined attitude as a previous outlook to counter positively or negatively to an object, person and event or institution discriminable trait of an individual. Behaviour is predicted depending on person's boldness towards an action and individual societal belief. Numerous research's highlighted attitude towards the use of technology to be linked to strong behavioural intention and there after the actual behaviour (Sumak et al., 2011). Thus the recognition of mobile technology and the plan to use the new technology for booking processes depends on three main factors. They include the perceived:

- i. Effectiveness of the technology
- ii. Simplicity of use
- iii. Availability of resources to be used for the technology

Perceived effectiveness is the extent to which a user has faith in exhausting a specific technology would improve his or her performance. The higher the users perceive the technology as useful, the higher the likeliness that the technology would be adopted.

Perceived availability of resources encompasses carrying out a task and providing necessary maintenance to staff and users as well as technology aspects such as system accessibility, access cost, certification and observed level of regulator over the technology. The greater the awareness of the simplicity of use of these assets, the greater the approval of users (Mahapatra et al., 2008).

### **2.2.3 Internet Coverage**

The internet connectivity has been a challenge for a very long time since most passengers could not access the internet due to poor connection and terrain. The issue of internet penetration through the urban areas is good as equated to the country side areas thus making it a challenge to embrace different technologies in the public transport sector. Some of the issues leading to high costs include sheer gradients and remoteness from the main roads and main metropolitan centers which have affected the mobile phone coverage unfavourably across the region. This explains why the rollout of mobile device services in countries largely depends on the geographical landscapes of a specific country. The evolution of mobile phone systems from third-generation (3G) to fourth-generation (4G) structures and extra innovative technologies has led to cheaper phones, the scope, difficulty and effect of mobile application and services which repeatedly develop and make it easier for people in the rural areas access the internet.

### **2.2.4 Cost**

The cost of purchasing the inexpensive mobile device cost partial the average once-a-month revenue, adequate enough to nourish a household for five days. The adoption rate of mobile phones in Kenya has been significantly lower. According to FinAccess surveys carried out between the years 2006 and 2009, it is evident that the fraction of Kenyans owning a mobile device continued being fairly static but the number of subscriptions tripled to 17 million by 2009 (GSMA, 2009). The acceptance of mobile phones devices improved by 74 percent between 2006 and 2009 from 27 percent to 47 percent respectively. However, a third of Kenyans shared their mobile phones with the extended families, being in support of qualitative

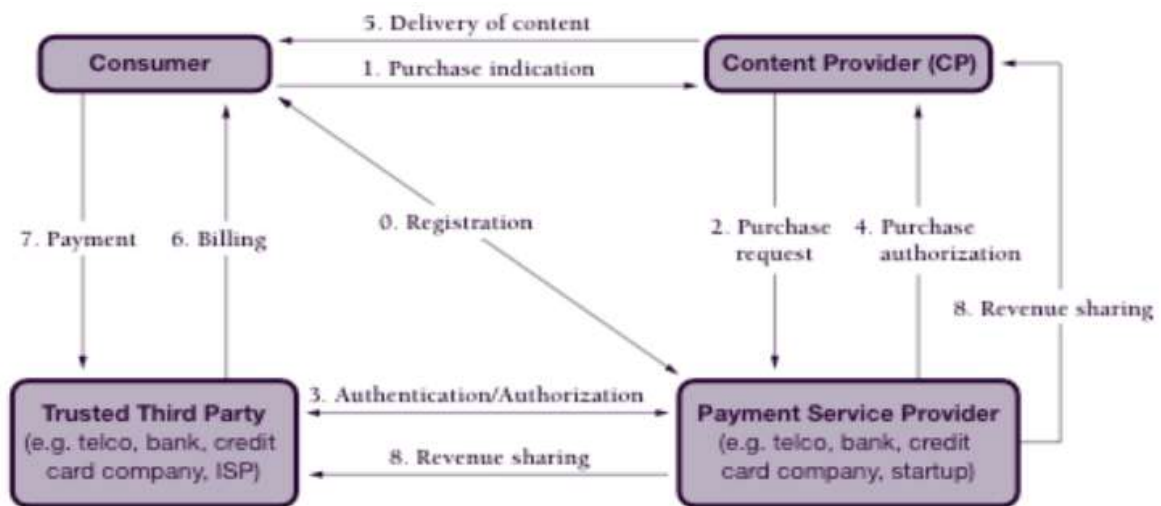
evidence of free-riding and use of mobile phone as a common property resource in sub-Saharan Africa. In addition, such arrangements could also mirror cost-sharing amongst the low income earners in the rural areas for whom the cost of handsets and services is still expensive. Thus the naivety of the mobile market and the uncertain return on investment offered by mobile market are supplementary hurdles for technology acceptance (Frolick & Chen, 2004; Gebauer & Shaw, 2004; Mallat & Tuunainen 2008).

### **2.2.5 Security**

Absence of assurance in safety of the services has made the passengers not to adopt to the technology since mobile business communications are susceptible to scam and unauthorized payments. According to Comminos et al. (2008), users would only execute by electronic means if there is accessibility and safety. In addition, Sharma and Singh (2009) establish that Indian mobile banking consumers are specifically worried about concerns such as economic scam, account misappropriation and user responsiveness among others; struggle in memorizing the changed codes for not the same natures of operation, presentation software setting up and updation due to absence of normalization. Further they recommended that the safety of the e-channel is a main effect preventing widespread implementation. Those at present making use of electronic system of banking seem to have additional assurance that the system is trustworthy, where as non-users are much more service sensible, and do not depend on financial operations made by means of electronic networks. Non-electronic method of financial transactions consumers have a tendency to additional undesirable administration perception towards it.

### **2.3 Mobile Payment Models**

Mobile payment is defined as a compensation being carried out in a wireless form via a mobile device (Adrian, 2002). Mobile transactions were recommended as a substitute mode of expenditures at a point-of-sale systems where money as a means of payment has been declining for countless years. The mobile service providers launched initiatives based on four-entity model which brought together the consumer, merchant, trustworthy third party and the payment service provider. Figure 2.1 shows the main mobile payment phases (Buhan et al. 2002) which is has been achieved through the use of mobile device in making payment due to its convenience and speed.



**Figure 2.1: Mobile Payment Main Phases**

The change in technology has brought about changes in how businesses are handled or run. For instance, the consumer is in a position to make purchase of goods or services remotely since they are in a position to make payment via their mobile devices. Initially, payment had to be made on a face-to-face basis or in form of cash but with the development in data wired networks has made it possible for payments to be made remotely. The current changes in technology is aimed at implementing wireless systems that can handle distant as well as cash basis single devices.

However, a business deal can be viewed in different dimensions where they are used in making payment thus identifying multiple dimensions associated with payment but there are strategic issues that need to be focused on when dealing with payment selection. Table 2.1 shows the categorization of payment market dimensions as adapted from (Telecom Media Networks, 2002).

**Table 2.1: The Different Dimensions of Payment**

Dimensions By	Examples
Means	Cash, Paper, Card, Electronic, Tokens/money surrogates.
Size	Micro-payments, Macro-payments.
Place of purchase	F2F, Remote/online via Emails.

Origin of the Seller or Buyer	B2B, B2C, P2P
Type of Purchase	Physical goods, Digital/electronic goods, Rights (rich media)
Clearing and Settlement Method	Bilateral, Multilateral (joint clearing house), Using intermediaries
Type of Transaction	Pay Per View (PPV), Pay Per Unit (PPU)
Type of Payment	Debit, Credit, Pre-pay (against stored value).
Geography	Domestic, Cross-border, Single currency, Multiple currency.
Location of Payer's Account Details	Network-/server-based, Client-based i.e. Device or Chip

The emergence of mobile payment has gained popularity over years due to its usage on a day-to-day basis but is still a voluntary method for legacy payment systems because the total cost of every transaction and the payment technique differs (Wiedemann et al., 2008). This poses some challenges such as security of the mobile payment that need to be taken care of. According to Dahlberg, SMS and value added services are considered to be costly and transaction fee irritate some customers (Dahlberg 2002). Thus the service providers should find the correct model for consumers to adopt the new mobile application that are yet to penetrate the market. A careful analysis should be put in to consideration to implement the solution effectively, thus some factors should be considered before the implementation of the new application. They include the ease of use, reliability, cost effectiveness, security and flexibility among others.

- i. **The simplicity of use:** This is the extent to which the consumer may possibly operate the solution with minimum struggle. The customers should be in a position to adopt the new application and make payment with few instructions.
- ii. **Dependability:** The proposed solution ought to function with least problems in normal conditions as well as survive astonishing conditions that might arise.

- iii. **Cost effectiveness:** The additional cost of transaction contributes to the final product price thus an increase in price with a small margin could lead to customer lose.
- iv. **Security:** The solution should safeguard payment information and consumer's information further inhibiting commerce scam from happening. This can be achieved by putting into consideration concerns of concealment, confidentiality and non-repudiation.
- v. **Flexibility:** This takes in to account in what way the solution may possibly be combined with additional means of payment since it cannot reach higher number of customers if it might work individualistically with the kind of equipment the users possess.

With above factors in consideration, mobile payment solution can therefore be categorized in to four models based on different authentication methods (Ondrus et al., 2005). They include:

### 2.3.1 Direct Mobile Billing

Direct mobile billing is a payment method for goods or services by charging the consumption to a cellular mobile account. The customer decides on the mobile billing preference on a smartphone device and follow a two aspect validation technique (Feig, 2007). The authentication involves PIN (personal identification number) and One-Time-Password (OTP) where a customer's mobile account is deducted for the quantity of the acquisition inclusive of the appropriate levies and in some cases dispensation charge (Kendall et al., 2011). The benefits provided by this model includes:

- i. **Safety:** Two-aspect validation and a risk administration engine inhibits scam.
- ii. **Accessibility:** Prior registering and new software device is not essential.
- iii. **Simplicity:** A customer should be in a position to use the application with few instructions.
- iv. **Fast:** Businesses are accomplished within at most 10 seconds.

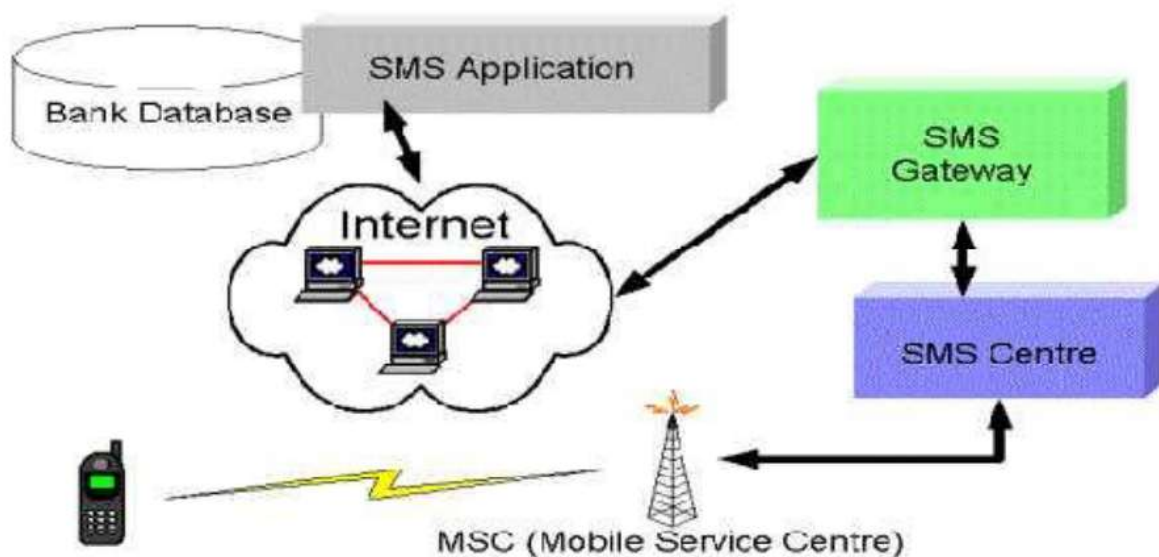
Thus 70 percent of all digital content acquired virtually makes use of this method.

### 2.3.2 Premium SMS, MMS based Transactional Payments

The use of SMS necessitates a communication procedure facilitating the interchange of short manuscript posts amongst two mobile devices (Valcourt et al., 2005). This means making use of text messages to pay for products or services. The SMS has been the traditional compensation tool and has developed the utmost revenue prospective surrounded by mobile

payment applications (Kadhiwal and Usman, 2007). The customer makes a request through an SMS text message or an USSD to a short code in order to make payment and a quality duty is applied to their mobile device. The consumer engaging in transaction is notified of successful compensation and can be able to issue the merchandises paid for (Patel et al., 2015). According to (“eecommerce.fandom.com – Premium SMS based transactional payments”), there are benefits associated with this model which include the immediate admission to billions of mobile phone operators since billing is controlled by the handset consumer. Below is the typical process used by the end users in transacting using this model:

- i. A consumer directs SMS with keyword and unique digit to a Premium Short Code.
- ii. A consumer obtains a PIN (User payable via the short code on acknowledgement of the PIN).
- iii. In conclusion, a consumer enters PIN to get right to use the content or services.



**Figure 2.2: SMS Architecture**

As far as transactional payment is concerned, there are several limitation associated with this it. They include slow speed whereby sending messages can take ages for the merchant to acknowledge the payment. This model is unreliable since the transactional payments are associated with high costs and can fail to deliver messages as they get lost since the settling of payments via MMS and the customer support costs for a number of messages that get lost or are delayed is high (Pigneur et al., 2010). The MMS deliver barcodes which can then be scanned for confirmation of payment by the merchant. The limitation associated with MMS payment model is that it is not being used due to its security issues (Salonen, 2017).

### 2.3.3 Mobile Web Payment (WAP)

The Mobile Web Payment makes use of Wireless Application protocol where the user connects to the bank by using this gateway and transact online (Yeun and Farnham, 2001; Teo and Pok, 2003; Hung et al., 2003). The consumer makes payment via web pages exhibited on browser installed on a mobile device. This model is considered due to its advantages of uniqueness and openness to standards technologically advanced by selected main wireless telecommunications corporations in the world (Wap forum, 2011) that provides high customer satisfaction due to quick and predictable payments and simplicity of use from a conversant set of virtual compensation enjoyed by customers. It makes use of credit/debit card or prior registration at virtual recompense clarification unless the mobile account is directly indicted through the mobile network operator (Steve, 2019). Below is an architecture on how Mobile Web Payment works.

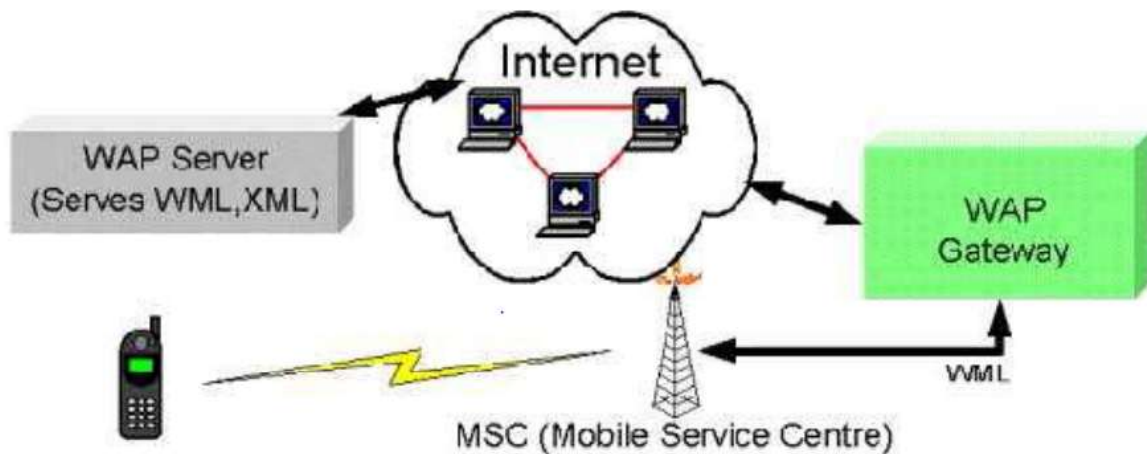


Figure 2.3: WAP Architecture (Schiller et al. 2003)

### 2.3.4 Contactless NFC (Near Field Communication)

NFC technology is a short range half duplex communication relying on the inductive connection standard amongst conveying and reception devices. The NFC technology consists of several players who make use of client-server architecture. They include the motivator who initiates the communication and control interchange of information and the receiver who responds to requests from the motivator. This model can either work with the terminal interchanged on or off, refining its functionality (Kanniainen, 2010; Kumar, 2010; Ruijun et al., 2010) by associating the purchaser's banking information to the terminal done via a chip, the SIM card of the receiver or even the memory card. Thus NFC communication involves three devices that is smartphones, NFC tags and NFC readers (Madlmayr and Langer, 2008;

Van Damme and Wouters, 2009; Sanchez, 2009; Ruijun et al., 2010; De Bont, 2011; Ok et al., 2011). The NFC tags mechanisms include an inactive way thus no transistor occurrence field is produced, while the reader generates a broadcasting regularity field to interconnect and the smartphone communicates with others in a reflexive or vigorous way. A customer by means of a special handset armed with a smartcard brings their device close to a reader section (Gelb & Clark 2013). A number of dealings involve verification PIN before a business deal is concluded where payment is made through deduction from pre-paid account or indicted directly from a mobile or bank account. NFC possess challenges such as slow implementation due to inadequate supporting infrastructure, multifaceted network of investors and standards (Bravo et al., 2007; Sanchez, 2009; Ozdenizci et al., 2010; Issa, 2011). Thus NCF can be used in combination with a barcode on the portable device for mobile compensation.

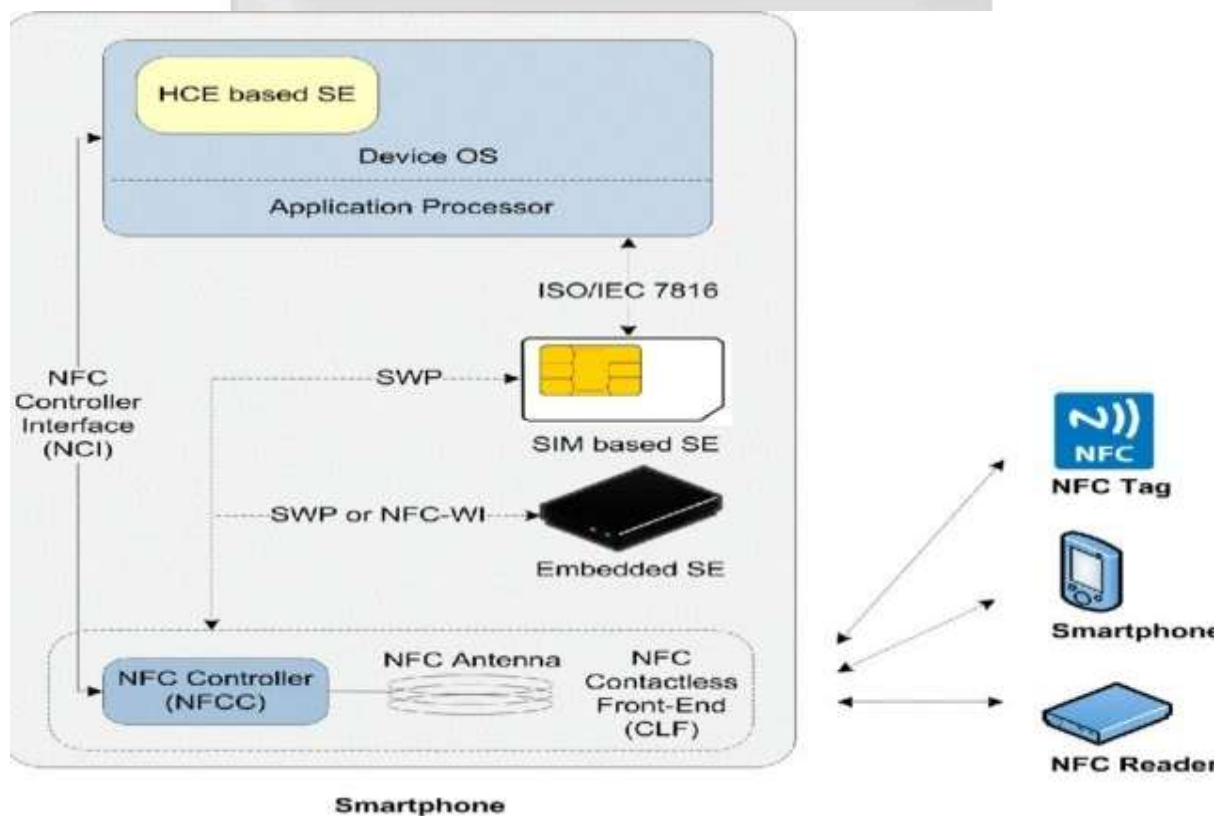


Figure 2.4: General Architecture of a NFC smartphone (Coskun et al. 2013).

## **2.4 Mobile Payment Framework**

Mobile payment provides clarifications which may be described on the basis of attributes relating to a procedure or tools in use. Process dimension on the other hand is well-defined as the payment method in usage and should include client significance as a measure while technology dimension describes how a payment process works and incorporates both physical and virtual payments. This can however be categorised as either value or integration dimension. The value dimension is known to be associated with both customer benefits and needs (Kauffman and Walden, 2001) while integration dimension is concerned with mechanisms, or technologies through which payments are implemented. It is concerned with how compensation is administered and independence of either operation type or payment networks (Gump and Pousttchi, 2005).

### **2.4.1 An Initial Framework for Mobile Payments Integration**

Payment Integration is a process of merging demand and supply. Its measurement discusses the extent to which the payment features are known and communicated and involves the shift from outdated modes of payment to increased modern payments (Olsen et al. 2011). In the context of electronic payments, a framework has been suggested to conceptualize the mobile payments position. The information valuable to consumers is based on binary magnitudes, one and only being associated to the level of visibility of acquisitions and compensation facts and the other correlated to the regulator of the transmission of worth due to the point to which imbursement practices are incorporated by an automated means. The purchase control facet deals with the shift between a guarantee to purchase and settle the owed amount (Carton et al. 2012). It is with this reason that makes it possible to link the cost of scheduled disbursement with the concrete funds accessible.

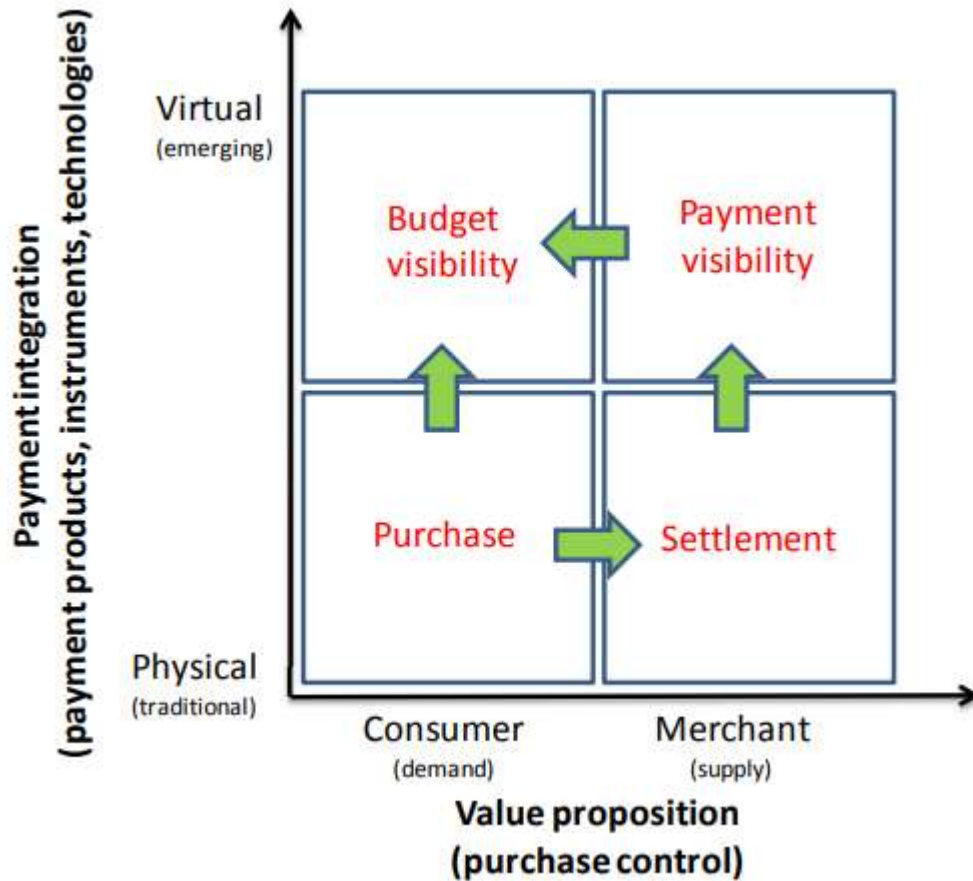
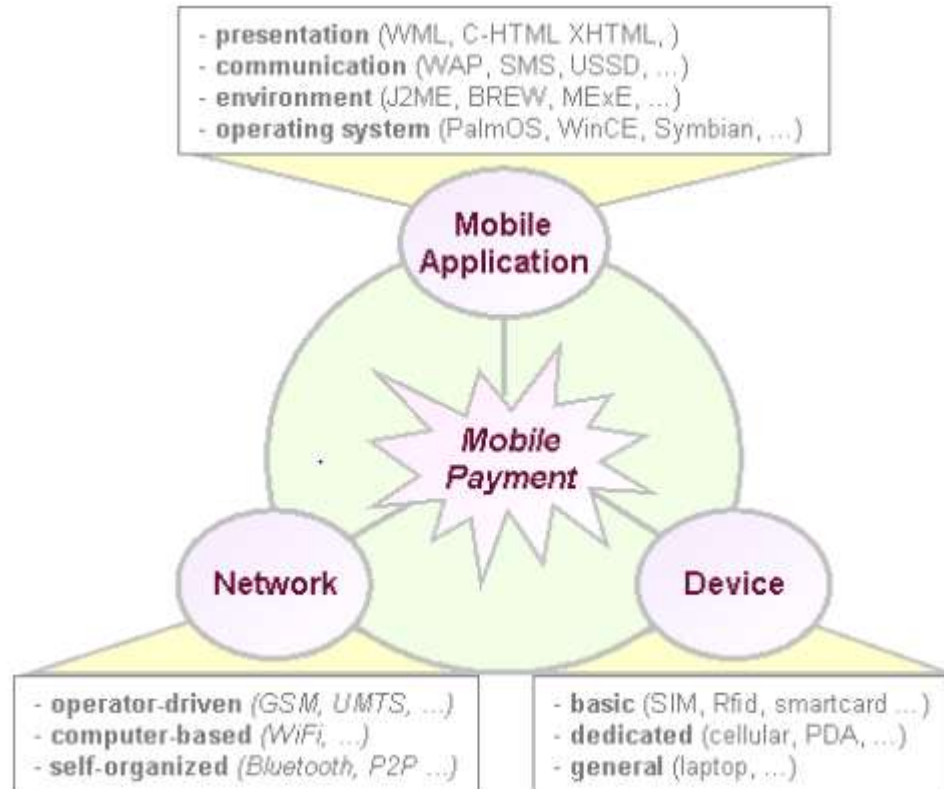


Figure 2.5 Integration Framework for payment model (Dahlberg et al. (2007).)

### 2.4.2 Mobile Payment Framework

According to Dahlberg, consumers get irritated by the operators and banks transaction charge by making use of SMS and value added services which are quite expensive (Dahlberg, 2002). Thus the service providers should put in to consideration the correct revenue model if they want the consumers and merchants to make use of the new mobile application. Camponovo and Pigneur 2003 proposed three dimensions to enable a consumer understand the technologies in mobile payment.



**Figure 2.6: Mobile Payment Framework**

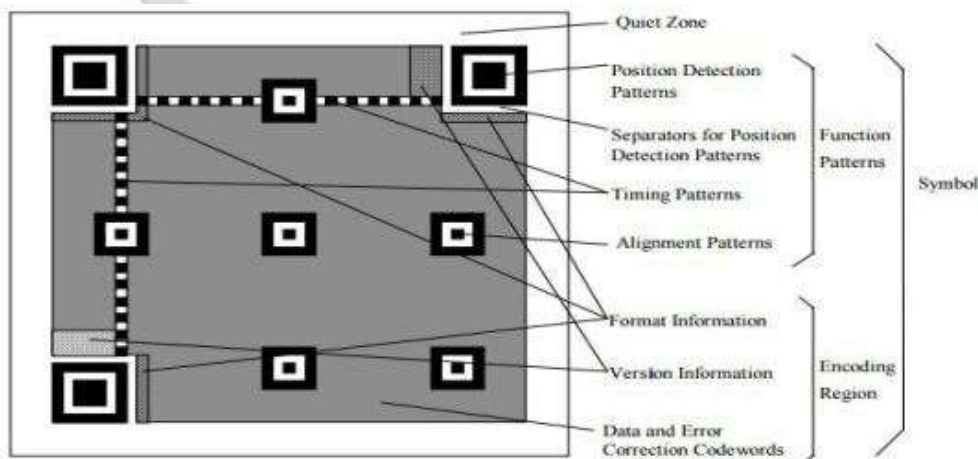
As shown in Figure 2.6 above, the network brings together the technologies used in wireless network infrastructure while the device signifies the wireless consumer infrastructure such as mobile phone and the mobile application designates the technologies used by mobile application developers, service and content providers.

## 2.5 Payment Architectures

### 2.5.1 Quick Response Barcode Technology

QR code a binary-measurement (2D) barcode that is in a position to be read by specific portable headsets with assimilated cameras. A reason behind the 2D is its capability to transmit data in both the perpendicular and the plane path. The QR Code is a listed emblem of Denso Wave Inc. in Japan and supplementary nations (Lyne, 2009). However there is existence of advanced QR codes which make use of 3D codes with the extra facet colour-depth and 4D codes with multi-sequential demonstration (Langlotz & Bimber, 2007). Coming up with a decision on which code to use is largely governed by the requests of the solicitation situation. QR Codes have been made popular by users of the handsets since the barcode can be castoff as a medium of storage where addresses and URLs are kept. Consumers can image QR code

which has been coded to do several tasks such as displaying manuscript, providing interaction details or vulnerable webpages in a browser with the help of a camera-enabled smartphone. By making use of QR Code standards, the software ensures that the codes are read correctly thus they can be reproduced and exhibited somewhere for portable devices users to access and scan to enable transaction payment. It can as well be presented virtually (Waters, 2012) thus various virtual services can produce a QR Code established on the evidence provided when representing the QR code.



**Figure 2.7: QR Code Architecture (Rani et al. 2016)**

QR Codes were originally used to track parts in vehicle industrial, but are presently being used for comprehensive collection of requests targeting mobile-phone users. The QR code can prompt mobile device to show encrypted manuscript, access virtual URLs stored in QR code and ring a phone number, start manuscript communication or import contact information (vCard) after scanning (Sansweet, 2011). It has several benefits such as having high capability of encoding information, small printout size, and opposition to dust and destruction, comprehensible flexibility, organised appending and high creativity levels (Garg and Singh, 2013). Despite the QR code continuously gaining popularity in the market, awareness and familiarity of QR codes should be created due to its significant contribution to make positive impact in businesses (Okazaki et al. 2011a; 2011b).

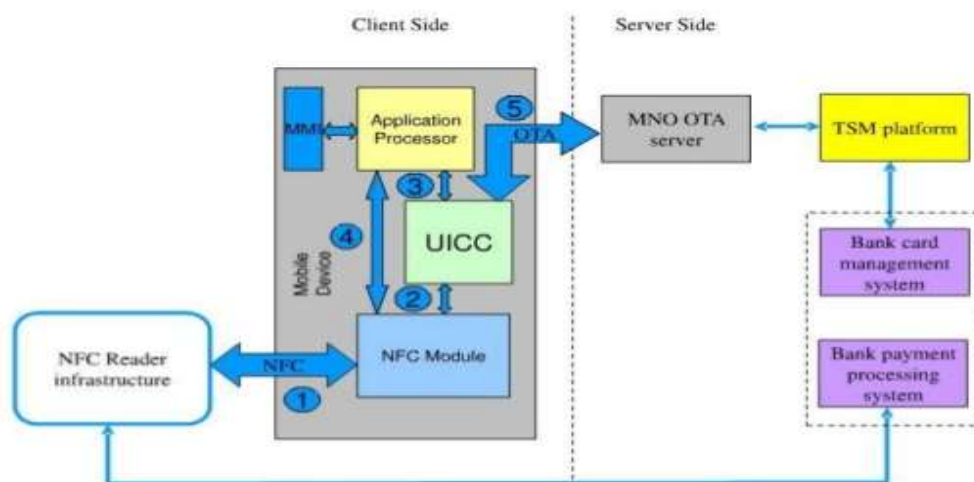
### **2.5.2 Near Field Communication Technology**

The NFC know-how integration to portable devices has been getting bigger over years. It enables consumers to connect to various Mobile-commerce prospects in day-to-day activities. NFC evolved from Radio Frequency Identification (RFID) technology which was

established from tiny range wireless communication equipment bringing dual NFC well-matched devices composed in an expanse of less than four centimeters. NFC chips are entrenched in method that can direct encoded information at a near field to reader positioned to conduct business. This knowledge enables people to transfer data between two devices in close proximities.

According to Frost & Sullivan (2013), the number of mobile phones which have adopted NFC will increase to 863 million by 2015, which will account for 53% of total mobile phone sales in the market (McBride, 2011). The motivating factor behind NFC is the society’s perpetually accumulative requirement on, and demand for smartphone functionality. General public are making use of their handsets to make life cooler through the use of considerate applications. Portable receivers are now being used much more replacing personal computers, and the tendency is swiftly developing. With this rising inclination, advanced technology establishments are discovering new ways to make people’s lives simple by linking mobile devices with the use of ultra-short wireless waves.

The idea of NFC in public transportation is not new but how to implement it efficiently is. Bay Area Rapid Transit (BART) a California transportation system executed its first experimental back in 2008. The sample nominated riders who were given a NFC aided Sprint phone which allowed them to enter the train gates and pay for their trips by tapping their phone on the platform of the gate entrance (Drey, 2011). With the advancement of expertise within portable devices, additional transportation specialists partake the implementation of mobile technology with United States, Europe and Japan being on the lead.



**Figure 2.8: NFC Mobile Payment (Okuboyejo, 2014)**

NFC has proved to have some strengths and weaknesses over years. The upstanding side of NFC being the security measure as compared to other wireless connectivity protocols such as Bluetooth and Wi-Fi. The closeness brings about security thus making it less predisposed to horse-riding by third party. The security feature could be used as an identification and validation technique for both Bluetooth and Wi-Fi connection to be established for sophisticated data transmission promptness (Ochikubo 2012). NFC's ability to transfer data with lesser rapidity of 106 kbps to 424 kbps ensures low power consumption for mobile phones. However, its advantages can be counted as disadvantages as well. For instance, the low data transfer speeds makes it impossible to be used in streaming data and it is prone to hacking since hackers can gain full access to the android based smartphones and run malicious codes. Despite the drawbacks, NFC is a promising technology in making payments since its adoption has been successful over years. This has been achieved due to its ability to consume less battery than other comparable wireless technologies.

## **2.6 Payment Technologies**

With the escalating attention in e-commerce, automated compensation methods have exploded in various means, the furthest common technique being payment by credit card, perhaps due to its minimalism. The consumer just enters the appropriate information that is the card number, expiry date and the CVC where the dealer change to these details authenticated and compensation made. The security should be improved through encryption of communication between the user and the merchant. Alternative payment methods such as credit cards, electronic coupons and e-wallets have gained popularity in the current market.

### **2.6.1 Mobile Wallets**

Mobile devices has created value in a multitude of dimensions one of them being the replacement of desktop as indicated by CamScore (2014) since most people prefer use of mobile devices to access internet. According to Burdge, 2014, 65% of the emails opened are achieved through the use of mobile devices. Use of mobile devices for making purchases is becoming supplementary communal every year. A research done on 3,000 retailers by Criteo in 2015 revealed that mobile devices accounted for 31% of e-commerce operation in the U.S. and half of the dealings in Japan and South Korea (Criteo, 2015). The rapid improvement in use of smartphones in e-commerce led to acceptance of mobile devices which stimulated mobile payment tools. With this background, mobile payment (MP) is known as the

commencement, endorsement or conclusion development of recompense via mobile communication systems and devices (Pousttchi, 2008). MP has emerged as an alternative compensation technique to credit cards and cash. MP methods are anticipated to be most important tools in numerous transactions outstanding to the cumulative acceptance of mobile devices and swiftly developing portable commerce undertakings (Ondrus & Pigneur, 2006). Considerate inspirations and obstructions to implementation would help all the contributors of the mobile payment environment extending from smartphone fabricators to banks and small to large retailers in designing workable policies.

### 2.6.2 Payment by Credit Card

Credit card compensation structure encompasses the usage of malleable card with a magnetic stripe which has been improved to a chip that stores cardholder's credit account information with a bank or supplementary monetary organization (Elif et al., 2009). The consumer makes use of the card to recompense for products and services in lieu of cash and transactions are recorded by the bank as commitment to be paid off at a prearranged period.

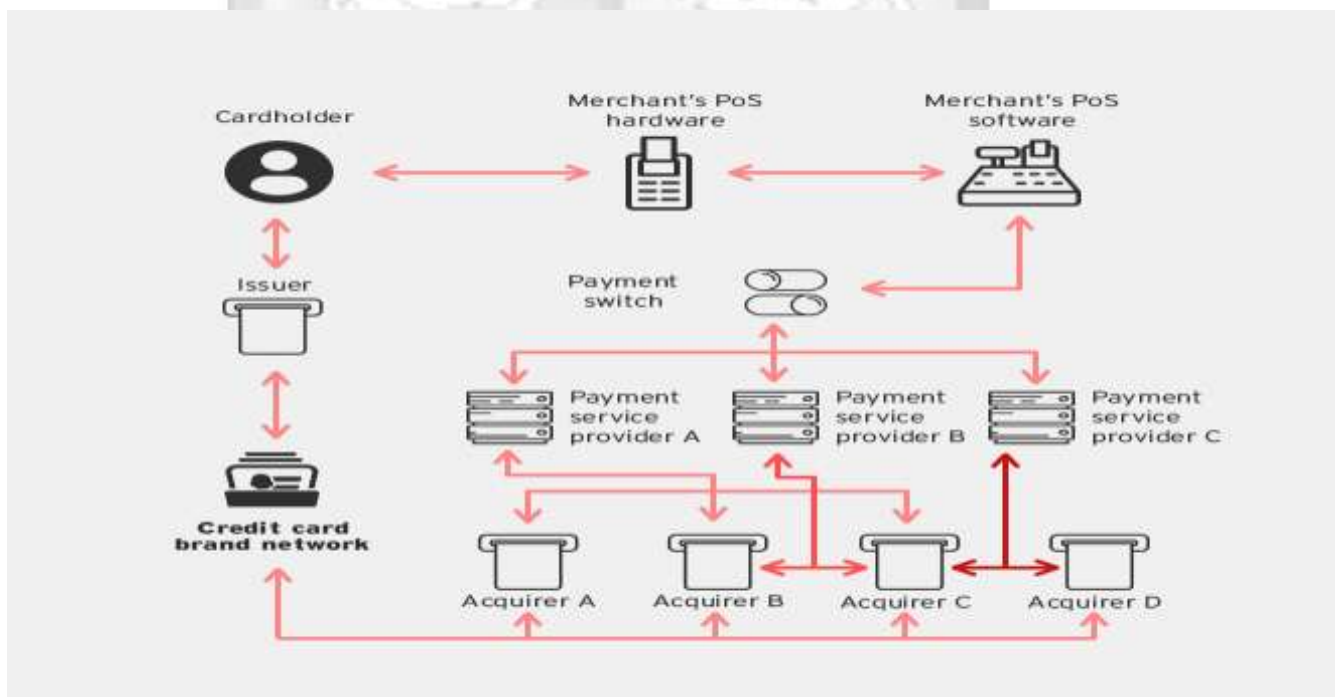
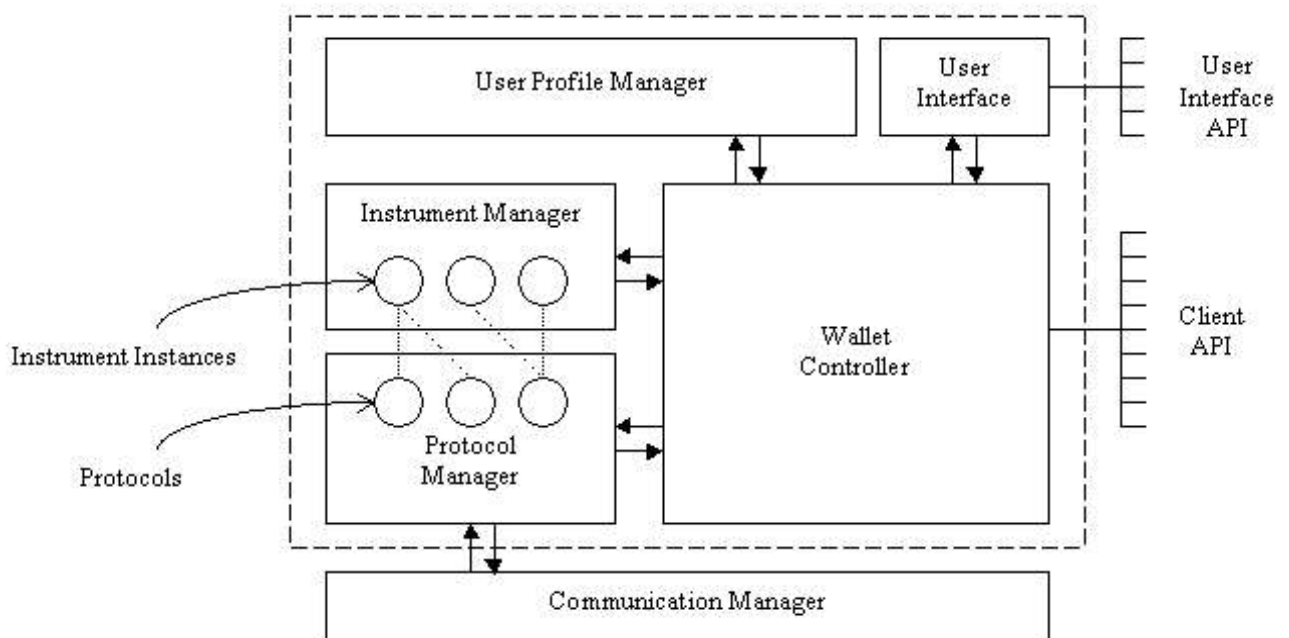


Figure 2.9 : Payment by Credit Card (Singh, 2013)

### 2.6.3 Digital Wallet

Digital Cash is the method in which an individual can securely recompense for goods or services automatically devoid of essentially encompassing a bank to intercede the transaction (Bagla et al., 2018). Other names used in place of digital wallet include e-currency, e-money, electronic cash, electronic currency, digital money, digital currency, cyber currency. Electronic money is clearly known as an electronic storage of economic assessment on a technical device that may extensively be used for performing transactions activities other than the issuer deprived of certainly linking bank accounts in the business deal, but acting as a prepaid conveyer tool. A Digital Cash transaction consist of a payer, payee and a financial network like a bank where withdrawal from the account, disbursement to the payee's wallet and credit currency is relocated to the payee's account.

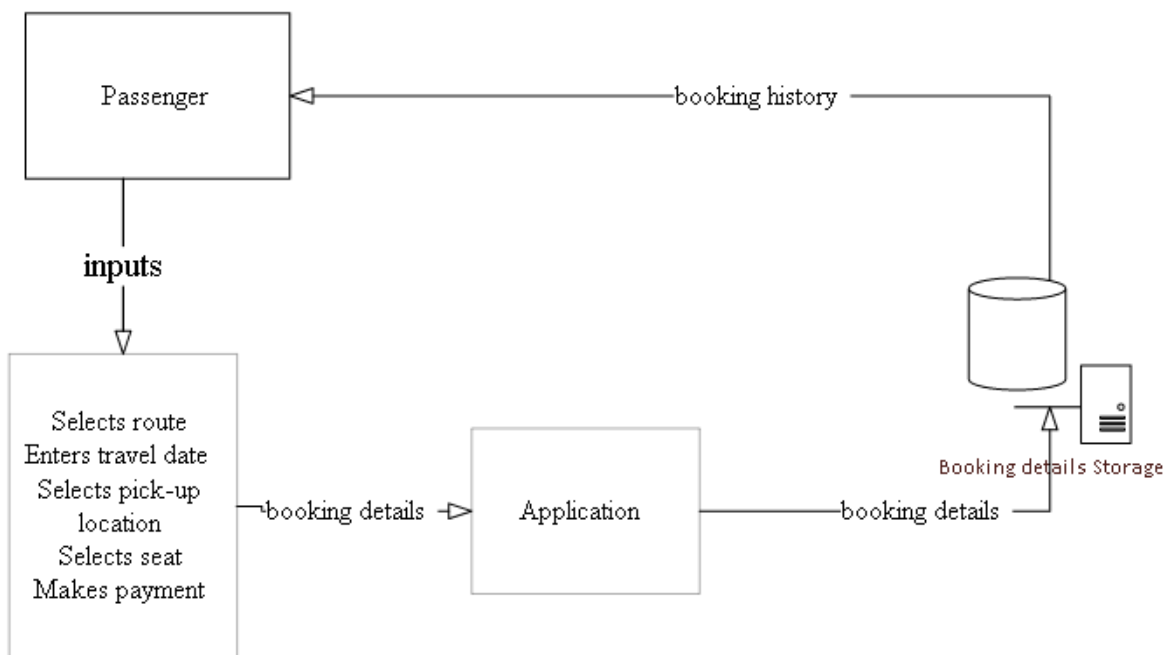


**Figure 2.10: Digital Wallet Architecture (Daswani N., et al. 2000)**

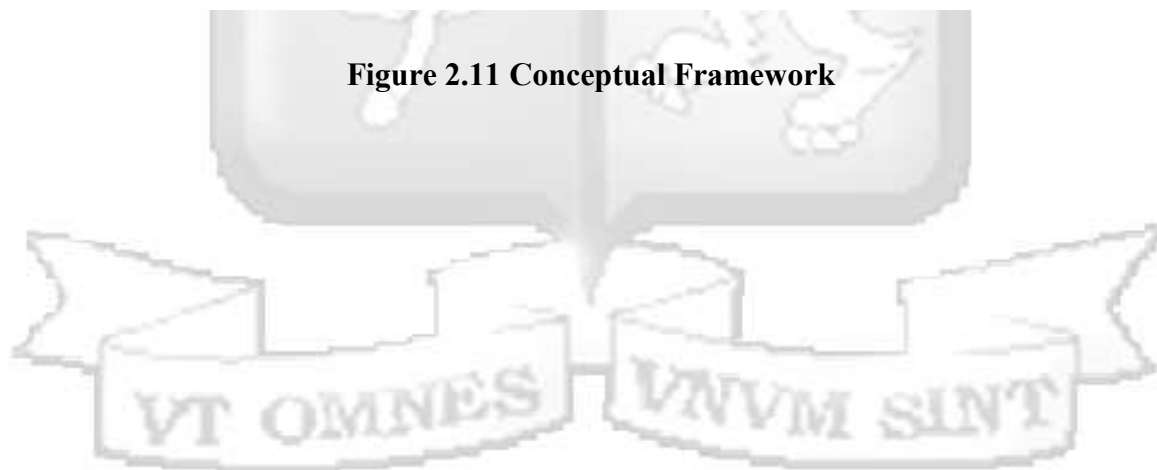
### 2.7 Conceptual Framework

Kombo and Tromp (2005) describe a concept as an intellectual or universal idea that is derived from specific occurrences or experience. Conceptual framework is therefore defined as a model that has been hypothesized that maps the relationship among the constructs of a model under study (Mugenda, 2003). Its aim is mainly to classify and show the relevant

concepts that would map the research, identify the gaps in the research and show the relationship among concepts. For this research, the researcher adopted Pre-purchase model achieved through the implementation of mobile payment and payment by credit card technologies.



**Figure 2.11 Conceptual Framework**



## **Chapter 3: Research Methodology**

### **3.1 Introduction**

Wolf and Pant (2005), define research methodology as a design used to discover knowledge which aids in answering specific questions or issues. It is further emphasized by Chekland (1981) as a set of principles of methods which in any particular situation, has to be reduced to a way uniquely suited to a particular situation. This chapter describes the techniques and methodologies that were used to collect relevant data that would help in analysing the challenges faced by passengers in making a booking. It also provides an in-depth examination of steps, procedures and methodologies employed to design and develop the mobile application solution

### **3.2 Research Design**

A research design gives a deep understanding of how the researcher collected the preferred data (Churchill & Iacobucci, 2009; Bryman, 2008). The research applied survey where a representative and unbiased sample drawn from both passengers and staff of bus companies were selected to examine the PSVs booking systems. It is estimated that most passengers invest their time and an extra cost to visit the booking offices in order to obtain a ticket. Passengers spend their time travelling to the offices and queue in order to make a booking while incurring a cost to achieve the same. On the other hand, the bus company employs more staff to serve the customers thus increasing the company's costs. To counter the challenges experienced by both the customers and the bus company, a mobile solution was designed to provide a platform through which passengers would make booking at their own convenience and Bus Company to generate more profits due to reduced employees.

### **3.3 Population, Sampling Design and Sample Size**

#### **3.3.1 Population**

A population is defined as the entire collection of elements about which a researcher wishes to generalize study findings (Cooper and Schindler, 2000). They further referred to population element as the subject on which the measurement is being taken. The study's target population included the staff of bus companies and the passengers making use of long distance PSVs. The target population of the study comprised of 100 both staff of the bus companies and the passengers.

### 3.3.2 Sampling Design

Yin (2013) notes that sampling design specifies the possibility of a particular sample being drawn from the entire study population categories. Any declarations made about the sample should be true of the population. Since the sample would be drawn from different categories such as the bus company staff and passengers, the study used stratified sampling to come up with a specific number of respondents based on the percentage of the total population that share the same characteristics

### 3.3.3 Sampling Frame

According to Turner (2003), a sampling frame is a set of items where the sample size will be drawn from. It also refers to a list of elements present in a population from which the sample is to be drawn from. The sample frame for this study included the selected PSV routes achieved through purposive sampling since long distance vehicles operate in different routes.

### 3.3.4 Sampling Technique

According to Jackson (2011), stratified sampling is a technique designed to ensure that sub-groups or strata are fairly represented and obtained by dividing the population in to sub-samples or strata. It is used for a population that is not homogeneous and whose members can be grouped into sub-groups that have similar characteristics. Thus this sampling technique was used to group the passengers and staff as a representative of the entire population.

### 3.3.5 Sample Size

Sample size is an integral part of the total population of persons involved in a study that have been selected to participate in the study using different sampling techniques (Creswell, 2013). To get a representative sample from the target population of 25,000 persons, this study applied Yamane (Yamane, 1963) formula, with 90% confidence level.

The calculation formula is represented as follows:

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

Where:

n=sample size required

N= the population

e=the level of precision (%)

By substituting in the formula above where  $N=25,000$ , with a precision level  $e=10\%$ , the sample size is estimated to be 100 with the precision level of 0.1. Stratified sampling was applied where the population was placed in two groups of strata: passengers and staff. Simple random sampling was then applied that allowed all respondents an equal chance of being selected to be part of the study. According to Mugenda and Mugenda (2003), a sample of between 10-30% is deemed sufficient enough for homogenous population. Thirty percent (30%) of respondents were selected from each stratum: thus totalling to a sample of 31 respondents out of the population of employees and staff of bus companies operating in long distance routes.

**Table 3.1 Sample size**

<b>Description</b>	<b>Population</b>	<b>Percent</b>	<b>Sample</b>
Passengers	85	30%	26
Staff	15	30%	5
<b>Total</b>	<b>100</b>		<b>31</b>

The data collected designed the basis for determining the solution adopted. Using the data gathered, a mobile application was developed and presented to users to understand the needs and fulfil their requirements.

### **3.4 Data Collection**

Data collection is a means by which information is obtained from the selected subjects of an investigation (Creswell, 2013). The choice of a tool and instrument depends on the attributes of the research topic, the objectives of the study, design and expected data and results. The research used questionnaires to collect primary data. A questionnaire is a document for data collection, where the respondents answer the same set of question asked in a predetermined order. The study collected primary data by making use of closed questionnaire in an effort to easily collect quantifiable information. Secondary data was also collected through review of existing data from journals, books, online and other research previously done.

### **3.5 Data Analysis**

Data analysis and interpretation involves cleaning up the collected field research information before undertaking to deduce it so as to give a meaningful interpretation, explanation and draw conclusion (Kothari, 2004). The filled questionnaires were checked for comprehensiveness and reliability then coded and analyzed quantitatively. The quantitative data was grouped in to categories that would enable the researcher to make general reports from the observable elements. Data from feedback form was summarized, coded and analyzed. The coded data was fed in to the Statistical Package for Social Sciences (SPSS) version 21 for analysis since it can easily be linked with Microsoft office utility programs and user friendliness. The study derived percentages from the data analysis for each variable. Results of the study were then presents in pie charts and bar graphs.

### **3.6 Research Reliability and Validity**

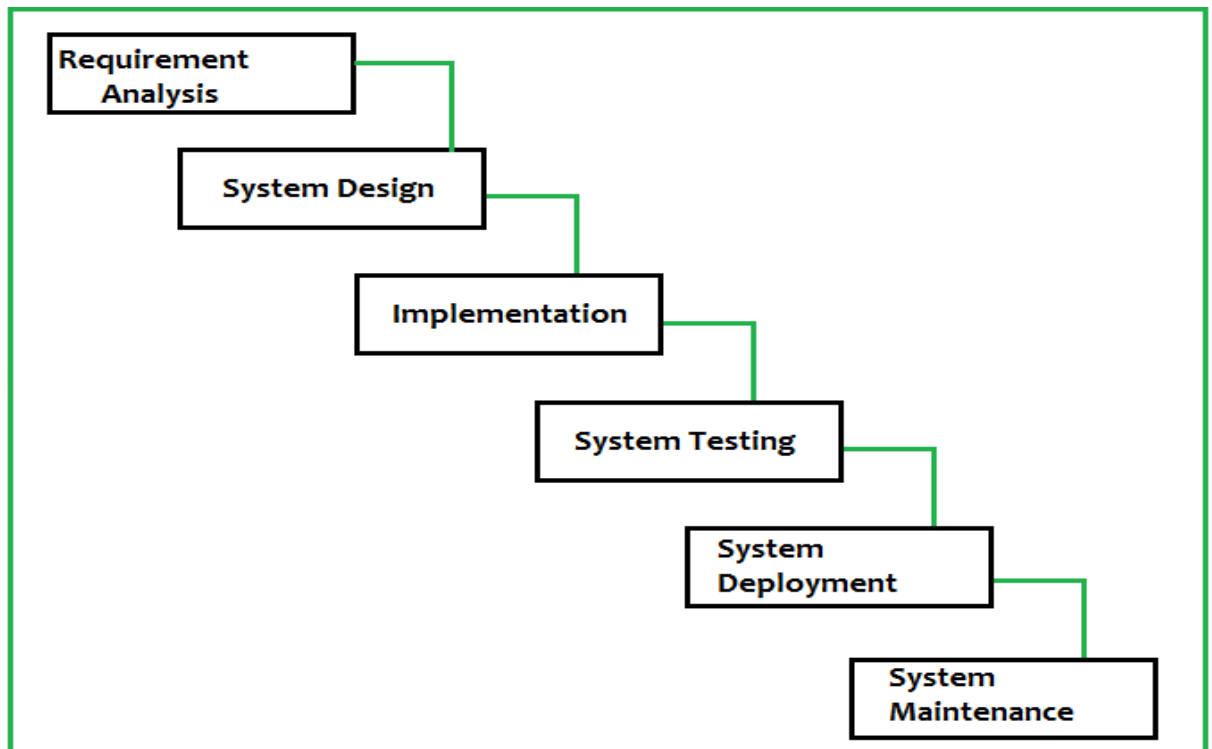
A test is reliable when it can be used by a number of different researchers under stable conditions, with consistent results reflecting consistency and replicability over period. Thus reliability has been defined as the extent to which a test is free from measurement errors, since the more dimension errors occur the less reliable the test becomes (Fraenkel & Wallen, 2003; McMillan & Schumacher, 2001, 2006; Moss, 1994; Neuman, 2003). Validity has been defined differently by different researchers. Bond (2003) defined validity as the core of any form of assessment that is trustworthy and accurate but according to Messick (1989) validity is the degree to which experimental evidences and academic rationales backing the competence and suitability of clarifications and actions based on test scores. Having understood the reliability and validity, the researcher put in to consideration the rationality and dependability of the research results. The questionnaires were formulated on the basis of the research questions by ensuring that the questions were as simple as possible to enable respondents answer quickly. This ensured that the results obtained can be replicated in other similar researches. In addition, the solution was methodically developed so as to closely duplicate real world operations and meet the user requirements.

### 3.7 System Development Methodology

A prototype was built to demonstrate system functionality and proof a concept. The system has a back-end database that stores data and front-end that interacts with the user. The backend was developed using MySQL database management system, whilst the front-end mobile application was built using Java for Android. Laravel a PHP framework was used to build the server side web service scripts and the web application through APIs. The development of the application implemented a standard software system development lifecycle (SDLC) that comprises of several stages as discussed below.

- i. **Requirement Analysis:** This stage involved gathering of system requirements where tools and techniques were used to collect and define both the functional and non-functional requirements of the application.
- ii. **System Design:** System design was guided by both the function and non-functional requirements of the application. During this stage, inputs, processes and outputs were identified hence contributing to logical and physical design of the application.
- iii. **Implementation:** The actual writing of code based on the system design was carried out in this stage.
- iv. **System Testing:** According to IEEE standards, system testing is the investigation conducted to evaluate whether a complete and integrated software system complies with its specified requirements. The system was put in to testing to establish whether the functionality and usability of the application were met. This stage also assisted in identifying any possible errors in the application. The diagram below shows the methodology used in the implementation of the solution.





**Figure 3.1 Waterfall Methodology (Royce, 1970)**

The advantages of the implemented methodology is that it identifies the system requirements long before programming begins and minimizes changes to requirements as project progresses.

### **3.8 Research Quality**

The study safeguarded the results obtained that were to be replicated in other researches. The solution was developed to closely replicate the real application that PSVs would want to adopt. There are three important objectives in data analysis namely, getting a feel of the data, testing the goodness of data and responding to the research questions (Sekaran 2003). The research established the goodness of data providing credibility to all subsequent analysis and findings because it was to measure the reliability and validity of the measures used in the study.

## **Chapter 4: Data Interpretation and System Design**

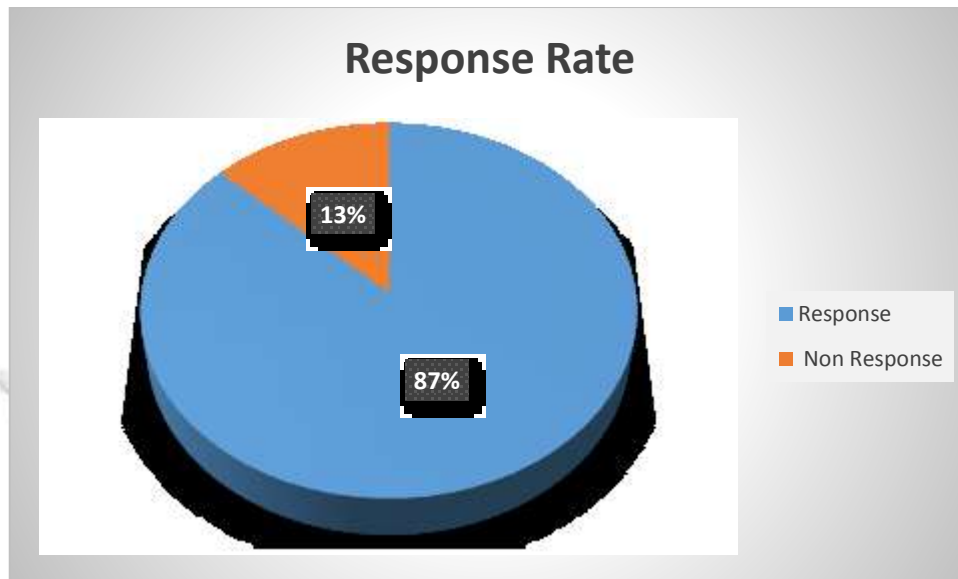
### **4.1 Introduction**

The aim of this research was to come up with a mobile application that will enable passengers to make booking at their own convenience. To achieve this, a survey was conducted by the researcher through primary data collection from the stakeholders. The finding of his research was based on the data that was collected from the respondents who filled the administered questionnaire. The questionnaire comprised of categories such as challenges, demographics and familiarity with the existing applications and the factors determining the preference of certain technologies such as the operating system in use and improvements to be made on the existing applications. Thus data was collected from sample population of 31 comprising of the PSV stakeholders i.e. 26 passengers and 5 bus companies' staff picked from long distance vehicles that operate in Kenya. The data collected were analysed to identify the existence of research gap and the willingness of the stakeholders to explore the level of usage and readiness in long distance PSVs to use the mobile application technology in order to make a booking.

### **4.2 Survey Information**

#### **4.2.1 Response Rate**

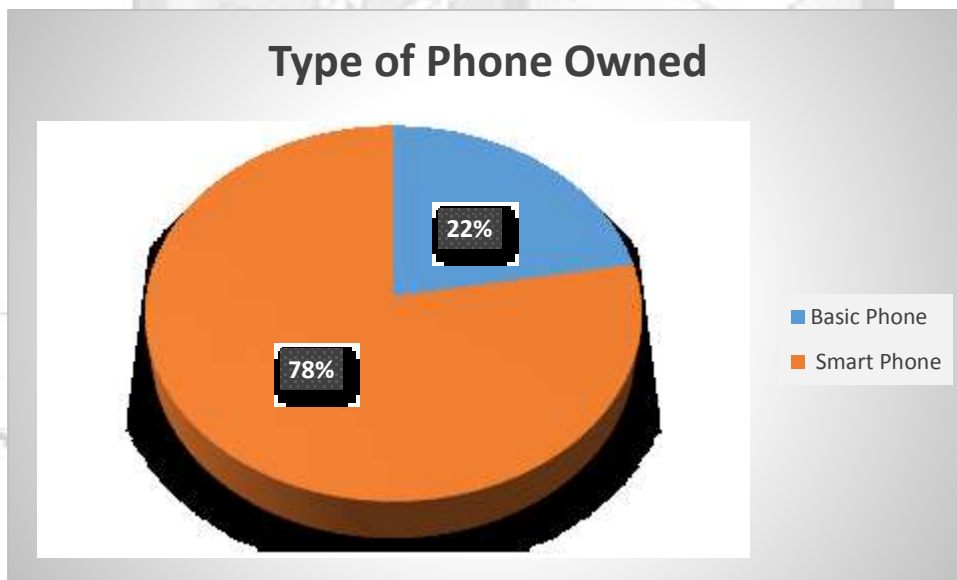
A total of 31 questionnaires were distributed out of which 27 questionnaires were returned giving a response rate of 87%. This response was good enough and representative of the population and conforms to Mugenda and Mugenda (2003) stipulation that a response rate of 70% and above is excellent. The finding is presented in Figure 4.1.



**Figure 4.1 Response Rate**

#### 4.2.2 Respondent's Ownership of Smart phone

Figure 4.2 shows that 78% of the respondents owned a smart phone while 22 % owned basic phones. The level of ownership of smartphones would go a long way in determining the readiness of respondents to use the proposed solution.

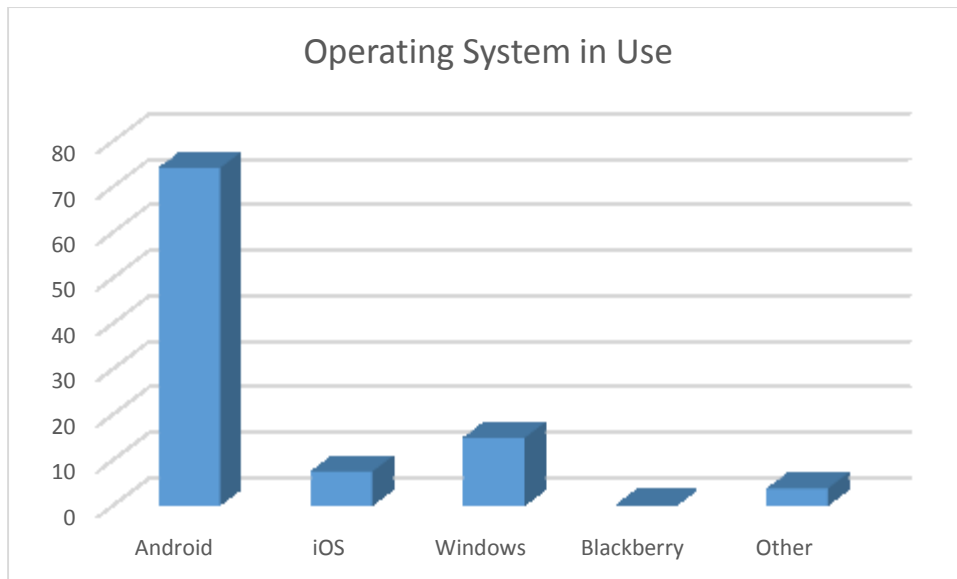


**Figure 4.2 Type of Phone Owned**

#### 4.2.3 Operating System in Use

As shown in Figure 4.3, 74% of the respondents use android operating system, 7% iOS, 15% windows and 4% other operating systems respectively. Blackberry was not commonly

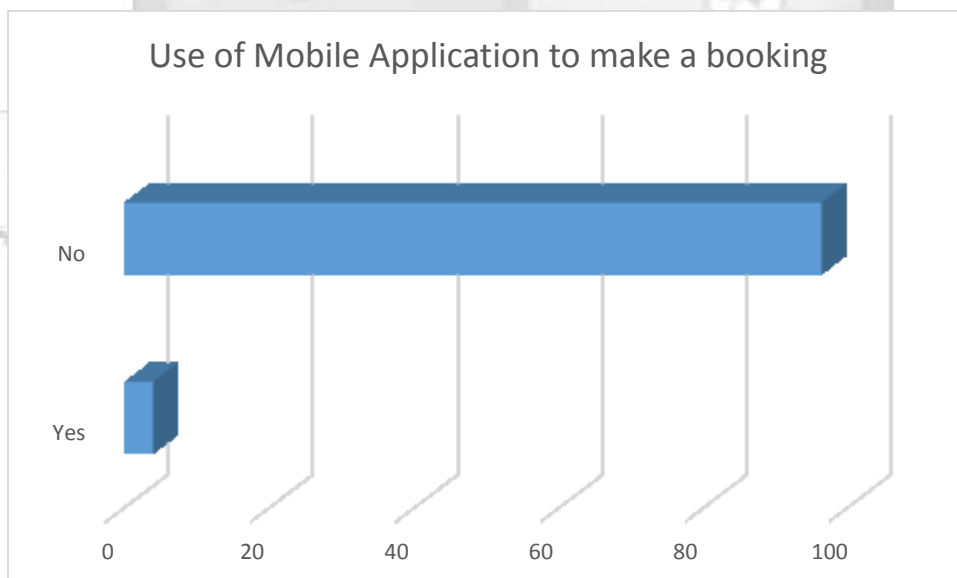
used. This would go a long way in determining the operating system in which the proposed solution would run on.



**Figure 4.3 Operating System commonly in use**

#### **4.2.4 Use of mobile application to make a booking for long distance journey**

As shown in Figure 4.4, 96% of respondents revealed that they had not used mobile application in making a booking while 4% of respondents had used. This shows a majority of respondents have not used mobile applications in making a booking hence proof that there is need for a proposed solution to make a booking for long distance journey.



**Figure 4.4 Use of mobile application to make booking for long distance**

#### 4.2.5 Challenges in making a booking for Long Distance journeys

The respondents were asked whether they had experienced challenges in making a booking for long distance journey. From the findings, Figure 4.5 shows 85% of the respondents experienced challenges such as long queues and travelling cost to make prior booking in the booking office while 15% did not.

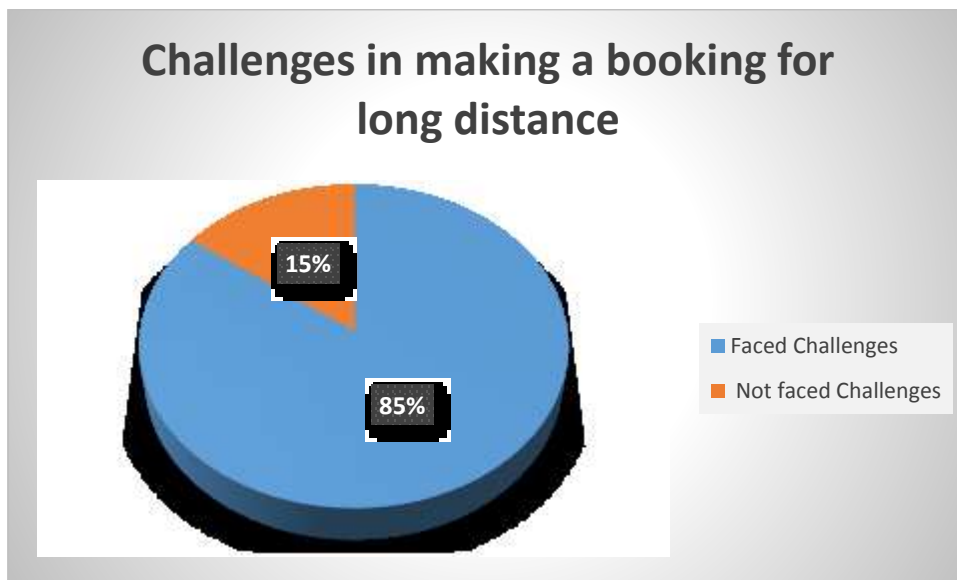
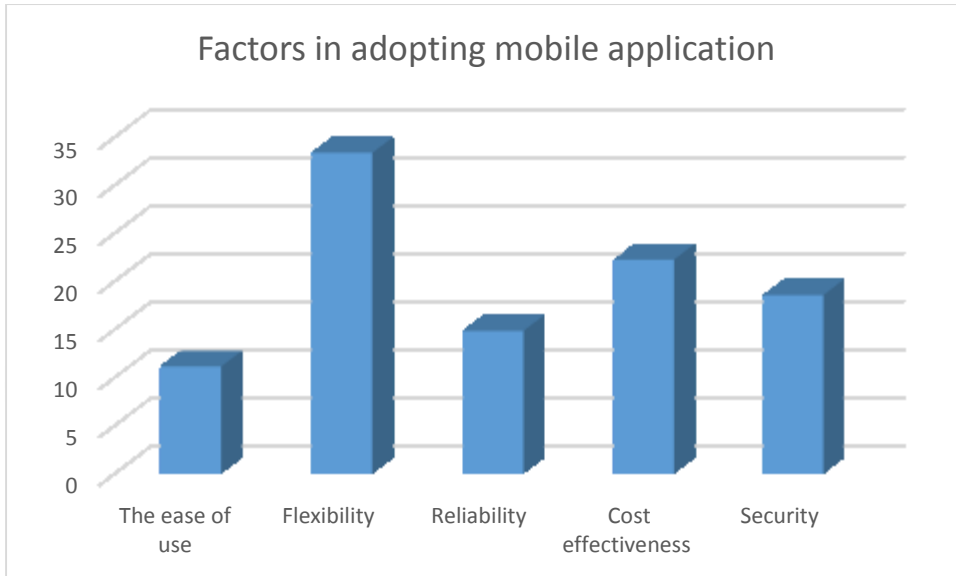


Figure 4.5 Challenges in making a booking for long distance

#### 4.2.6 Important aspects in the adoption of Mobile Applications

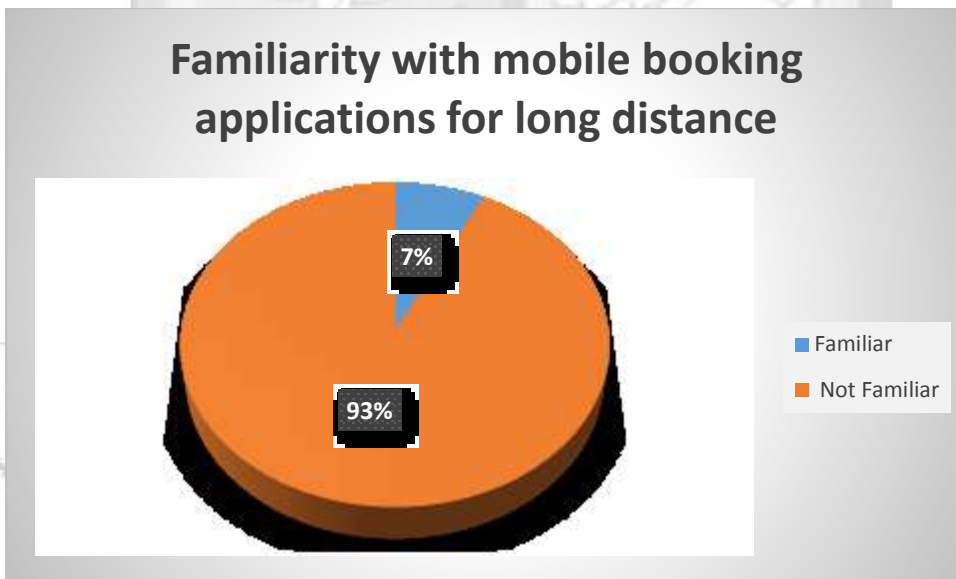
Respondents were asked to rate the aspects they considered to be of great importance when adopting a mobile application. Flexibility and cost effectiveness were the most important aspects whereas reliability and security also a major consideration in determining the mobile application to adopt in long distance PSVs as shown in Figure 4.6 below. Respondents indicated that they would also consider the ease of use.



**Figure 4.6 Important aspects in adoption of a mobile application**

#### 4.2.7 Familiarity with the booking mobile applications

A large population of the respondents pointed out that they were not familiar with existing booking mobile applications for long distance journey as shown in Figure 4.7.



**Figure 4.7 Familiarity with booking mobile applications for long distance**

#### 4.2.8 Use of mobile application in solving booking challenges

A mainstream of the respondents strongly agreed that the mobile application would solve the challenges experienced in making a booking for long distance PSVs as shown in Figure 4.8.

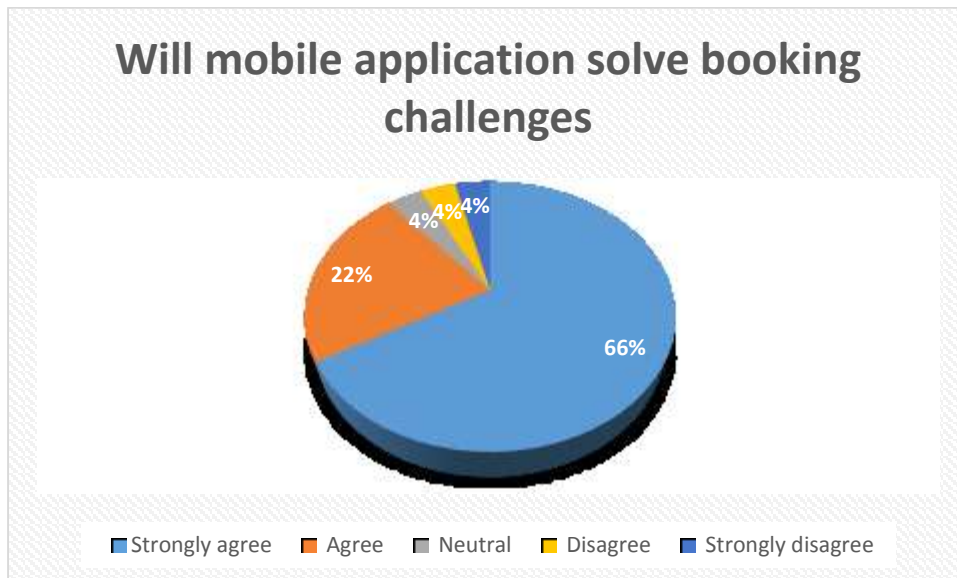
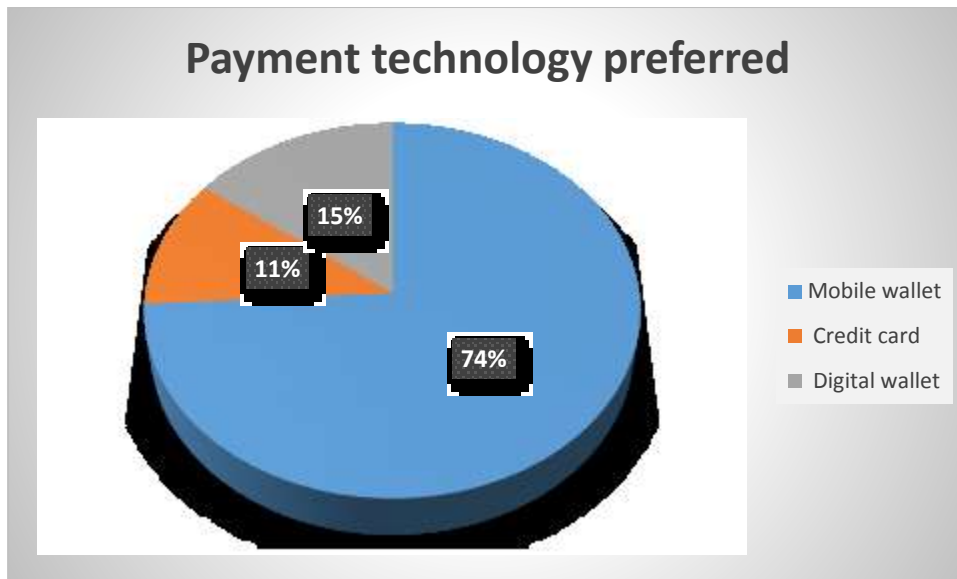


Figure 4.8 Use of mobile application in solving booking challenges

#### 4.2.9 Payment technology preference in making a booking

A popular group of the respondents believed that mobile wallet would be their most preferred method in making booking payments as compared to credit card and digital wallet which had 11% and 15% respectively as shown in Figure 4.9. The reasons cited by the respondents were due to convenience because the user would make a booking wherever at any location as well as cost effectiveness since the user would not incur an extra cost to make a booking.



**Figure 4.9 Payment technology preferred in making payment for booking**

### 4.3 Interpretation of Results

From the results presented, it is evident that passengers indeed faced challenges in making a booking. Most respondents faced challenges in one way or another in making a booking for long distance journeys thus presenting a gap that requires to be addressed to fully meet user requirements. It is with this reason that the mobile application would provide an environment in which the passengers would make a booking at their own convenience by indicating the pick-up location thus not required to visit the office in order to board a vehicle and at a cheaper cost.

### 4.4 Summary

The survey findings reveal that there was need for a mobile solution that would help the passengers make booking and payment at their own convenience thus streamlining the operations of the bus company. The daily revenues collected would be accounted for since every transaction will be accounted for due to reduced cash handling. The analysis of the collected data presented important critical design requirements in that the majority of the respondents owned internet-based smart phones which would enable the users to make a booking and payment at their respective locations. In conclusion, the majority of respondents acknowledged the need to carry out the development of the proposed mobile solution to assist in making a booking for long distance journeys.

## 4.5 Requirements Analysis

Requirement analysis is a process of determining user expectations for a new or modified product. This section consists of the system architecture of the proposed mobile application and a graphical representation of various system requirements. Information collected from the survey was incorporated in a bid to determine the requirements needed to design the new system. The mobile solution is expected to enable a passenger to make a booking and payment at their own convenience via smartphones. The system requirements is composed of both the functional and non-functional requirements based on the user needs. Below are the functional and non-functional requirements of the proposed mobile application.

### 4.5.1 Functional Requirements

Functional requirements explains what has to be done by identifying the necessary task, action and activity that must be accomplished.

**Table 4.1 Functional Requirements**

ID	REQUIREMENTS
FR-1	User ability to launch the application on their mobile device and access the registration and login page
FR-2	Allow authorised user to make a booking on their mobile phone
FR-3	Allow authorised user to make payments for their booking
FR-4	Store the transaction details in a database
FR-5	Allow authorised users to view history of their booking details

### 4.5.2 Non-functional requirements

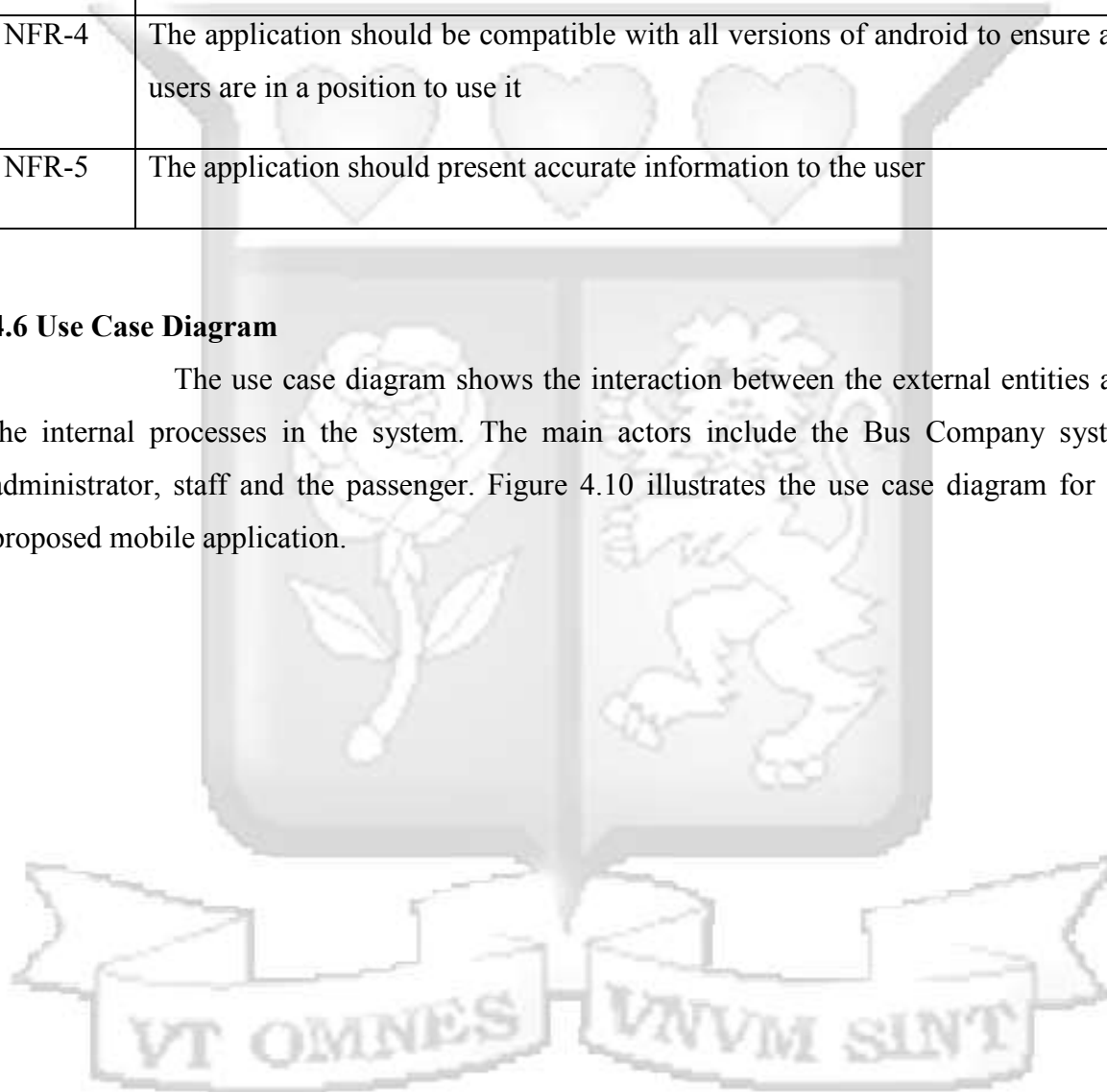
These are requirements that specify the criteria that can be used to judge the operation of the system, rather than specific behaviours.

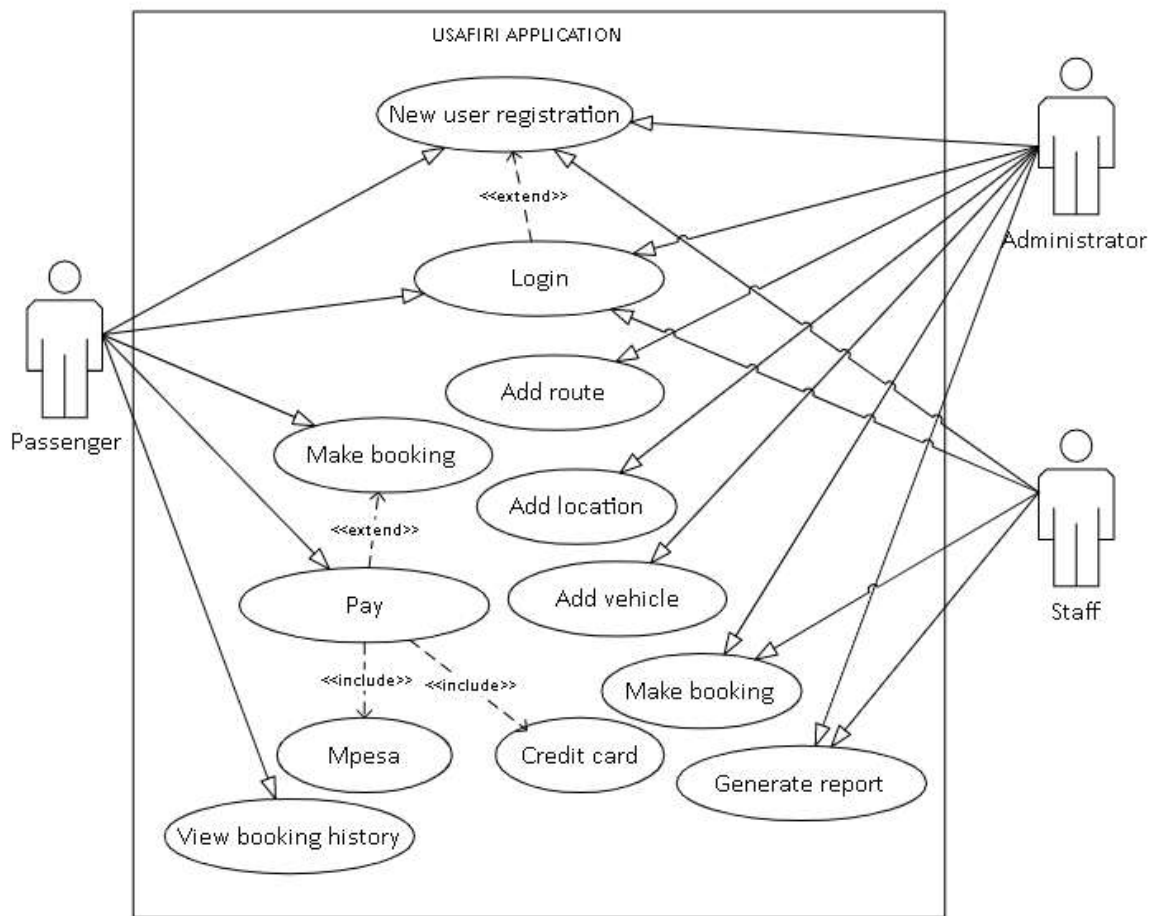
**Table 4.2 Non-Functional requirements**

<b>ID</b>	<b>REQUIREMENTS</b>
NFR-1	The application should be user friendly to allow novice users to use it
NFR-2	The application should be reliable when being used by users
NFR-3	The application should be scalable to cope with the increasing number of users
NFR-4	The application should be compatible with all versions of android to ensure all users are in a position to use it
NFR-5	The application should present accurate information to the user

#### **4.6 Use Case Diagram**

The use case diagram shows the interaction between the external entities and the internal processes in the system. The main actors include the Bus Company system administrator, staff and the passenger. Figure 4.10 illustrates the use case diagram for the proposed mobile application.





**Figure 4.10 Use Case Diagram for Usafiri Application.**

To better understand the Use Case diagram, each of the main usecases were described in detail. Table 4.3 describes the process of registering new user. The rest of te use cases are described in Appendix C.

**Table 4.3 Full Description of Passenger Registration**

Passenger Registration	Description
Use Case Name	Passenger Registration
Scenario	Passenger-Based, involves passenger and the application
Event (Trigger)	Passenger demands a profile in order to make a booking
Brief Description	Passenger creates a profile and logs in to their account.
Actors	Passenger

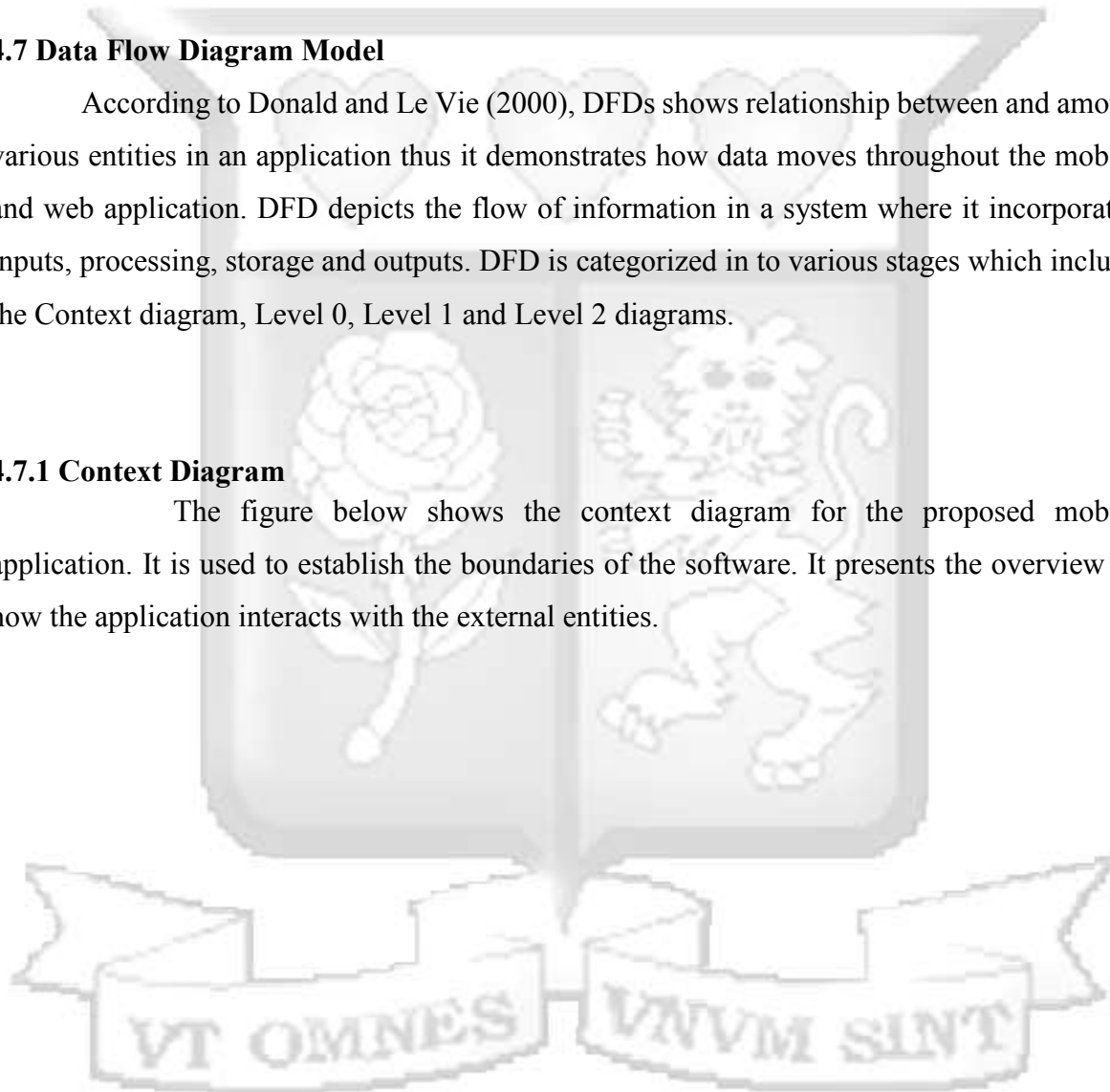
Stakeholders	Passenger and System Administrator
Preconditions	The person making a booking must be of minimum 18 years
Post conditions	The bus company should ensure smooth running of booking process.

#### 4.7 Data Flow Diagram Model

According to Donald and Le Vie (2000), DFDs shows relationship between and among various entities in an application thus it demonstrates how data moves throughout the mobile and web application. DFD depicts the flow of information in a system where it incorporates inputs, processing, storage and outputs. DFD is categorized in to various stages which include the Context diagram, Level 0, Level 1 and Level 2 diagrams.

##### 4.7.1 Context Diagram

The figure below shows the context diagram for the proposed mobile application. It is used to establish the boundaries of the software. It presents the overview of how the application interacts with the external entities.

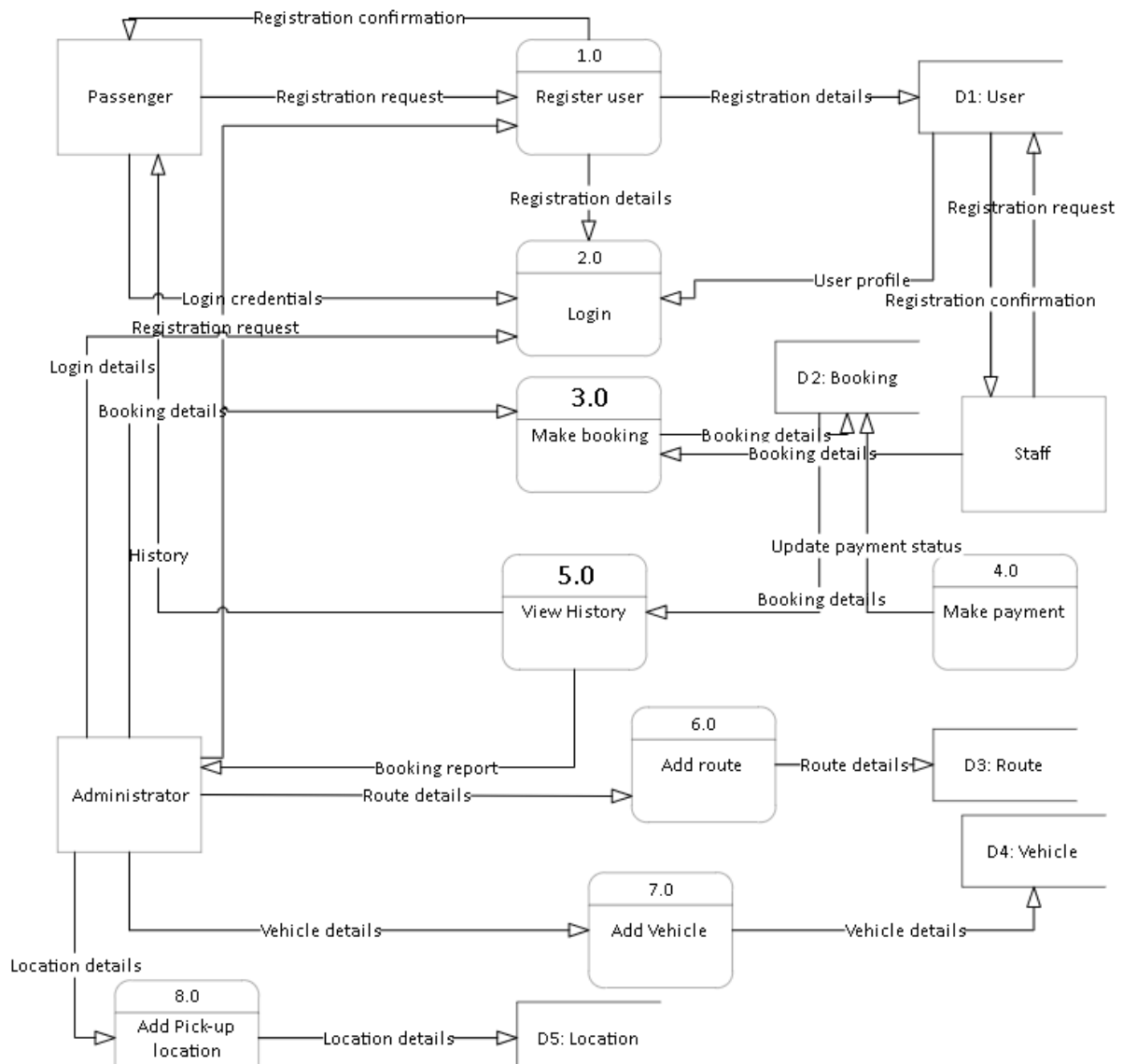




**Figure 4.11 Context Diagram**

#### 4.7.2 Level 0 Data Flow Diagram

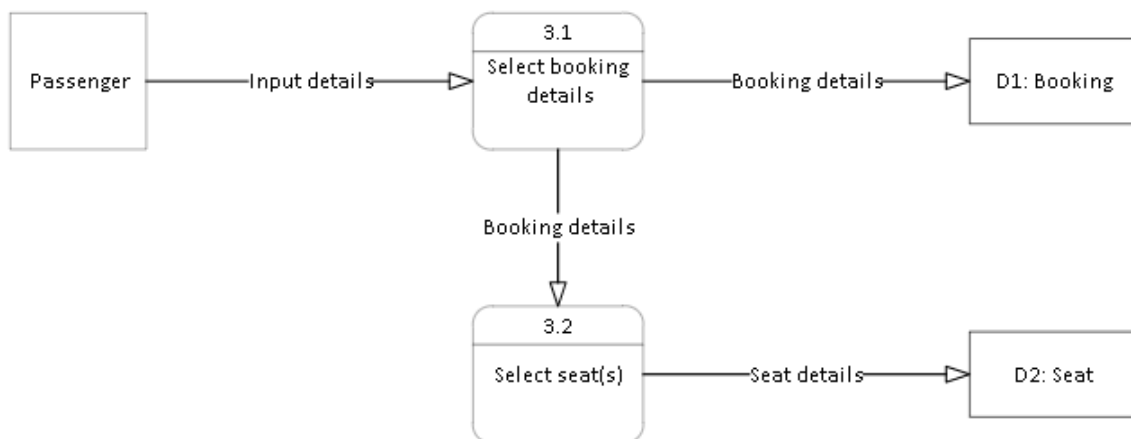
Tao and Kung (1991) described DFD as an effective technique used in expressing functional requirement for large complex systems. Figure 4.11 Level 0 DFD shows how information flows through the mobile and web application including the inputs, outputs, where information is stored and where it travels. It presents a detailed view of the context diagram. It also involves processes such as registration, login, booking, payment and viewing of history via mobile application and report via the web application.



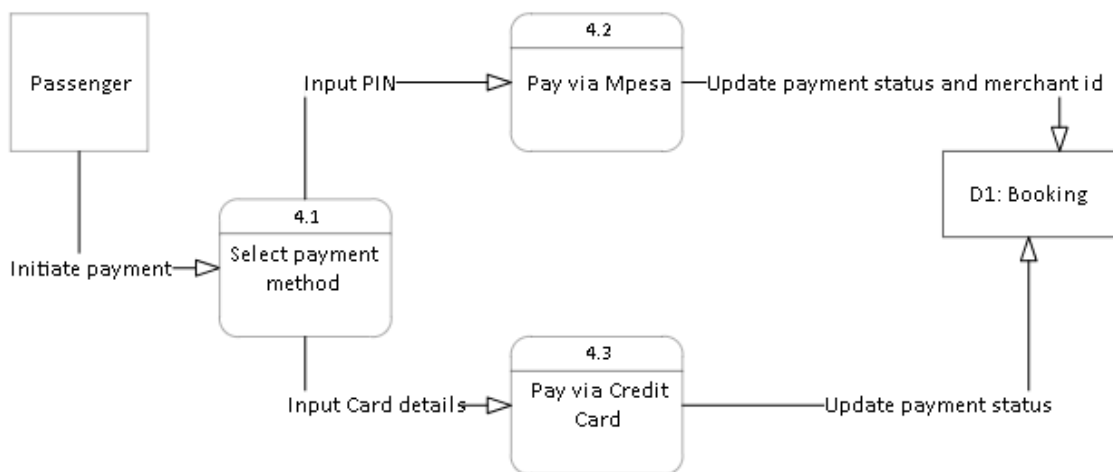
**Figure 4.12 Level 0 Data Flow Diagram**

### 4.7.3 Level 1 Data Flow Diagram

Figure 4.13 and 4.14 shows the Level 1 diagrams for both the making a booking and making payment respectively. The Level 1 diagram decomposes all the processes in the context diagram to show the sub processes in the proposed mobile solution. It displays the major processes, data stores and data flows within the main processes.



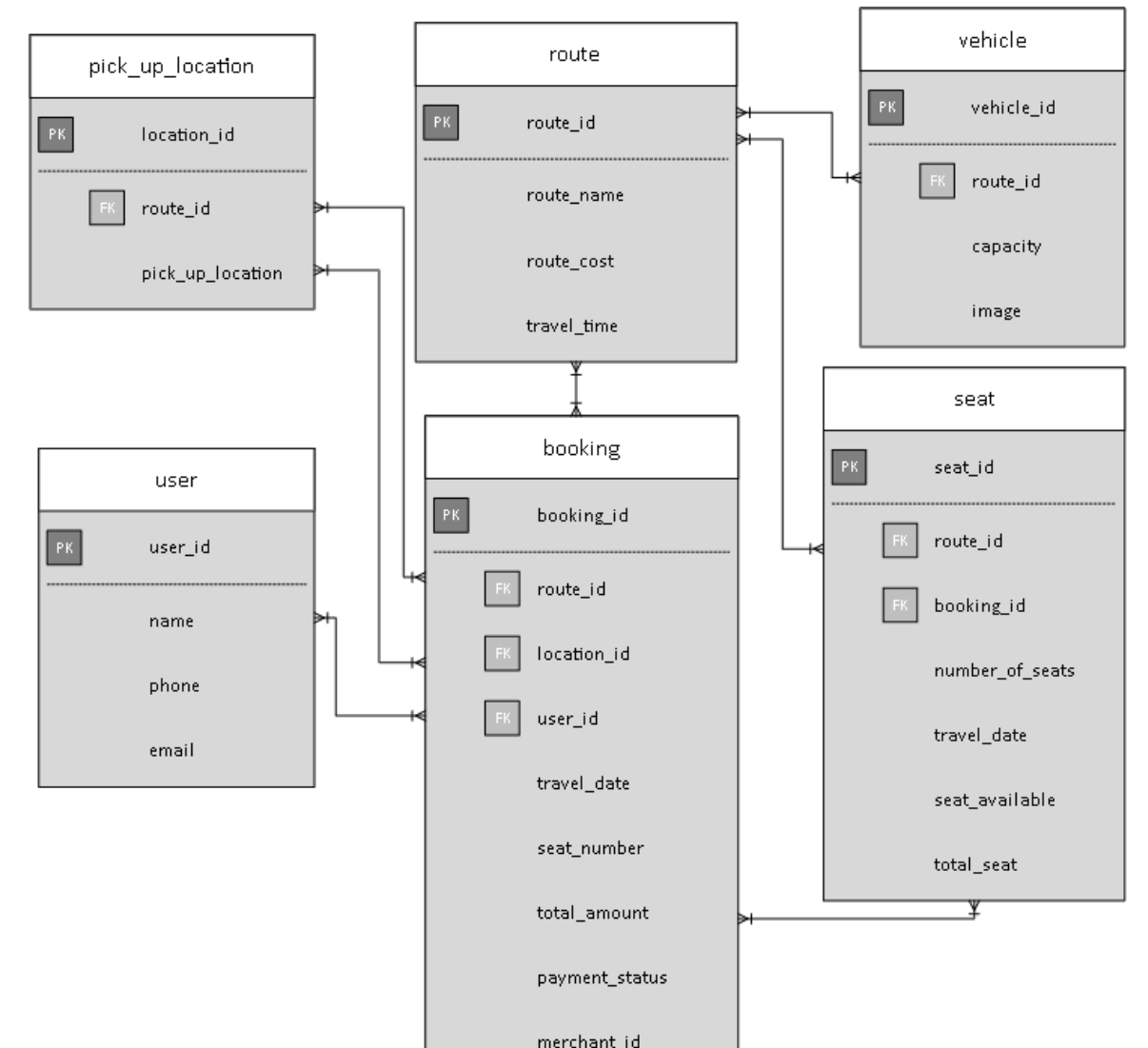
**Figure 4.13 Level 1 DFD for Booking Process**



**Figure 4.14 Level 1 DFD for Payment Process**

**4.7.4 Entity Relationship Diagram**

An ER diagram describes the structure of a database with the help of a diagram. It depicts the interconnectedness of entities relationships and its attributes as shown in Figure 4.15.



**Figure 4.15 ER Diagram of the Proposed Application**

#### 4.8 Database Schema

A schema is a description of a database. This section shows a tabular representation of the database schema that was used to model the mobile solution.

**Table 4.3 Pick\_up\_location**

Pick_up_location	
Column	Type
location_id(PK)	int (10) unsigned
route_id(FK)	int (10) unsigned
pickup_location	varchar (191)

**Table 4.4 Route**

<b>Route</b>	
<b>Column</b>	<b>Type</b>
route_id(PK)	int (10) unsigned
route_name	varchar (191)
route_cost	Double
travel_time	varchar (191)

**Table 4.5 Seat**

<b>Seat</b>	
<b>Column</b>	<b>Type</b>
seat_id(PK)	int (10) unsigned
route_id(FK)	int (10) unsigned
number_of_seats	int (11)
booking_id(FK)	int (10) unsigned
travel_date	Date
seat_available	int (11)
total_seats	int (11)



**Table 4.6 Vehicle**

<b>Vehicle</b>	
<b>Column</b>	<b>Type</b>
<b>vehicle_id(PK)</b>	<b>int (10) unsigned</b>
<b>route_id(FK)</b>	<b>int (10) unsigned</b>
<b>Capacity</b>	<b>int (11)</b>
<b>Images</b>	<b>varchar (191)</b>

**Table 4.7 Booking**

<b>Booking</b>	
<b>Column</b>	<b>Type</b>
<b>booking_id(PK)</b>	<b>int (10) unsigned</b>
<b>route_id(FK)</b>	<b>int (10) unsigned</b>
<b>travel_date</b>	<b>Date</b>
<b>seats_number</b>	<b>int (11)</b>
<b>passenger_id(FK)</b>	<b>int (10) unsigned</b>
<b>pickup_location</b>	<b>varchar (191)</b>
<b>Amount</b>	<b>Double</b>
<b>Status</b>	<b>tinyint (1)</b>
<b>payment_status</b>	<b>tinyint (1)</b>
<b>merchant_id</b>	<b>varchar (50)</b>

**Table 4.8 User**

<b>User</b>	
<b>Column</b>	<b>Type</b>
<b>user_id(PK)</b>	<b>int (10) unsigned</b>
<b>Name</b>	<b>varchar (191)</b>
<b>Phone</b>	<b>varchar (191)</b>
<b>Email</b>	<b>varchar (191)</b>

## 4.9 System Architecture

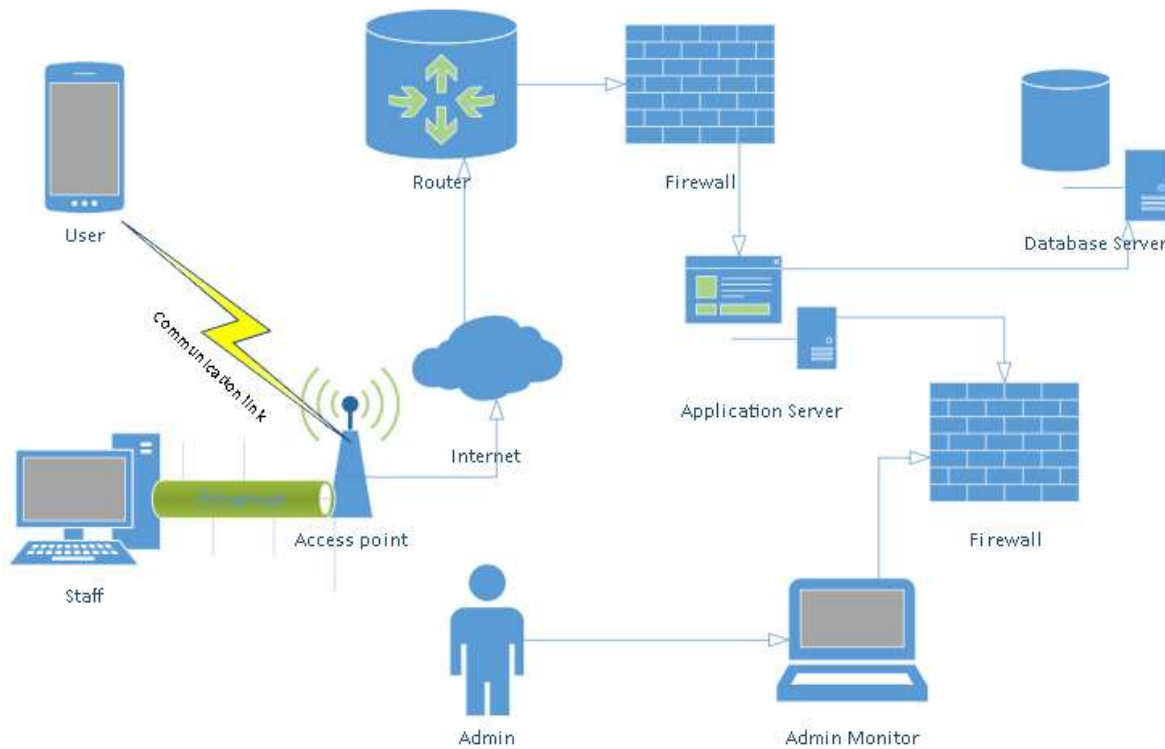
System architecture implemented client-server model where the clients include the staff and passengers. The passengers will utilize the mobile application installed in their devices which will communicate via the telecommunication network at any location. The staff on the other hand will access the server through a web application such as the browser installed on their monitor. This communication among devices will be facilitated through the internet. The application server will process and store information in the database server. The components of a system architecture include:

**4.9.1 Mobile Application:** The passengers will use this application to make booking, make payment via either M-Pesa or Credit Card for the journey and view history of the booking details.

**4.9.2 Web Application:** The system administrator will use the web application to add route details, pick-up location details and vehicle details and make booking for those passengers who would want to make the booking from the office and generate report for a certain period as requested. The staff on the other hand will make a booking for passengers and generate reports since they will not have the same rights as the administrator.

**4.9.3 Database Server:** The server hosts the system database where all transaction and booking details are stored.

**4.9.4 Application Server:** This server uses HTTP protocol to provide the necessary services and resources to client applications. The APIs will handle the communication between the client applications and the server. This system will run on Apache web server.



**Figure 4.16 System Architecture of the Proposed Application**

#### 4.10 Security

Security is a critical aspect of any payment. Thus there are international specifications on the payment systems (ISO, 2001) in existence, putting in to consideration the CAO recommendations about passwords security in contactless smart cards (ISO, 2004). Considering that in the proposed application the means of payment are supported by non-proprietary technology devices such as Stripe cards and cellular telephones, three main security issues have been put in to consideration. First, authentication of the mobile application; the passenger cannot be replicated, for this reason any application has to be associated to a unique user. Thus, a basic requirement of booking application consists of providing a service to get the unique identification key associated to the user at run-time. Second, access control to the applications; any access to mobile and web application have to be done by authorized users. If an unauthorized access is detected, the booking process has to be rejected. And finally, transactions control; unauthorized users must be detected and rejected by the application. Another transactions control aspect consists of the detection of incomplete transactions where by the passenger will not be booked for the journey until they pay. When it happens the user have to complete the payment process.

The application has been in a position to make use of APIs to develop the backend of the applications. The security feature used in the implementation of the APIs is Passports a common feature in Laravel, a PHP framework. The authentication has been achieved by the help of Laravel passport which provides OAuth2 server implementation. It involves the use of username and password combination where the user sends a request to the server. OAuth2 allows users to access resources on the server via authorization servers in a secure, reliable, and efficient manner. Tokens are an important component in OAuth 2.0. Tokens are divided in to two namely access tokens and refresh tokens. Any user with valid account credentials can access protected resources which has a short life span so that even if there is a security breach and the access token is leaked, the damage can be quickly controlled. When an access token expires, developers can use an optional refresh token to request a new access token without having to ask the user to enter their credentials again.

#### **4.11 Development**

The proposed solution was developed to run on Android mobile that will be used by passengers while the web-based system will be accessed by the system administrator and the staff for passengers who visit the offices for booking purposes. Java for android was used to develop mobile application while PHP framework Laravel was used to build server-side web APIs and the web application.

The use of services has been implemented in both the mobile and web application where by the passenger or user receives a notification once they complete the booking process and be able to make payment. This has been achieved through use of Queues in APIs. Queues allow users to defer the processing of a time consuming task, such as sending an email or SMS until a later time. Deferring the time consuming tasks speeds up the web requests to both the web and mobile applications. A directory is created to keep track of jobs in the queue where after payment has been made the message is dispatched to the passenger. This was achieved through integration with AfricasTalking. The mobile application was integrated with M-Pesa and stripe card where the user is in a position to make payment by entering their PIN and the transport cost would be deducted automatically from their M-Pesa account while in stripe cards the user enters their card number, expiry month and year and the CVC code that helps in the verification of the card and the amount will be deducted automatically.

## Chapter 5: System Implementation and Testing

### 5.1 System Development Environment

Table 5.1 and 5.2 below illustrate the hardware and software components that were used to come up with the system and their justification.

**Table 5.1 Hardware Specifications**

Hardware	Justification
Laptop: HP Core i5, 4GB RAM and 500 GB hard drive	Used for documentation, design and development of the proposed mobile solution.
HOTWAV_Cosmos_V20	Used for running and testing the functionality of the proposed solution.

**Table 5.2 Software Specifications**

Software	Justification
Android Studio	Used to develop the mobile application
PhpStorm	Used to write PHP scripts
MySQL	Used as a database to store booking details
Windows 10	The operating system running in the computer.
MS Word 2013	Used for writing the dissertation document
XAMPP	Used for testing the web service/web application.
SQLite	Used to store data temporarily before sending it to the database.

## 5.2 System Implementation

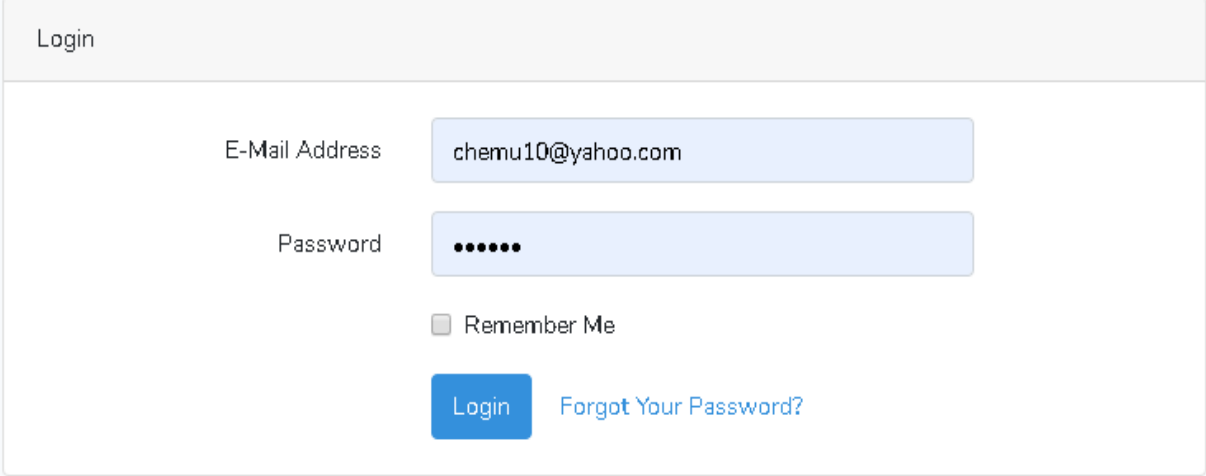
The development of the system combined two technologies that is mobile and web technology. Android studio was used to develop mobile application while PhpStorm was used to script the server- side web service/web application. The databases used were SQLite to store data temporarily before posting the data to MySQL database for storage purposes.

## 5.3 Web Application

The web application is accesses and used by the system administrator and the staff of the bus company to manage the system and allocate tickets to passengers who visit their offices to make booking. The web application allows the system administrator to view the booking details done via the mobile application and add the routes that the vehicle operates the car details and pick-up locations for designated routes. The staff can only make a booking and generate report due to different rights the administrator and staff have.

### 5.3.1 Login Page

The Login Page Figure 6.1 allows the user to login onto the web application. The login feature ensures that no unauthorized user has access to the web application.



The screenshot shows a web application login page. At the top left, the word "Login" is displayed. Below it, there are two input fields: "E-Mail Address" with the value "chemu10@yahoo.com" and "Password" with masked characters "•••••". Below the password field is a checkbox labeled "Remember Me" which is currently unchecked. At the bottom, there is a blue "Login" button and a link labeled "Forgot Your Password?".

**Figure 5.1 User Login Page**

### 5.3.2 Registration Page

The Registration Page Figure 6.2 allows new users to create an account in order to access the web application.

Register

Name

E-Mail Address

Password

Confirm Password

**Figure 5.2 User Registration Page**

### 5.3.3 Reset Password Page

Reset Password Page enables users to reset their passwords when they forget.

Reset Password

E-Mail Address

**Figure 5.3 Reset Password**

### 5.3.4 Vehicles Page

The Vehicle Page allows the system administrator of the bus company to add vehicles of different capacity to the database.

Add Car

10:45 | Nairobi-Mombasa

Capacity

Choose File No file chosen

Submit

**Figure 5.4 Vehicle Page**

### 5.3.5 Location Page

The Location Page enables the system administrator to add different pick-up locations for different routes.

Add Location

Nairobi-Mombasa

Pick-up Location

Submit

**Figure 5.5 Location Page**

### 5.3.6 Route Page

The Route Page enables the system administrator to add routes with their details in to the database.

Add Route

Route Name

Route Cost

--:--

Submit

**Figure 5.6 Route Page**

### 5.3.7 Book Page

The Booking page allows the system administrator to make a booking for passengers who choose to visit their offices to pay for their journey.

Make Booking

10:45 | Nairobi-Mombasa

Name

Phone

dd/mm/2019

Mlolongo

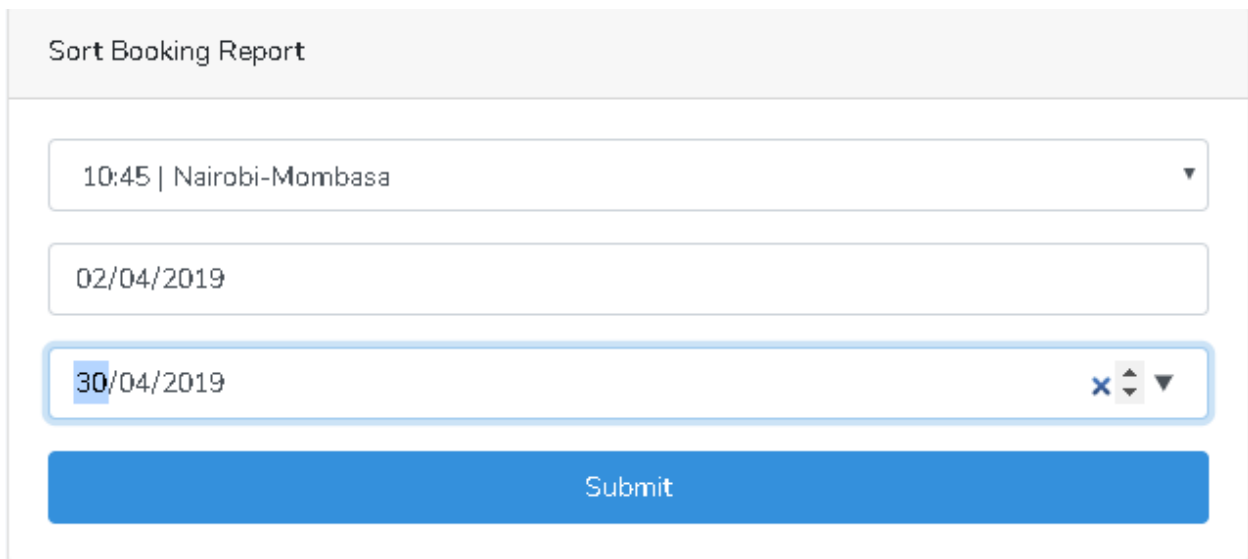
Seats Number

Submit

**Figure 5.7 Booking Page**

### 5.3.8 Report Page

The figure below shows a report for a specified period as requested by the system administrator or the staff.



Sort Booking Report

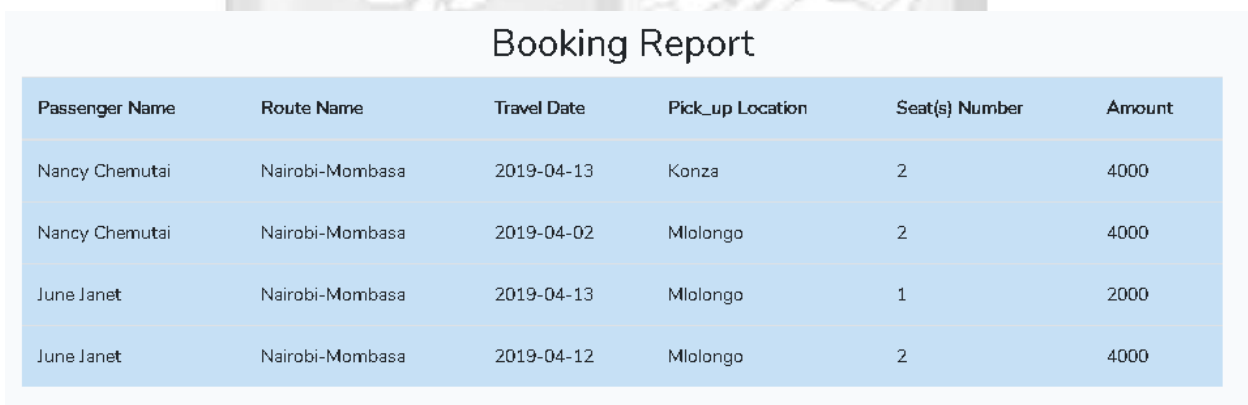
10:45 | Nairobi-Mombasa

02/04/2019

30/04/2019

Submit

**Figure 5.8 Sort report**



Passenger Name	Route Name	Travel Date	Pick_Up Location	Seat(s) Number	Amount
Nancy Chemutai	Nairobi-Mombasa	2019-04-13	Konza	2	4000
Nancy Chemutai	Nairobi-Mombasa	2019-04-02	Mlolongo	2	4000
June Janet	Nairobi-Mombasa	2019-04-13	Mlolongo	1	2000
June Janet	Nairobi-Mombasa	2019-04-12	Mlolongo	2	4000

**Figure 5.9 View Report**

### 5.4 Mobile Application

The mobile application is accessed and used by the passenger to make their booking and pay for the journey at their own convenience. There are several activities that are integrated to perform different functions in the booking process. They include:

### 5.4.1 Registration Page

Figure 5.10 is used for registration. A new user creates an account by providing registration details through the screen below.

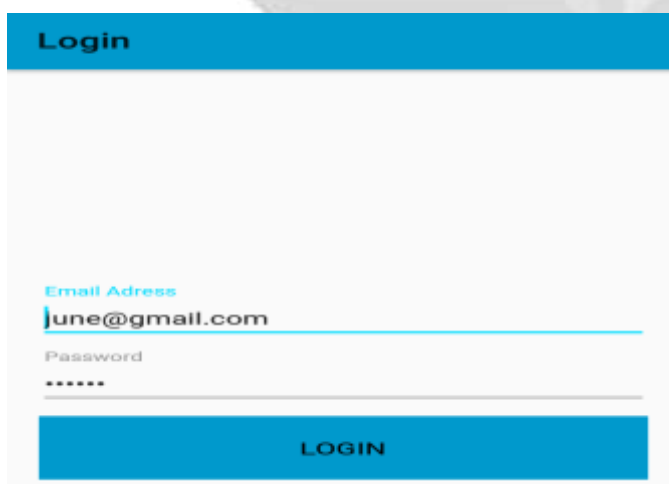


The screenshot shows a registration form with a blue header labeled "Registration". Below the header are five input fields: "First Name", "Last Name", "Phone Number", "Email", and "Password". A blue "REGISTER" button is positioned below the fields. At the bottom, there is a link that says "Already Registered? Please click here to Login".

**Figure 5.10 Registration Page**

### 5.4.2 Login Page

Figure 5.11 below allows the user to utilize the login page whereby the authentication process allows only registered users to have access to the mobile application. Upon successful authentication, the user is presented with the next window to begin the booking process.



The screenshot shows a login form with a blue header labeled "Login". Below the header are two input fields: "Email Address" containing "june@gmail.com" and "Password" with masked characters "\*\*\*\*\*". A blue "LOGIN" button is positioned below the fields.

**Figure 5.11 Login Page**

### 5.4.3 Booking Page

This page enables the passenger to fill their journey details by selecting the Booking icon which takes the user to the Booking Page. Thus the user select the route they intend to take, the travel date, their pick-up location and then select the seats they would like to occupy.



Figure 5.12 Booking Page

#### 5.4.4 Payment

Payment is made by either Mpesa or stripe card respectively where the user is prompted to enter the pin for the amount to be deducted from their Mpesa account. On the other hand, the user enters their card details such as card number, expiry date of the card and the CVC.

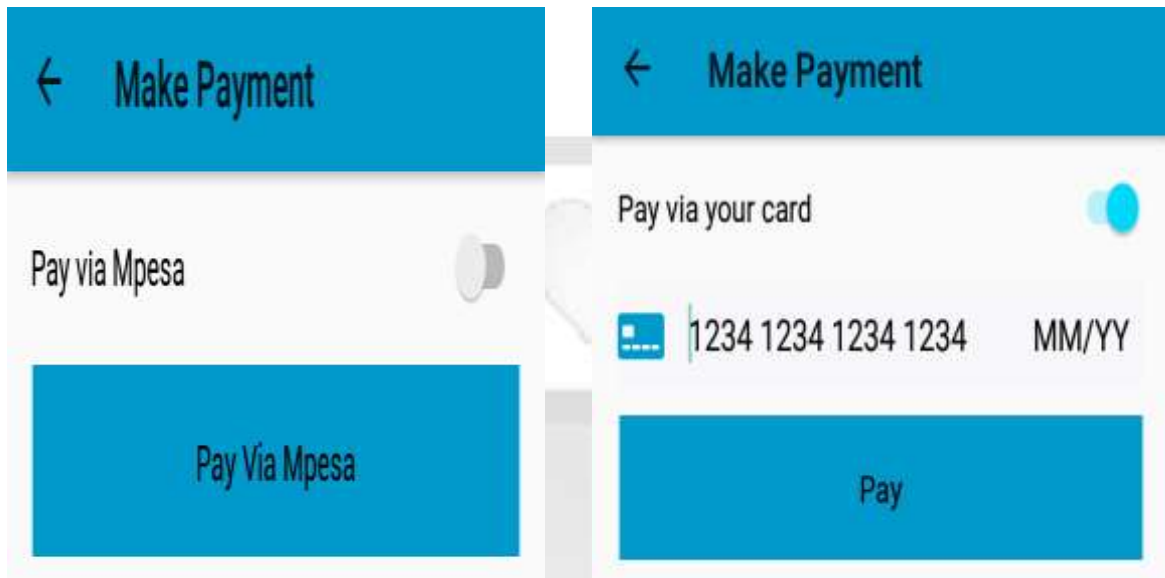


Figure 5.13 Payment

#### 5.4.5 History

The history shows the bookings the passenger has made over time.



Figure 5.14 History Page

## 5.5 System Testing

The application was given to several users to test the functionality and compatibility of the mobile application.

### 5.5.1 Functionality Testing

This test was carried out to determine the functionality of the mobile application. The mobile application was subjected to test and registered the following results as shown below. This was done to fix the bugs and ensure the key objectives are met and to ensure the system requirements are met.

**Table 5.3 Functionality Testing**

Test Case Name: Functionality Test					
Test Date: 22/03/2019					
Tested By: Muriuki Marigi					
Activity Tested	Description of Test Conducted	Expected Behaviour	Observed behaviour	Error	Verdict
Registration	Confirm whether registration is carried out	The application registers users and stores the user information into the database	The application registers users and stores the user information into the database	None	Ok
Login	Confirm whether only registered user has access	User is first verified before granting access to the system	User is first verified before granting access to the system	None	Ok
Booking	Make booking	Booking is made in a systematic manner	Booking is made in a systematic manner	None	Ok

Payment	Make payment	Payment is made with correct data	Payment is made with correct data	None	Ok
History	Check booking made previously	The correct information is displayed	The correct information is displayed	None	Ok

### 5.5.2 Software Metric Test

The quality assurance test was conducted to ascertain that the mobile application met the following software metrics which include: reliability, speed accuracy and scalability.

**Table 5.4 Speed Test**

Test Case Name: Application Speed Test					
Test Date: 22/03/2019					
Tested By: Muriuki Marigi					
Description: The application was subjected to speed test to evaluate the time taken for each request					
Operations	Time <1 min	Time >1 min <2 mins	Time >2 mins <3 mins	Time >3 mins <5 mins	Time >5 mins
Login	X				
Booking		X			
Payment		X			
History	X				
Installation	X				

The mobile application was subjected to speed testing as shown in Table 6.4 above. Most operations were found to work within a couple of seconds. Delay was experienced in booking and payment operations which took about 2 minutes. Speed metric was met for most of the operations.

**Table 5.5 Scalability Test**

Test Case Name: Application Scalability Test		
Test Date: 22/03/2019		
Tested By: Muriuki Marigi		
Description: The application was subjected to scalability test to evaluate whether it will handle extra users without breaking it. The number of users was increased gradually and the service quality evaluated.		
Number of users	Result	Comments
< 5 users	Pass	None
>5 users <10	Pass	None
>10users < 50 users	Pass	None

The number of users was gradually scaled up as shown in table 6.5 above and the mobile solution was able to handle the increase without any problem hence scalability metric was met.

**Table 5.6 Accuracy Testing**

Test Case Name: Application Accuracy Test		
Test Date: 22/03/2019		
Tested By: Muriuki Marigi		
Description: The application was subjected to accuracy test with focus on fetching and sending the correct information to and from the database		
Item tested	Result	Comments
Making payment	Pass	None

Sending data to the database	Pass	None
Fetching History information from the database	Pass	None

The mobile solution was tested for accuracy. Table 5.6 above illustrates specific items that were tested for accuracy. Payment information was tested for accuracy to safeguard against inaccurate payment details. The payment information changes every time the passenger makes a new booking. Further, the booking details need to be captured correctly to ensure every passenger is allocated the right vehicle.

The mobile solution has been in a position to meet three key software metrics namely: scalability, accuracy, and speed hence it can be deduced that the mobile solution is reliable.

### 5.5.3 Compatibility Testing

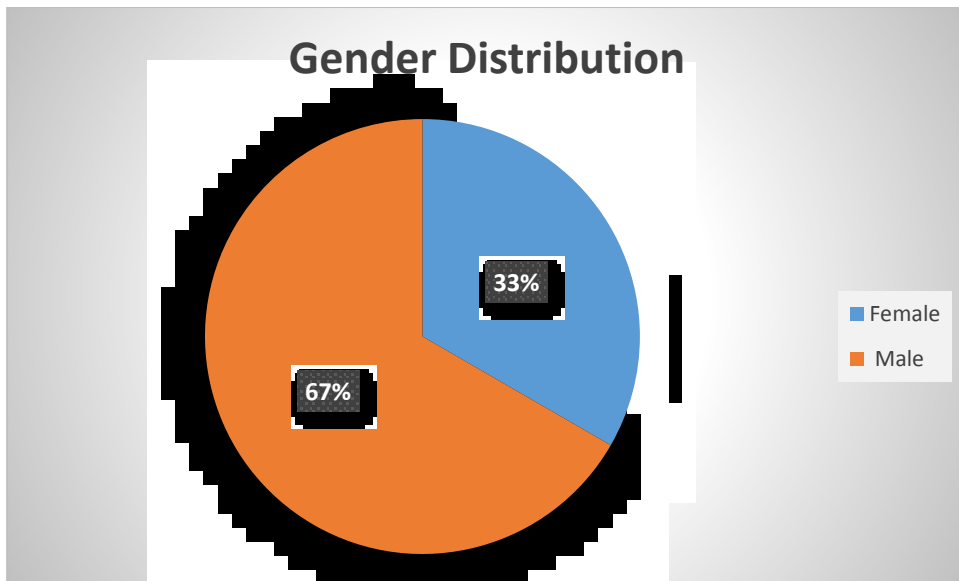
This was carried out to determine if the mobile application works in different environment with the same operating system.

**Table 5.7 Compatibility Testing**

Test Case Name: Compatibility Testing	
Test Date: 22/03/2019	
Tested By: Muriuki Marigi	
Test Description: The application was installed in three different devices	
<b>Phone</b>	<b>Compatible</b>
Lenovo A806 Golden Warrior	Yes
Zuri S56	Yes
Lenovo L18021 Android 8.1.0 API 27	Yes

### 5.6 Usability and User Experience

Post-test survey was conducted by the researcher on various users as shown in Appendix B. The test comprised of 33.33% (2) Female and 66.67% (4) Male respondents as shown in Figure 5.15



**Figure 5.15 Gender Distribution**

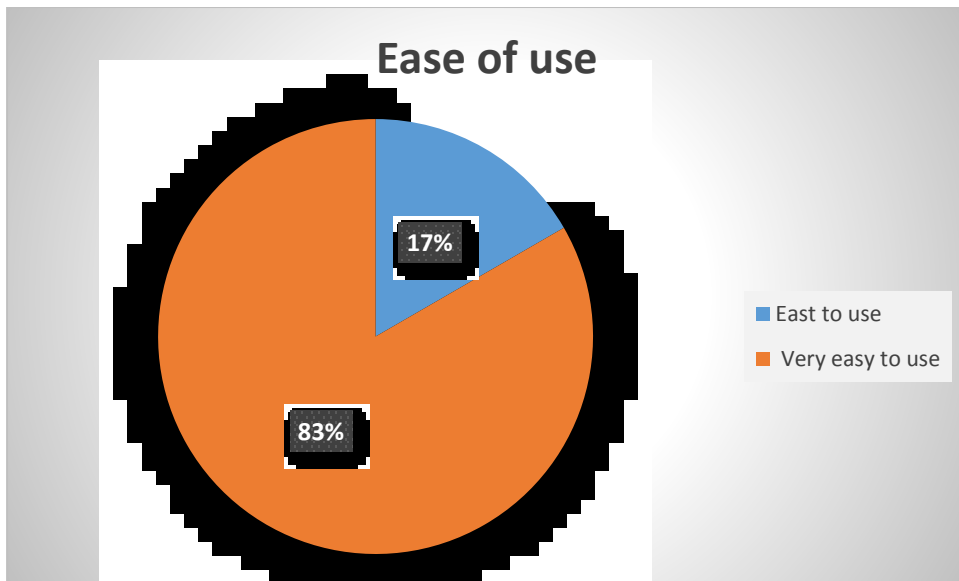
The table below summarizes the user experience, usability and acceptance responses from the users who carried out the test.

**Table 5.8 User Experience, Usability and Acceptance testing**

User Experience, Usability and Acceptance testing.			
	Yes	No	Neutral
Does the application look good?	66.67%	0	33.33%
Can you use the application without instructions?	100%	0	0
Would you use the application?	83.33%	16.67%	0

### 5.6.1 Ease of use

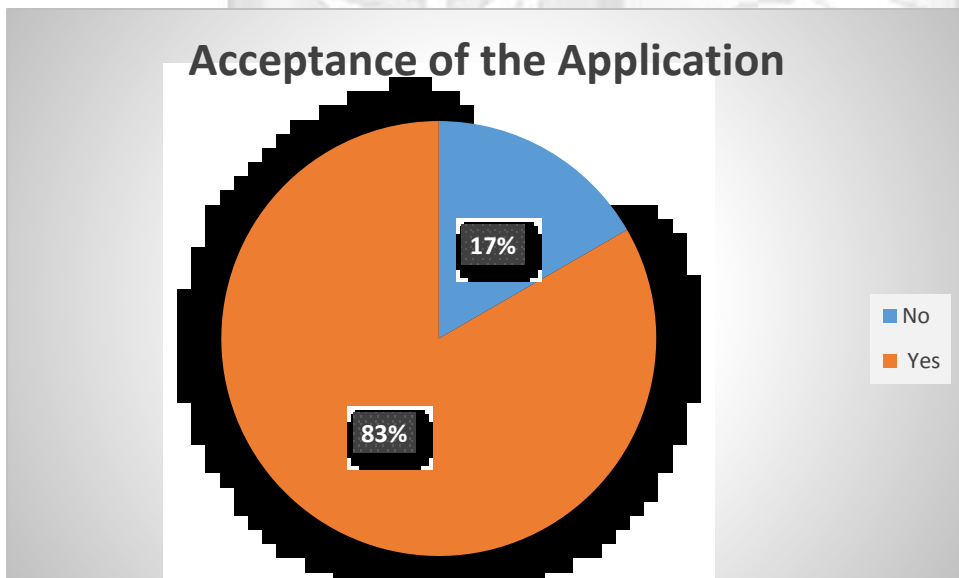
83.33% of respondents felt that it was very easy to use the mobile application while 16.67% felt it was easy to use the application. This is illustrated in Figure 6.14



**Figure 5.16 Ease of Use**

### 5.6.2 Acceptance

From the survey conducted by the researcher 83% of the respondents would want to use the solution. Figure 6.15 illustrates the findings on how users felt in terms of user experience and usability of the application.



**Figure 5.17 Acceptance of the Application**

### 5.7 Test Conclusion

The above results confirm that the system passed all the requirements set by the researcher and perform as expected thus fit for market.

## 5.8 System Deployment

The mobile solution would be deployed on the cell phones as an Android Package file (APK). The mobile application should be hosted on a public server or a store where it can be downloaded. On the other hand, the web platform and web services would be hosted on a web server that has an IP address which is exposed to public while the core database engine would be hosted on a server whose access is limited to the application server.

## 5.9 Summary

The chapter has presented some screenshots of a fully functional and complete application which was guided by waterfall model from the initial stage of requirement gathering to the implementation of the mobile solution. The post-test analysis gives a firm backing that the proposed mobile solution has met its objectives.



## **Chapter 6: Discussion**

### **6.1 Introduction**

This chapter reviews the inputs used for the prototype and thus discusses the result and findings of obtained from the study. The discussion is grounded on the objectives, data variables and various relevant literature reviews.

### **6.2 Review of Research Objectives: Findings and achievement**

The first objective of the research was to analyse relevant information related to booking in public service vehicles. A survey was conducted and a number of characteristics and data required for such an application were identified. Among the types of data identified were the payment model, seat allocation, stakeholders and the booking process. The data informed the design and development of the mobile application, the database and payment. The study found out that the consumer of the product required an application that was easy to use, secure, reliable and convenient.

The second objective was to review the challenges faced in adoption of mobile technology in public service vehicles. This was achieved by comparing what exists in the transport industry with what has been documented over years through research. It was established that there are several barriers to adoption which include the cost of purchasing a smart phone, internet coverage, and security of online transactions, complexity of the application and attitude and behaviour of the consumers. Lack of confidence with the mobile applications caused passengers to avoid online transactions citing fraud. The application data is protected thus secure to use Usafiri application

The third objective was aimed at reviewing the existing models, architecture and frameworks. The study achieved this through analysis of the literature and the information gained through the survey conducted. Literature was used to identify major models and architectures related to booking of mobile payment in long distance public service vehicles that formed part of the mobile application. The study established that several architectures, models and technologies existed and they incorporated different technologies ranging from web, USSD and mobile applications. The mobile applications used in booking include Little Shuttle application belonging to Safaricom and Swvl from Egypt but are limited to Nairobi. They both implemented mobile money. However, there are no existing long distance mobile applications used for booking. Instead there is use of USSD code by two bus companies' that is Easy Coach and Modern Coast Coach known as BuuPass used for booking. The passenger dials the USSD

code, selects seat, pay via M-pesa, credit card or bank transfer. Then after payment, the passenger is able to receive a notification of payment via SMS, email or in printed format. The researcher settled on implementing mobile and credit card payment technologies during the development of the application since the intention was to use the pre-purchase model where the passenger makes a complete booking before boarding the vehicle.

The fourth objective was to develop a mobile application that would assist in improvement of PSV operations. The solution was designed with the full knowledge of stakeholders in mind that were identified. Design tools used were Data Flow Diagrams, Entity Relationship Diagram, and Database Schema which assisted in identifying relationship among entities in the database. Therefore the solution was implemented through tools such as Android Studio, PhpStorm for PHP scripting and MySQL.

The last objective was to test the functionality of the application to assist in identification and fixing of bugs that existed in the system during the development process. This objective was met through several software techniques which were incorporated in order to test the functionalities of the mobile solution. The techniques included functionality testing, usability testing, software metric testing and compatibility testing. This assisted the researcher to compare the developed application and the existing applications in the industry for purposes of validating superiority of the new application.

### **6.3 Benefits and limitations of the developed mobile solution**

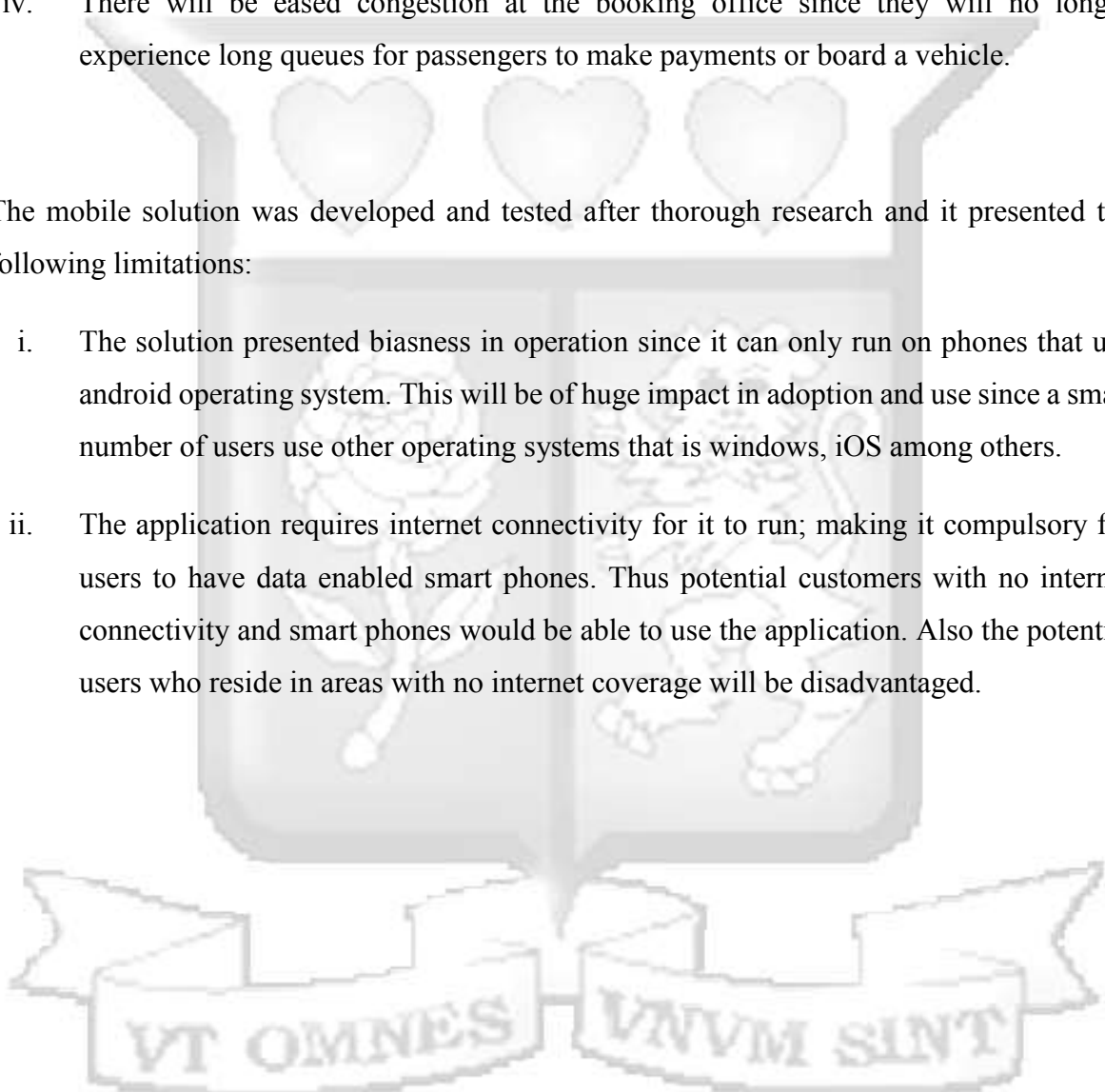
In line with the research objectives, the mobile prototype was developed which requires internet connection and this came with various benefits and limitations. The prototype presents the following benefits compared to other application:

- i. The application enables the passenger to make a booking at their own convenience without visiting the booking office. The passenger is required to select the route they intend to travel, the travel date, the pick-up location and the seats they intend to pay for. For the travel date, the passenger is allowed to book a journey that is within a month from the current date. On the other hand for seats, the passenger has an option of selecting several seats since they are in a position to view the booked and available seats for a specific route and date. This will save the travelling cost and time since the passenger will be in a position to make a booking at their own convenience making it a cheaper option as compared to the existing applications.

- ii. The application offers two payment methods that is mobile money (M-pesa) and payment by credit cards. So the passenger may pay for the journey with comfort. Payment will be processed when a passenger has successfully made a booking.
- iii. The application assists the bus company to prevent loss of revenue since every transaction is captured in the database.
- iv. There will be eased congestion at the booking office since they will no longer experience long queues for passengers to make payments or board a vehicle.

The mobile solution was developed and tested after thorough research and it presented the following limitations:

- i. The solution presented biasness in operation since it can only run on phones that use android operating system. This will be of huge impact in adoption and use since a small number of users use other operating systems that is windows, iOS among others.
- ii. The application requires internet connectivity for it to run; making it compulsory for users to have data enabled smart phones. Thus potential customers with no internet connectivity and smart phones would be able to use the application. Also the potential users who reside in areas with no internet coverage will be disadvantaged.



## **Chapter 7: Conclusions and Recommendations**

### **7.1 Conclusions**

The research sought to investigate and hence attempt to address the challenges that exist in booking in public vehicles in Kenya. Thus the goal of the research was to identify the challenges faced by passengers when making a booking to travel from one destination to the next especially those going for long distances as well as making payments for the journey hence implementing a mobile solution that would address the challenges faced. To achieve this goal, a survey was conducted that involved different stakeholders in public transport industry. This was done to provide a basis for a comprehensive understanding of the challenges and knowledge of the public service vehicles, payment technologies involved and how to settle travelling cost and the shortcomings of these methods. A review of literature was also conducted to identify the challenges as well as key requirements that users would consider information that played a key role in identifying the challenges and limitations of the existing system as well as the development of the mobile application that has the identified characteristics.

The literature has proved that mobile applications over years is gaining popularity as countries move towards convenience in terms of services and more so cashless payments as well. However, passengers still face challenges in making booking and payments for their journey. A review of literature indicated that this was due to inexistence of a mobile application that can be used in booking at the passenger's convenience, lack of trust in transacting online due to fraud cases, the attitudes of users towards technology among others. This study determined that incorporating mobile technology with cashless payment in public transport sector would go a long way in enhancing the efficiency of their services.

It is in this study's conclusion that the use of mobile app in making bookings as well as payments for the same can impact the passengers positively hence offering better services through cost and time saving as well as convenience.

## 7.2 Recommendations

As seen in the study, making booking at one's convenience saves time and money making it efficient for passengers, thus in light of this it is recommended that:

- i. The implemented mobile solution to be scaled up to incorporate the use of Google maps geo-fencing where it will be notifying the passenger when the vehicle is approaching the pick-up location within a specific radius.
- ii. Integration to more Payment Services such as the remaining mobile money services, MasterCard and bank payment services to provide an alternative through which passengers can pay for their journey.
- iii. Implementation of notification feature which will provide an avenue through which the passenger will know that the vehicle they are yet to board is approaching.
- iv. Implementation of the driver's side whereby the driver will be able to view the pick-up and destination locations for the next passenger and confirm that they have picked the passenger on time.
- v. Implement a way to charge for intervals within the journey by providing a mechanism to charge a passenger for intervals covered within the journey other than a flat fee charged for the journey regardless of the pick-up and destination points.
- vi. Implement a way to charge for Passenger's luggage by providing a mechanism to charge for passenger's luggage depending on the weight. The revenue generated from the luggage should be accounted for on the mobile application.

## 7.3 Suggestion for Future Research

The application can be enhanced further with future improvements such as developing a cross-platform mobile solution that is an application that can be used with any existing operating system and implement different secure electronic payment architectures such as QR code and NFC technologies.

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## Appendix A: Sample Questionnaire

1. Please tick the appropriate category as a respondent.

Passenger

Bus Company Staff

2. What type of phone do you own?

Basic Phone

Smart Phone

3. Which operating system runs on your phone?

Android

iOS

Windows

Blackberry

Others

4. Have you ever used a mobile application to make a booking for long distance journey?

Yes

No

5. Have you experienced any challenges when making a booking for long distance journey?

Yes

No

If yes in question 5 above, please select which challenges from the list below (Select all that apply)

Long queues in booking offices.

Cost of making a booking

Others

6. How important to you are the following aspects of adopting a mobile application?

	Not at all important	Slightly important	Important	Fairly important	Very important
The ease of use	1	2	3	4	5
Flexibility	1	2	3	4	5

Reliability	1	2	3	4	5
Cost effectiveness	1	2	3	4	5
Security	1	2	3	4	5

7. Are you familiar with booking mobile application that has been rolled out in long distance PSVs?

Yes

No

8. Do you agree that mobile application will solve the challenges of making a booking in long distance PSVs?

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

9. Which of the payment technologies listed below would you prefer to use in making a booking?

Mobile Wallet

Credit Cards

Digital Wallet or e-wallet

10. What are your reasons for preferring the payment technology you have selected in 9 above?

Due to convenience

It is cost effective

It is more secure

It is reliable

It is simple to use

Thank you.

## Appendix B: Post Test Survey

1. Tick your gender

- a) Male ()
- b) Female ()

2. Does the application look good?

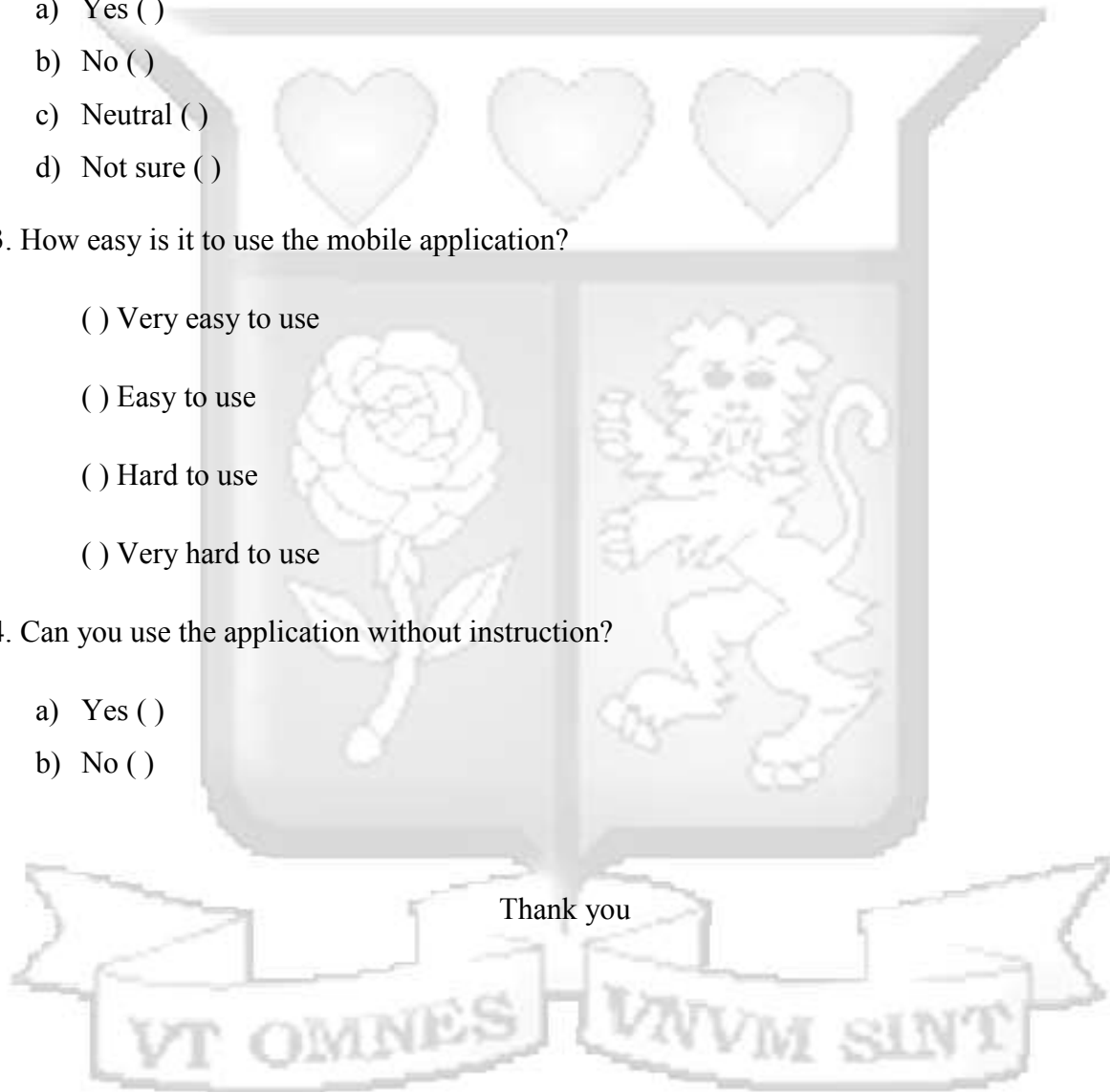
- a) Yes ()
- b) No ()
- c) Neutral ()
- d) Not sure ()

3. How easy is it to use the mobile application?

- Very easy to use
- Easy to use
- Hard to use
- Very hard to use

4. Can you use the application without instruction?

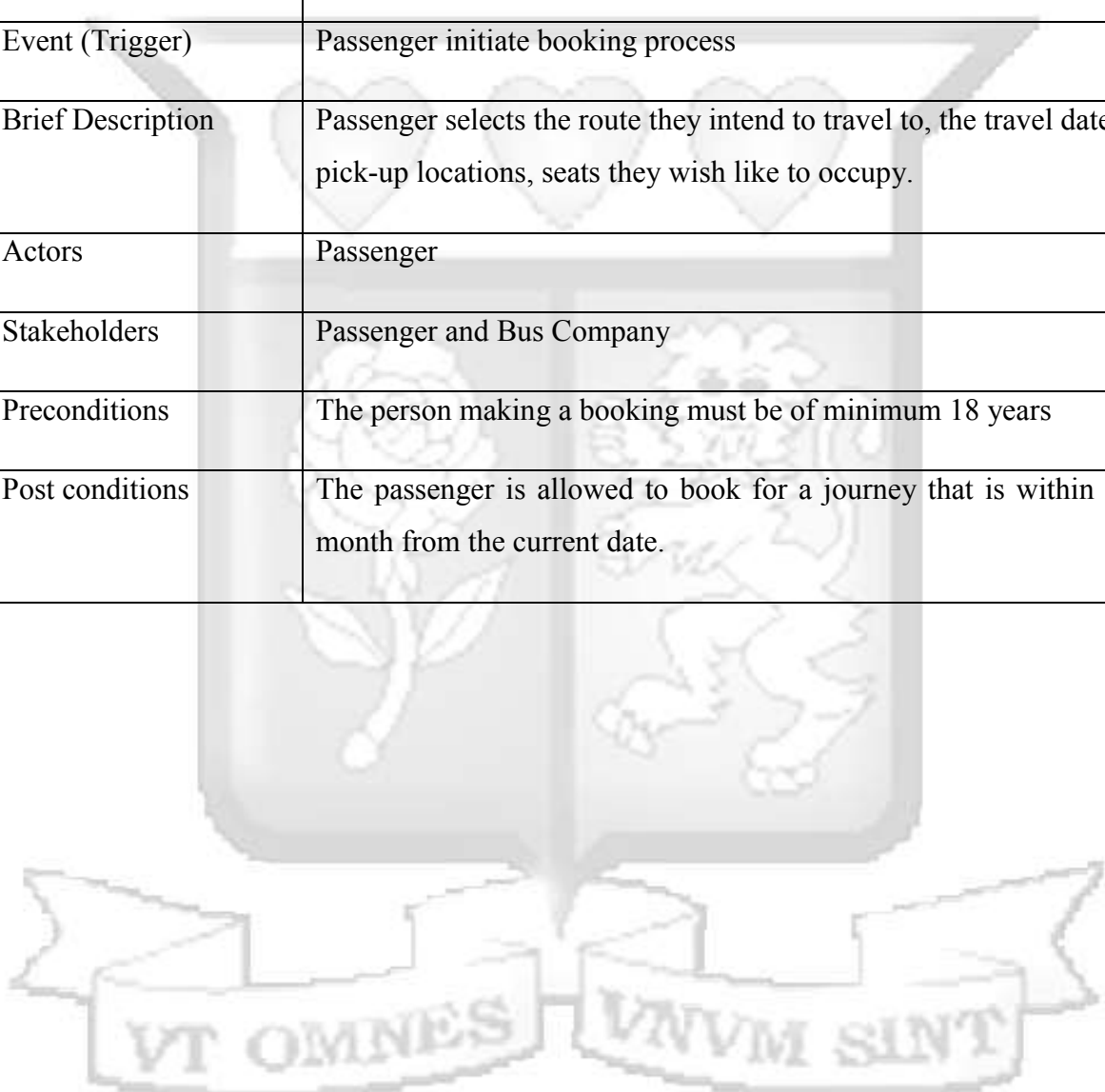
- a) Yes ()
- b) No ()



## Appendix C: Description of Use Cases

**Table C.1 Full Description of Booking**

<b>Booking</b>	<b>Description</b>
Use Case Name	Make Booking
Scenario	Passenger-Based, involves passenger and the application
Event (Trigger)	Passenger initiate booking process
Brief Description	Passenger selects the route they intend to travel to, the travel date, pick-up locations, seats they wish like to occupy.
Actors	Passenger
Stakeholders	Passenger and Bus Company
Preconditions	The person making a booking must be of minimum 18 years
Post conditions	The passenger is allowed to book for a journey that is within a month from the current date.



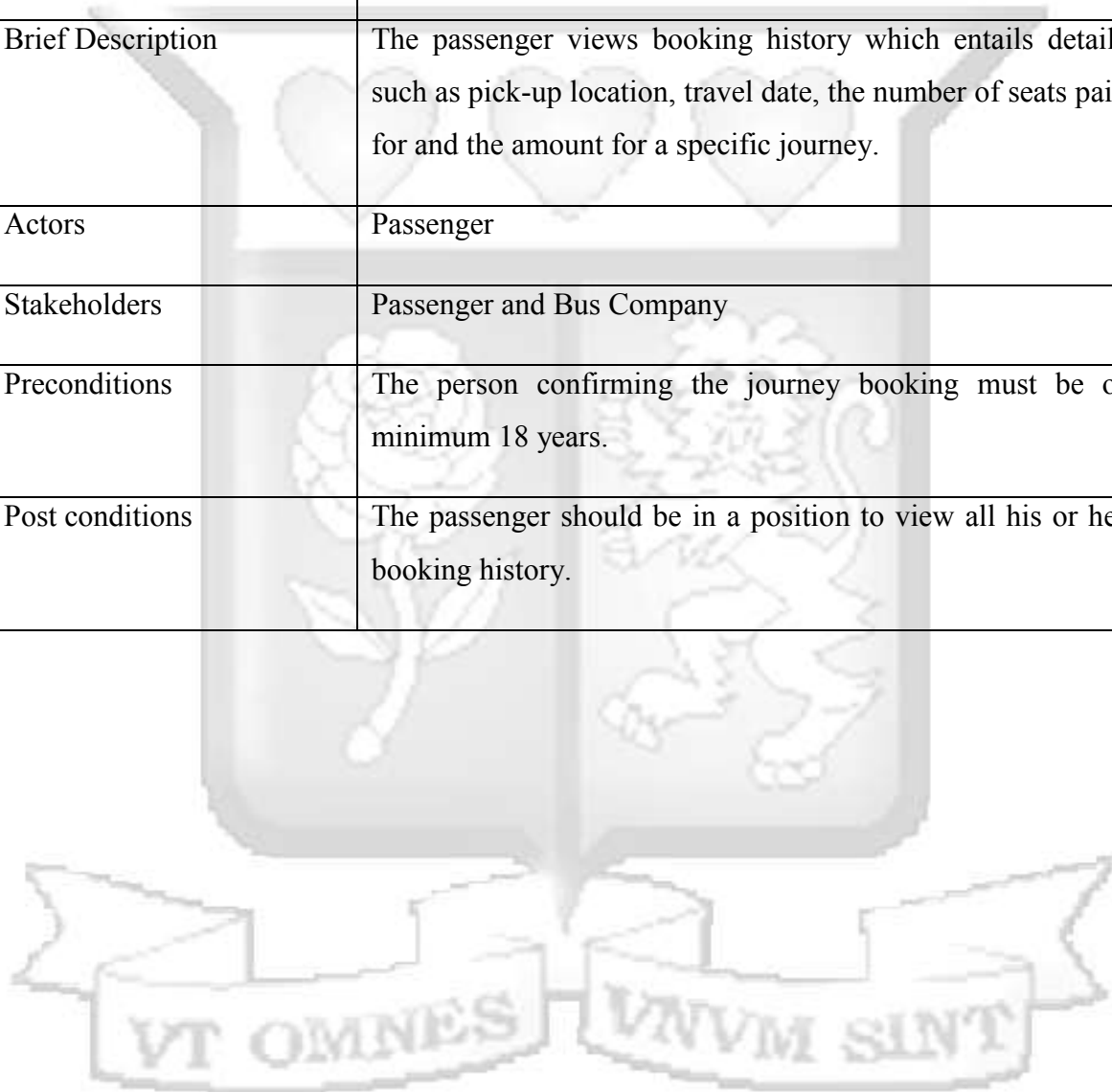
**Table C.2 Full Description of Payment**

<b>Make Payment</b>	<b>Description</b>
Use Case Name	Payment Method
Scenario	Passenger-Based, involves passenger and the application
Event (Trigger)	Passenger selects their payment method
Brief Description	Passenger selects the payment method and makes payment of their journey.
Actors	Passenger
Stakeholders	Passenger and Bus Company
Preconditions	The person making a booking must be of minimum 18 years
Post conditions	The vehicle will pick passengers who have made their booking complete through payment via either M-pesa or stripe card.  The passenger should complete the booking process before they commence their journey.



**Table C.3 Full Description of View History**

<b>View History</b>	<b>Description</b>
Use Case Name	Confirm journey booking
Scenario	Passenger-Based, involves passenger and the application.
Event (Trigger)	Passenger views history to see all the transactions made.
Brief Description	The passenger views booking history which entails details such as pick-up location, travel date, the number of seats paid for and the amount for a specific journey.
Actors	Passenger
Stakeholders	Passenger and Bus Company
Preconditions	The person confirming the journey booking must be of minimum 18 years.
Post conditions	The passenger should be in a position to view all his or her booking history.



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