



**Design of Integrated Smart Payment System**

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**Design of Integrated Smart Payment System**

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**DECLARATION**

I declare that this Dissertation contains my own work except where specifically acknowledged

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**CERTIFICATE**

This is to certify that the project work entitled “Design of Integrated Smart Payment System” is a record of original work done by MUNEZERO Jean De Dieu no: **215030299** in partial fulfilment of the requirement for the award masters of science in information systems of College of Science and Technology, University of Rwanda during the academic year 2014-2016

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May God bless you all!

## **ABSTRACT**

The future of Information Communication Technology (ICT) in Rwanda is about technology and how Rwanda plans to use information technology to deliver better services. With the introduction of smart money, major changes are on horizons. This thesis aims to revolutionize the payment process in Rwanda, where transactions will now be conducted electronically from getting paid, to all monetary transactions using digital money stored on the card, phone and on the bank account.

To achieve this goal, this research followed a framework guided by the research methodology which relates to payment process. Based on the data collected from different payment stakeholders, the researcher highlighted the above concepts and interviews were conducted among different companies and financial institutions. In addition, smart payment system to be developed different stakeholders (like businessman, government and individual) will need to come together to have common understanding on new mode of payment and clear guidelines that ensure the smart payments will be nationally utilized.

Even though the implementation of the system expected to increase the efficiency, this research revealed that there is still a lot to improve on technical setup of the system and the existing infrastructure in order to benefit more efficiency. This will facilitate economic activities in the country by providing safe and efficient mechanisms for making and receiving payment with minimum risks. In addition to that, economic and social factors are the main ones to consider when designing a payment system.

Resources limitations have impacted the size of the research and consequently, the generation of the recommendation. In this regards, further research in this field has been recommended as this system is planned to be implemented in payment industry.

**Keywords:** Smart payment, NFC, Electronic payment, E-Money, mobile payments, Information, Integration, Interoperability

## **LIST OF ACRONYMS**

3G: Third Generation

4G: Fourth Generation

ADI: Applicant Data Interface

API: Application program interface

ATM: Automated teller machine

BNR: National Bank of Rwanda

BPR: Banque Populaire du Rwanda

CST: College of Science and Technology

E: Electronic

E-banking: Electronic banking

EDGE: Enhanced data for Global Evolution

EWSA: Electricity, Water and Sanitation Authority

GPRS: General Packet Radio Service

GSM: Global System for Mobile communication

ICT: Information Communication Technology

IEC: International Electro technical Commission

ISO: International Organization for Standardization

M-commerce: Mobile Commerce

MFS: Mobile financial services

MNO'S: Mobile network operators

NFC: Near field communication

PDA: Personal Digital Assistant

POS: Point of sale

RDB: Rwanda development board

RFID: Radio-frequency identification

RURA: Rwanda utilities Regulatory Authority

SIM: Subscriber identity module

SMS: Short Message Service

SP: service provider

SQL: Structured Query Language

UML: Unified Modeling Language

UMTS: Universal Mobile Telecommunications System

UR: University of Rwanda

USSD: Unstructured Supplementary Service Data

WAP: Wireless Application Protocol

WLAN: Wireless local area network



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# **CHAPTER ONE : GENERAL INTRODUCTION**

## **1.1 Introduction**

Rwanda is steadily moving towards its vision of becoming an information-rich and knowledge based economy and an ICT hub in the region. However, the focus is not just technology, but how it can be used to deliver better services to transform society. Since the mobile banking and mobile payments markets are relatively new in Rwanda, the new integrated smart payment system will allow better service and create cashless society. A smart payment system is any system used for transferring money or use of digital cash. Contrary to traditional systems of paper cash like notes, checks and drafts or coins, this offers a unique service on how banks and non-bank companies will work together for better service. The new design has potential to change in financial sectors more than any other technology since cash based payment is going to be replaced by digital cash, the later providing an understanding of the ongoing changes happening in the payment sector, the impact of mobile based payments as well as the role of banking sector and telecommunications players in it. The purpose of this thesis is to study the role of smart payment, evaluate the business potential of new payment system based on mobile phone and NFC technology and design an integrated smart payment system for Rwanda. This may be considered as fusion between card payment and smartphone. It is a subject of interest due to the vision of Rwanda and due to widespread use of mobile phones, smart phones and tablet device.

## **1.2 Background of the Research**

Your phone is no longer just a device used for making calls or surfing the internet; you can now use it as a platform to boost your payments transaction under different products provided by telecoms and financial institutions. The number of Rwandans owning mobile phones has increased slightly to 8.807 million subscribers in march compared to 8.769 million customers in February. This is an increase of 0.4 per cent, as Rwanda utilities Regulatory Authority (RURA) mobile phone subscription statistics for March indicate. The developments and innovation taking place in the ICT sector and widespread use of mobile phones and the trend towards digital cash are paving way for a cashless economy where everything is done electronically at any one's convenience and that is the key driver of smart payment. The most active players in this industry are mobile operators, financial institutions and device manufacturers. They all have their own interests in driving the future in the direction they desire. Today, smart payment is in use by many individuals,

businessmen, and public and private sector organizations that process over thousand payment transactions per day and it is very convenient for customers who can send and receive money safely. With integration and interoperability of payment systems, Rwandans will be able to enjoy a lot of services like those offered by MTN Mobile money and BPR with EWSA for paying goods and service electronically.

### **1.3 Problem Statement**

Observing the weaknesses of existing payment systems, People ask which payment schemes are adequate for business. We hypothesize that, Economic and social factors are two main factors to consider, when selecting a payment system. Lack of appropriate payment systems, systems integration and Interoperability are the main problems. The purpose of this research is to critically evaluate the business potential of smart payment and propose a new design of an Integrated Smart payment system based on mobile phone.

### **1.4 General Objective**

The objective of this study is to design an integrated smart payment system based on mobile phone that is more convenient in performing financial transactions using digital cash and allow Customers and business to connect for payment.

### **1.5 Specific Objectives**

- To explore existing system and identify their inadequacies of payment systems;
- To evaluate existing payment system used in settlement;
- To gather requirements for implementing smart payment system in Rwanda;
- To Design an integrated smart payment system for improving payment process;

### **1.6 Scope and Limitation**

Payment service is a very wide discipline especially when it comes to exchange money.

This research will focus on analyzing and evaluating existing payment system applied in Rwanda, highlighting weaknesses and/or areas of improvement, and designing an effective integrated smart payment system. The current research will focus to design integrated smart payment system between Telco's and financial institutions for local currency to improve existing system. Payment in foreign currencies will not be covered in this research.



## **1.7 Significance**

The research study could provide information on the issues of payment in Rwanda particularly on the integration and interoperability of smart payment systems. Further, this study would also be a review on the payment technologies present. This study would be beneficial to the country as digital payment is one of the goals to be achieved in vision 2020 as this study enhance the settlement using digital money from paper based payment. Furthermore, this study would be beneficial to all stakeholders, service providers and customers as this study would provide the necessary information on the different threats and attacks in payment technology. To the future researchers, this study can provide baseline information on the recent status of payment system in Rwanda and payment technology in general.

## **1.8 Organization of the Study**

This section describe each chapter in order for readers to gain a quick insight into the overall structure of the master thesis. The thesis is structured as follows:

This research starts by presenting an abstract of the thesis and the essential contents of the thesis.

First chapter begin with an introduction, background of the research, problem statement, general and specific objectives, scope and limitation, and finally, the structure of the study with all necessary information for the understanding of the concepts to be discussed in the other chapters. Second chapter discusses the literature review in connection with different aspects relating to the research area. The third chapter focuses and opens discussion on research methods followed. It describes the different methods involved on gaining data for this thesis. Chapter Four discusses the results of investigation with the corresponding interpretation and illustration of the results and discussion. The last chapter provides the conclusion and recommendations for further studies. Appendix and References are presented at the end of the thesis.

## **1.9 Chapter Summary**

This chapter has described the current research topic and interest. It highlighted the objectives, scope and limitations among others, and ends with the structure of the research which provide clear guidance to the researcher as well as the readers. After describing the research topic, the next chapter focuses on the review of the literature that helped to identify key concepts and theories that are related to this topic.

## CHAPTER TWO : LITERATURE REVIEW

### 2.1 Introduction

Due to the varying use of terms relating to mobile commerce and mobile financial services, it is important to understand the definitions attached to them. Especially, since different information sources often attach different meanings to the same terminology. This variance of terms and definitions is a strong indicator of the state of constant change in the industry. While technology and services rapidly develop, the related terminology tends to be lagging. It has resulted in the lack of a common terminology and definitions getting attached to terms, according to what best please the author. In such circumstances, it is easy to get confused about what is actually being discussed.

The aim of this chapter is to discuss different previous literatures focusing respectively on smart payment system and quality of service delivered theories. It also focuses on how these theories relate to this research as well as other similar researches. The framework of this part deals with the analysis of the findings of other researchers about the quality of service and the impact of smart payment system to enhance those services in Rwanda.

The examination follows a path outlined in figure 1 according to which mobile banking and mobile payments constitute a part of mobile finance, which in turn is a component of mobile commerce.

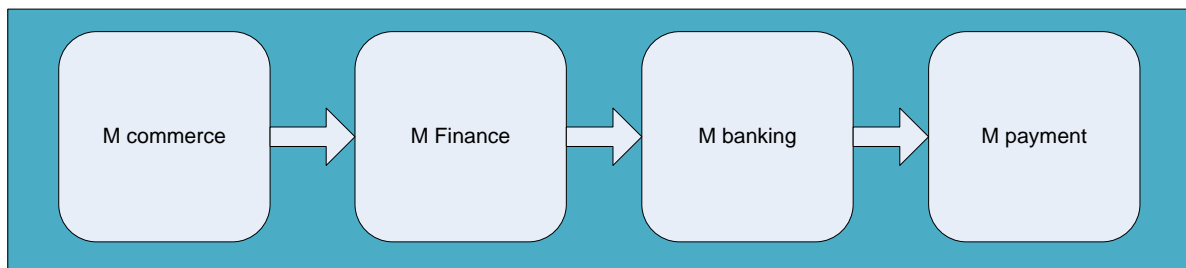


Figure 1 Mobile payment Evolution

Mobile Commerce (m-commerce) according to Singh, Srivastava & Srivastava (2010) is defined mobile commerce as the delivery of products and services via wireless technologies that enables Internet commerce activities, without the restriction of time and space through a hand held device such as a cellular phone or Personal Digital Assistant (PDA). Mobile commerce can also be understood as electronic commerce (e-commerce) or a part of it as defined by White and Ariguzo (2011, p. 135). Goldmanis et al. (2009) recognize e-commerce as any business conducted online.

By a more specific definition, Nelson & van Ketel (2005) define e-commerce as the buying and selling of goods and services on the Internet or other electronic network by firms or individuals.

Different authors in different books has the most detailed definition of e-commerce. E-commerce, electronic commerce, or internet commerce refers to buying or ordering goods via the internet for a consumer's consumption, regardless of whether the goods are paid for later via invoice or immediately via electronic banking, credit card, electronic payment or similar. Internet commerce consist of orders made on electronic platforms and sent over internet, as well as commerce in online stores. Electronic commerce comprise of both domestic and foreign electronic commerce.

For the purposes of this study, electronic commerce is understood as incorporating all commerce that is conducted over electronic network and using digital money. Mobile payment is a part of e-commerce and refers to electronic commerce conducted through mobile devices such as mobile phones, smart phones, tablet computers, laptop computers and other mobile devices.

Mobile Finance (m-finance) refers to the use of mobile technology in financial services. Castello (2004) understands the concept as the freedom to conduct financial transactions when and where users choose helping them to overcome the shortcomings of physical infrastructure with services such as mobile banking, mobile payment etc. M-finance allow its users the ability to access financial information, manager financial transactions and make choices related to purchases via wireless or internet network using mobile devices.

Mobile Banking as defined by Singh, Srivastava & Srivastava (2010) is a channel whereby the customers interacts with bank via a mobile device, such as mobile phone. Pousttchi & Schurig (2004) have a more detailed of the term. According to them mobile banking is a subset of electronic banking (e-banking). Pousttchi & Schuring further define mobile banking as type of execution of financial services in the course of which, within an electronic procedure, the customer's uses mobile communication technology in conjunction with mobile devices. GSM/GPRS, EDGE or UMTS are different technologies can be used in mobile communication.

Mobile payments according to Heyer & Mas (2011) is a system that allows users to hold money in virtual stored value account maintained in a server by a service provider, like telecom, and operated by users through their mobile phone. Users can deposit or withdraw cash within agent, send money to other mobile phone users, by airtime, pay bills and store money.

Mas & Radcliffe (2011) use the terms e-payment and e-money in the same respect. This is understood as having monetary value that is recorded in electronic media and exchangeable. E-payments are transfers of monetary value that occur entirely, and by electronic means, involving the crediting and debiting of electronic accounts, whether these are bank deposit or e-money.

Mobile financial services (MFS) is often used as a synonym for mobile finance. Refers to the term in the Payers (2012), the Mobile financial Services ecosystem is busy place where traditional banks rub shoulders with mobile network operators (MNO'S).

In the literary review, an overlapping of definitions is evident. In general, mobile banking and mobile payments most commonly encompass the terms mobile money, mobile wallet, and mobile money transfer. For the purpose of this study, mobile banking and mobile payments are grouped together as mobile financial services

In this study mobile device also is very important point to discuss as this research focus on smart payment conducted through mobile device. Pousttchi & Schuring (2004) make a distinction between mobile devices, they exclude notebook computers, which are easily transportable but whose use is typically stationary. According to them the use of banking applications on laptop computer with a WLAN connection underlies the rules of electronic banking, not the special rules of mobile banking. This thesis does not share the same exclusion of laptops from mobile devices. They are considered as one mobile device among many even though a large focus in this thesis is placed on smart payment using smart phones and other devices that are truly mobile with use interface that differs from that of stationary device.

## **2.2 Review of related work**

### **2.2.1 Evolution of payment services**

According to Jan de Meester (2010) before the introduction of money, people were forced to trade goods and services directly for other goods and services using system called barter. Time and effort were required to find trading partners who had the goods or services one wanted for exchange purposes, Thomas Lerner (2013) define Payment systems as circulation system for modern monetary economies, ensuring money for spending and saving moves to the right person in the right place at the right time.

Mobile payments and others related services are not a new invention. This first coming of mobile services was at the turn of the 21st century when rapid changes gripped the banking industry. Deregulation, harmonization, increased competition by new players from the non-banking sector, product innovations, globalization advancements and digitization led to the market situation where competition for customers became intense. As a result, banks developed innovative channels, one of service products and offered a wide range of financial services through multiple channels, one of which was a wireless delivery channel available via mobile phones and personal digital assistants (PDA's). Mobile payment services were considered to form an important innovation in the payment system. (Aspara et al. 2012; Suoranta 2003)

In the 1970's the MikroMikko computer replaced traditional cash registers. This enhanced and streamlined the work of the only service channel by automating manual processes.

In 1980's ATM's brought about further developments in efficiency and automation with the intention of decreasing cash based services and simple functions were no longer offered as a person-to-person service, but were transformed into a self-service. A key feature was the automation of process as described by DeYoung (2005).

In the 1990's brought about payment terminals, which again shifted person-to-person services to self-services. As customers got used to pay their bills by themselves on a payment terminal, a natural migration occurred among the same users to the web bank when it was introduced. The web bank was a similar experience; once again customers paid their invoices by themselves.

This led to the point that a majority of invoices were paid through this new service channel, the web bank, and no longer at the bank branch officers of payment terminals. Web bank brought about a new way of doing banking.

With the introduction of payment terminals consumers had to adopt to new service channels that were easily accessible, cheaper, more efficient, and available.

The transformation of sweeping across the terminals in banking industry was the efforts of Sonera, telecommunications provider, to launch new procedures for electronic money transactions with its SmartTrust service (Sonera 1999). The purpose was to provide users a service with which they would be able to type their digital signature into their phone. It was the world's first mobile solution for e-commerce and online banking. The service would use the SmartTrust digital signature and

encryption technology. The goal was to secure a leading role as global supplier of wireless security solutions. Sonera saw business possibilities especially with offering banks and e-commerce companies the possibility of conducting their business securely around the world. The smartTrust service was an open solution, which was independent of handset manufacturers, mobile operators, and service providers and SIM-card. The technology was compatible with WAP, GSM, Bluetooth and future generation of mobile communication networks. The market for wireless e-commerce was seen as being in the early stage of development but with immense growth potential. (Sonera 1999, Kutler 1999)

In the beginning of 21st century the WAP evolution was one such story brought on by Nokia's rise to being the leading handset manufacturer in the world from 1998 to 2012 (Gartner 2012). The company's WAP endeavor was not as successful as was hoped, due to shortcoming in the system's user interface. The system was slow, clumsy, and in a way ahead of its time. People did not have a natural need for mobile financial services, which did not support using WAP. (Helsingin Sanomat 2011, Gow & Smith 2006, P.74-75)

Only in recent years through the development of mobile devices, their processing power, screen size, user interface and data connection has a need and demand for mobile payment services developed. MFS services are also much more refined, as they are fast and easy to use. This has made mobile banking and mobile payments as simple.

### **2.2.2 Developed vs. Developing countries**

Electronic payment systems are essential for stimulating economic growth; however, in contrast with the United States where there are a variety of electronic payment options, most African economies are cash-based. According to a June 2012 Gallup, Inc., survey of 11 countries in Sub-Saharan Africa, approximately 80 percent of adults make bill payments or remittances with cash. An August 2014 World Bank report, found that due to the lack of digital payment penetration in Africa, governments, consumers, and financial providers in Sub-Saharan Africa are still bearing the high cost of cash payments costs associated with manual acceptance, record keeping, counting, storage, security, and transportation.

There are fundamental factors that differentiate smart payment or digital payment initiatives between developed and developing countries. In developed countries smart payment failed to take off at the beginning of 21st century due to poor user interfaces, slow service, limited user and a

variety of competing services. Smart payment is now making its second coming, due to the rapid increases in the availability and adoption of smart phones and services available to them. The growth of mobile phone services and e-commerce, together with the evolution of the handset into smartphone, present two of the most significant opportunities for the payment technology industry. (Middleton 2011).

Customers in developed economies, the opportunities of mobile financial services have translated into increased affordability, convenience and security for conducting payment over a hand held device and especially for businesses it has meant the possibility of reaching vast numbers of new customers (Jenkins 2008). The challenges and opportunities of smart payment through mobile phone are quite different. The potential for smart payment is large as it offers to facilitate the flow of money among rural and poor families at much lower transaction cost, bringing the bank to those currently unbanked (Jenkins 2008). Mobile payment also has great potential in facilitating financial inclusion, which reduce poor people's vulnerability to shocks and increases their ability to invest in income generating activities and assets (Dolan 2009).

Developing countries have a large number of the population that are unbanked but has easy and cheap access to mobile communication. Based on one success story comes from one country in east Africa community named Kenya where the adoption of the M-Pesa has 18 million users who use mobile phone for payment (Van Dyk 2012).

In 2007 Safaricom launched M-Pesa in Kenya. 2009 the service had 7 million users. Especially young men and woman were the first to use M-Pesa to send money back to their families in the countryside. 2009 the use of the service expanded to pay for everything from bills to services. Using mobile money become a faster, cheaper and safer way to transfer money than traditional payment or Bank transfers, which tend to be slow and costly. (The Economist 2009)

Mobile banking and payment services have been a success in many developing countries. According to the Economist (2009) the progress of mobile banking and payments has been impeded by banks, which feared that mobile operators would eat their lunch. In many countries mobile money has been blocked because operators do not have banking licenses.

Mobile payment should be seen as an opportunity than a threat. As the Economist (2009) Banks should see mobile payment as an exciting chance to exploit telecoms firms, vast retail networks and powerful brand to reach new customers.

Mobile payments has huge potential in the markets, as it enables two parties to send and receive payment and exchange funds using the mobile channel anytime and anywhere. This allows the transfers of funds or payments of a bill using their mobile device. The payment received can then be redeemed as airtime, goods or cash depending on merchant. The potential services in emerging markets is a very attractive for all stakeholders.

According to Van Dyk (2012) smart payment is the biggest thing in retail and it give hope and promises to cashless economy. Many different people in different industries are now working hard to develop and promote a new way of payment, on how to use and implement mobile phone in financial services. All parties involved see mobile payment services as a unique business opportunity, where there is a great potential for profit.

In 2011 and 2012 companies and market leaders such as MasterCard, Visa, Nokia, Google, Samsung, Ericsson, Vodafone, Apple, Orange, Paypal, Facebook and others were looking to get first mover benefit in the mobile banking and mobile payments market. To recognize the potential of mobile payments technology is the key factors for companies to be competitive in the market. (The Paypers 2012; Kauppalehti 2012). In addition Sirpa Nordlund highlights the importance of banks in this new mobile payment system, Banks have a vital role to play for today and tomorrow. (The Paypers 2012) .In Rwanda mobile financial services are slowly gaining momentum, as service providers are finding way to promote the technology and come up with technology that will let them to get more customers.

### **2.3 Review of related technologies**

Today's business need to value time than ever and smart payment is going to be the solution with beginning of new era, where paper money will be replaced by electronic money.

With emerging technology ways in which people can pay electronically are becoming more and more sophisticated, leading to new options for transferring (or even depositing) money. Innovative payment services try to cater for new markets and needs. They may promise high convenience, flexible use, high transaction speed and/or lower fees than traditional payment instruments.



However, they have to compete with legacy solutions and comply with rules and regulations which often vary from country to country. The technology involved in mobile payment services has created a completely new service channel for banking and financial institutions as well as the non-bank companies. Traditional banking and payment channel still exist in today's world but their function is changing and some are being completely replaced by the mobile services.

Today's business banks are looking at mobile phone as their fifth customer service channel after branch offices, ATM's, Internet Banking, and Phone Banking (Goode 2008).

Mobile payment is the new service channel brought by new technology innovations and service models. Time in the past, customers had to conduct the financial services through stationary channel (e.g. Visiting bank branch office, or ATM, etc.). Nowadays, due to the mobile service channel, they have a wider range of options available at their disposal that allow them to use of financial services anytime, anywhere through mobile device.

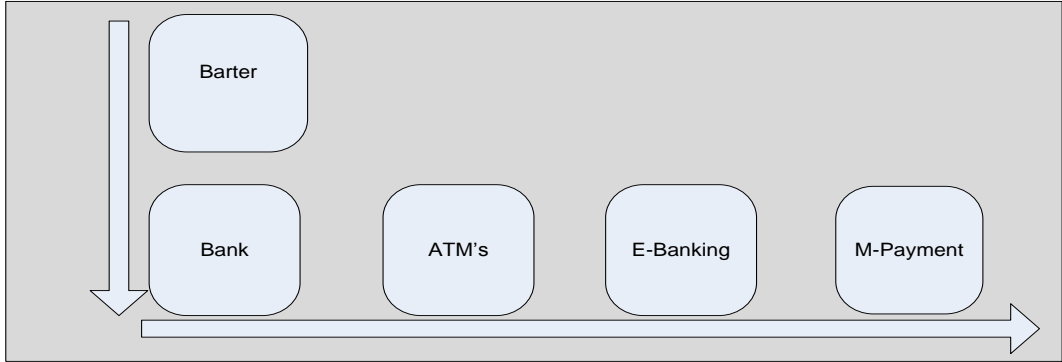


Figure 2 Payment service channels evolution

Technology companies and researchers, such as Apple, Google, Samsung and Square, have been looking into how payment system can be improved to allow Customers connect (All payments, anywhere, anytime) and Business connect (Complete business to business payments solution) using smart phone. Most of people currently depends on their smartphones on daily basis to complete their tasks. This technology has enabled some people work remotely using electronic devices. This has attracted many people including researchers studying ways in which smart phone can be even more profitable by integrating payment system. The vast array of mobile devices that allow consumers to use banking and payment services. The four main categories are presented in below figure 3.

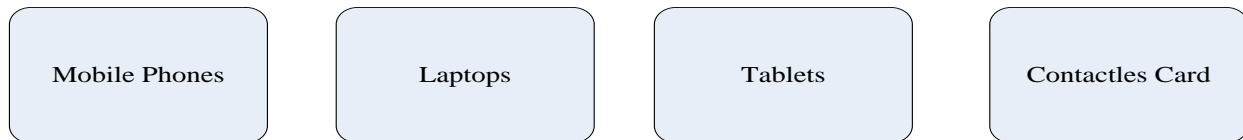


Figure 3 Payment devices

Mobile Phones and smart phones are generally used as service channel in terms of payments and Banking, as they have become available for consumers. Some other devices can also be used to access payments services as mobile phones and smart phones. These are laptops, tablets, contactless cards and any other devices that allow banking and payment features.

NFC Technology works in a similar way as with other contactless services available today. What makes difference with other contactless services is that it is designed to operate only over very short distances, less than ten centimeters. NFC chips use the same technology used by contactless cards with radio frequency communication standard as the contactless chip, but NFC has high capacity than contactless card technology because it can work in two ways: both as a reader and as a sender of data. This technology allow payment applications possible with more functionality than the contactless chip, with this customer can transfer money to another customer, payment of goods and services. (Balan, Ramasubbu et al. 2009).

Contrary to contactless chips, the NFC chip does require power, so it is not usable as standalone device like a contactless chip, but needs to be integrated into a device with a power source, most commonly a mobile smart phone. (Alliance 2007; Van Damme, Wouters et al. 2009) This currently is a problem in adoption of NFC based applications.

Since expectations for the future in the medium to long term are quite good, there are currently only a few smart phones on the market with an NFC chip. (Crowe, Rysman et al. 2010)

To overcome that challenge Rabobank is currently conducting pilots with such stickers. (News 2010) on how they can come with contactless chip inside a sticker that can be attached on mobile phone that does not have NFC to allow these phones to process payments others with NFC technology inside.

## 2.4 Services offered

### 2.4.1 Mobile Banking services

Since the introduction of phone banking or mobile banking in 1982, the range of service has increased. Besides being able to transfer funds from person to person and conduct account balance inquiries over the telephone, bank consumers can also make bill payments, trade in stocks and other different payments services. Mobile banking and mobile payments entail a large entourage of different financial services which can be grouped into two main service, mobile banking and mobile payments services. Each service group is then made up of several service as shown in figure 4. This section present the most common services offered by mobile banking and mobile payments.

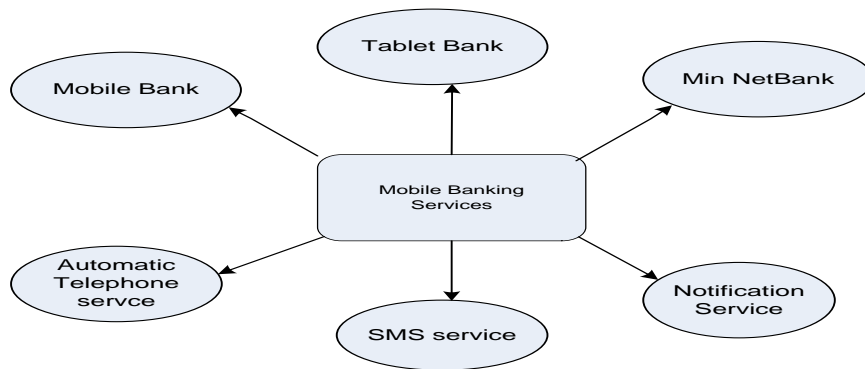


Figure 4 The Mobile Banking Services

The mobile bank service has different features such as account balance information, invoice payments, money transfers, messaging to bank personnel, etc. These services accessed through a mobile bank app on mobile device.

The tablet bank has the same services as the mobile bank, but this is customized for tablet device. Due to the size of the screen, tablet are able to display more information allowing for more possibilities compared to a smaller screen size of smart phone.

Compared to mobile bank and tablet bank the mini net bank service has many of the same service as the mobile bank and tablet bank. A user can browse their account information, transactions, pay invoices and access market information.

The automatic telephone service allows users to listen to an automated voice tells them their account and credit card balance, and transaction information.

Some service providers deliver both of those services together, while others separate them into an automated phone and SMS service. Few service providers have even defined their own notification service that sends automated SMS messages to customers about their account information.

### 2.4.2 Mobile payment services

The mobile payment service is bundles characterized in figure 5 form the basis for mobile payments service group. They are synonymous with mobile money and wallet services. As their name suggests, mobile payment services are focused on different ways of electronically transferring money from one party to another.

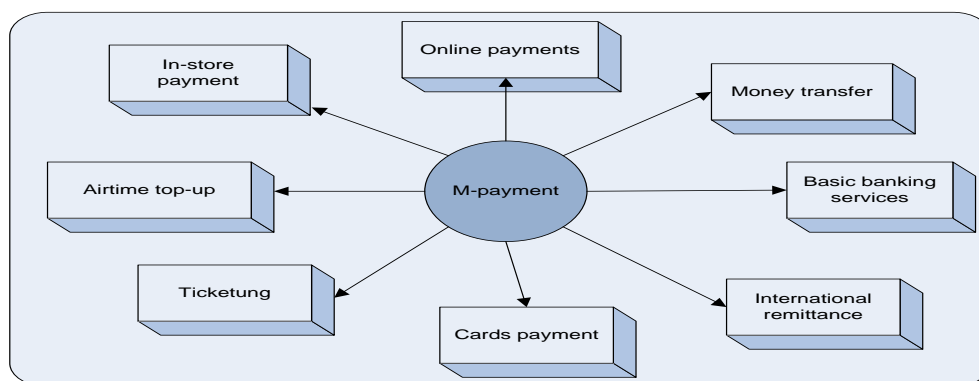


Figure 5 the Mobile Payments Service Group

In store payments refer to the physical act of payment in store environment. They revolve around proximity and contactless payments, which means that that customers is able to quickly and conveniently make a payments either by scanning, tapping, swiping or checking in with mobile device that recognizes the point of sale (POS) terminal upon becoming in close enough proximity-with it . Within store payments the mobile device can take on the form of variety of options, e.g. payment card, mobile phone, smart phone with NFC etc...

Online payment or remote payments refer to make payments through a mobile device by either logging on to an online service to make a payment, or having the payment charged directly to a customer’s mobile account. Online payments can be characterized as electronic payments, made with a mobile device that does not require any contact with physical POS terminal.

Money transfer in the mobile context refer to transferring monetary funds , from one party to another, through a mobile phone or mobile wallet account using a mobile internet connection. Mobile money transfers are much like a traditional account transaction except that the entire

process happens through a mobile device, and the value chain supporting it can involve a variety of different parties like money transfer agencies, telecoms and financial institutions.

International remittances are similar to money transfers, except that they are settled in an international setting, through remittance transfer providers, such as banks and credit unions.

Ticketing is the process of ordering, paying, obtaining and validating tickets through mobile device regardless of place or time. Mobile ticketing can be used with any service that requires a ticket as proof of purchase.

Airtime top-up refer to prepaid mobile credit that can be purchased online, at over the counter retailers and even at ATM's location. The prepaid credit are stored in an electronic account.

Basic banking services create its own service bundle in the mobile payments service group, as it provides convenient and often necessary services that amplify the user experience of other payments service bundles. They also an obvious service to offer consumers, as most payments services require a bank account, debit card or credit card to work. Basic banking services in the mobile payments service group consists mainly of accessing account information and making account transfers.

## **2.5 Chapter Summary**

In this chapter, an overview of Smart payment theories with its link to service quality and customer satisfaction has been carried out to point out, the impact of smart payment system on the enhancement of payment services in Rwanda and to deliver a good quality of service which lead to customer satisfaction. Furthermore, the next chapter is focusing on theoretical framework and research methodology used in this study.

## **CHAPTER THREE : RESEARCH METHODOLOGY**

### **3.1 Introduction**

The research methodology focused on an evaluation of the business potential of smart payments as an alternative to existing payment methods in Rwanda. There are three overall approaches to conducting research; quantitative, qualitative and mixed method research. Each approach consist of three levels; research considerations, research design and research methods. The choice of which approach to use is based on how the approach matches the research problem. As a result this chapter on research methodology will provide information on the research considerations, research design, research methods so as to justify the research approaches which were adopted in order to answer the research question.

### **3.2 Research Considerations**

Business research is subject to considerable debate concerning its relevance to practitioners and its fundamental purpose. Generally, the process in which knowledge is produced can be divided into two separate categories, to examine on which terms and how scientific knowledge contribute to society. The distinction is made between Mode I and Mode II forms of knowledge production. Mode I research is characterized by academic agenda and is essentially what is thought of when thinking about traditional university based academic research. In this mode, the research findings are expected to build upon existing knowledge within a particular research era and remain with the academic community with little emphasis on the practical application and diffusion of knowledge. Mode II research has a somewhat more practical purpose with research aimed at benefiting society in a normative and social useful manner. In this method, research results are closely linked to the context and environment and may as a result not be replicated easily. Mode II research also seeks to facilitate the collaboration between different research disciplines and to strengthen the cooperation between public institutions and private companies, academics and practitioners. Another consideration is what should be regarded as acceptable knowledge in business research. This thesis will be able to explain the potential of smart payment based on mobile phone.

### **3.3 Research Design**

A research design is a structure that guides the execution of a research method and the analysis of the subsequent data. For this research different type of research design were used. Among experimental design, the cross-sectional or social survey design, the longitudinal design, the case

study design, action research and comparative design. In order to understand the complex issue of smart payment and answer the research question a case study was chosen as the preferred research design. Case study research is concerned with the exploration and understanding of a single phenomenon or unit. Here the phenomenon under investigation is Smart payments technology. The choice of which approach to use should always be based on how approach matches the research problem. The next section will provide further detail on how the data was collected.

### **3.4 Research Methods**

In order to perform this research the different methods were used in evaluation of the business potential of smart payment based on mobile payments as an alternative to existing payments methods in Rwanda. To conduct this research two kind of data were collected, Primary data based on the semi-structured interviews and secondary data, based on an examination of integrated smart payment using mobile phone with NFC technology.

The methods that are to be used for this research in collection of the necessary data was chosen prudently so that they can fit the research needs of the researcher. A technique for collecting the primary and secondary data was also selected. The choice of methods depended on which qualitative data collection technique would facilitate the collection of informative data about payment in Rwanda. Semi-structured interviews are suitable method for studies to explore. The choice of method depended on which qualitative data collection technique would facilitate the collection of informative data about industry experts' perception of the potential of smart payment-based mobile phone and analyze the potential of novel payment technology.

In addition, earlier smart payment research has also demonstrated interviews as an appropriate technique for collecting valuable data. Consequently, face-to-face semi-structured interviews were selected as technique for collecting the primary data.

Before a final decision was made, alternative data collection techniques were considered, including two other widely used techniques within the qualitative methods; focus group interviews and telephone interview. The group interviews, is often a preferred data collection technique due to the special group dynamic that occurs when interviewing people together and which often evolves into an informative debate among the participant. Initial contact with different stakeholders in payment industry to participate in group interviews due to the conflict of commercial interest between different parties. Then face to face interviews were also conducted.

The telephone interviews, is also quite often a suitable alternative to face-to-face interviews, but for the purpose of this thesis the method was not used in preference to semi-structured interviews due to three main reasons. The first one was that survey would not be enough confidence between interviewee and interviewer. The second reason was the lack of possibility to observe the interviewee's body language, which could provide necessary information. The third reason not make use of telephone interviews had with the technical difficulties with recording the conversation. This confirm the choice of semi structured interviews as the method for collecting data.

### **3.4.1 Interviewees**

To determine who would be suitable interview subjects and establish some selection criteria to sort among them, a review of different stakeholders in payment industry was conducted. Based on the literature a list of interviewees was composed.

The selection criteria for choosing interviewees including persons with knowledge about smart payment based on mobile phone. In addition, the selected interviewees had to be knowledgeable to discuss about the technology to be used in smart payment implementation and the representation of all stakeholder in the industry. Most of the interviewees were identified from financial institutions (banks and micro-finance), telecommunication companies (Mtn Tigo and Airtel) and different Marchant, RURA, RDB, lastly National Bank of Rwanda as regulator (BNR).

Other interviewees were identified through direct contact with companies in the industry, asking for interviewees in relation to the research area. Sampling also was used as interviewees were asked to suggest potential interviewees. Sampling proved a very efficient way to get the right people to give interview from big number of people working in different area.

During 2 weeks period, 85 interviews were conducted, which were deemed sufficient to clarify the current situation. Table 1 gives a description of the interviewees.



INTERVIEWEE	AFFILIATION	NUMBER
Channel/ICT/Treasury/operation	Banking/ Equity Bank	Interviewee #10
Mobile payment Dept.	Telecommunications/ MTN	Interviewee #5
Mobile payment Dept.	Telecommunications/ TIGO	Interviewee #4
IT Dept.	Network SP/ Olleh Rwanda	Interviewee #4
Credit/Agency/IT Dept./Finance	Banking/Cogebank	Interviewee #8
Mobile payment Dept.	Mobile payment / Airtel	Interviewee #6
Taxes Collection	Rwanda Revenue Authority	Interviewee #9
Payment Dept.	National Bank of Rwanda	Interviewee #3
operation Dept.	Rwanda Bank association	Interviewee #3
Credit/payment/IT Dept.	Bank of Kigali	Interviewee #12
IT Dept.	R-switch	Interviewee #3
Product and Marketing	Rwanda Online	Interviewee #3
Customers and Merchants	Retailers	Interviewee #9
IT Dept.	RURA	Interviewee #2
IT security Dept.	RDB	Interviewee #4

Table 1 Description of the interviewees.

The interviews followed a semi-structured format. Initially an interview guide was produced and was subsequently tested in a pilot interview to address the potential errors. After a couple of revisions to the original interview guide after getting the feedback from the test. The interviews were conducted in different place where the interviewees are based but most of them were found in Kigali city. Based on an analysis of the findings this helped to reach to the conclusion of the overall research.

In order to research smart payment based on mobile phone an extensive examination of literature from both industry and academic sources such as books, journals, report, conference papers and government publication was conducted. The review of second data shows that smart payment research is rapidly developing. All literature material was critically evaluated and multiple sources, when available, were used to confirm findings.

During the 1990's the focus of the research community had primarily been on other aspect of electronic commerce, such as internet commerce, financial services and electronic funds transfer were investigated. Consequently, the year 2000 was selected as a starting date in the research for digital payment using mobile phone where the focus was to look on the possibility of combining mobile device and electronic commerce.

#### **3.4.2 Questionnaire**

Questionnaire are a set of related questions designed to collect information relating to certain study/research. They are a valuable method of collecting a wide range of information from large number of individuals, often referred to as respondents. Adequate questionnaire construction is critical to the success of a survey. Inappropriate questions, incorrect ordering of questions or bad questionnaire format can make the survey valueless, as it may not accurately reflect the views and opinions of the participants. Objective of survey have to be clearly defined before starting the questions so that respondent will be answer by considering that objective. A useful method for checking a questionnaire and making sure it is accurately capturing the intended information is to pretest among a smaller subset of target respondents. For this study questionnaire were used for data collection.

#### **3.4.3 Ethical issues**

The data we need to complete our research were considered confidential by the data owner. However, it is necessary to access those data in order to be able to address the current research question. Therefore, anonymity and confidentiality was given to any information that was judged sensitive by the owner of data.

#### **3.5 Development model**

The software development model that used in this project is waterfall model. This is the sequential software development model of six phases which are listed below. In this project the methods used are based on software engineering process and standards of system analysis and designing.

It provides for all majors workflows in the project including requirements gathering, analysis, design, implementation, coding and testing. This means that any phase in the development process begins only if the previous phase is complete.

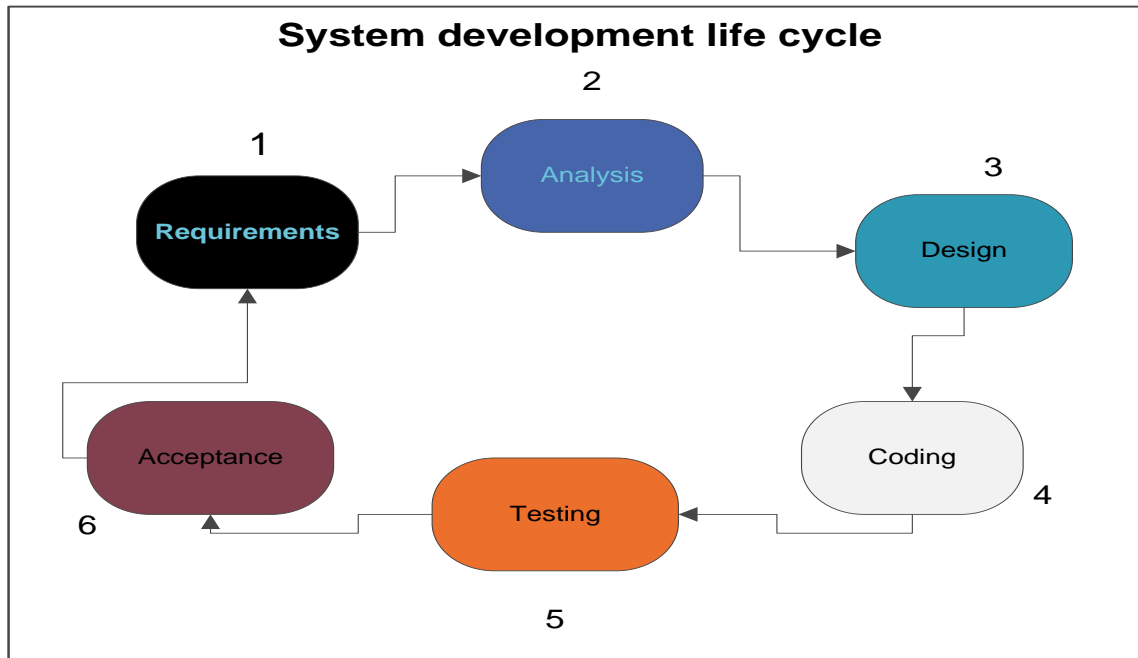


Figure 6 the waterfall model of the system

### 3.5.1 Requirements analysis

Before proceeding with development of the new system initial investigation was conducted to check out on different points of the requirements and to check on the proposal to identify if the necessary elements are in place to proceed with development and this include the main point that is the business need. It also involves a macro level study of the customer requirements. This phase also involved defining alternative solutions to the customer requirements and cost-benefit justification of these alternatives. With the investigation conducted in three different areas financial institution (Banking sector), Telecommunication companies and other different Stakeholders.

### 3.5.2 Analysis

The purpose of this stage was to determine if the customer's requirements as outlined so far can be met and to identify the best option available to achieve the business needs. Involves carrying out

detailed study of the customer requirements and arriving at the exact requirements of the proposed system. The phase involves freezing the requirements before the design phase begins.

Based on this study of smart payment system analysis phase was the next step considered after the requirements, the requirements were analyzed, and feasibility of the project was checked for proper design. For integrated smart payment system the requirement was gathered and the analysis of requirements was done and then proper documentation was prepared which helps further in the design and development process. Different Aspects were considered during the analysis stage including:

- Identifying the options available and selecting the most appropriate
- Further analyses risk and develop a plan to manage it
- Analyze preferred option in terms of cost, benefit, detailed plan
- Develop potential scenarios for the outcome
- Determine the appropriate strategy for implementation

### **3.5.3 Design**

To design a new proposed smart payment system waterfall model design was very important phase after gathering the requirements and analysis of feasibility of the project and involves translating the identified requirements into a logical structure, called design that can be implemented in a programming logic. Based on all information collected from the two first phases design was prepared. After Design stage we will the system architecture to submit to the programmer for development of the proposed solution.

### **3.5.4 Coding and testing**

Based on the designed system with consideration of all inputs from the previous phases, the system was developed in small programs called units, which was integrated in the next phases of testing and implementation and each unit is developed and tested for its functionality to insure the quality. After coding then testing involves integrating and testing all the modules developed in the previous phases as a complete system.

## **3.6 Existing systems**

Traditional payment system is now facing different problems caused by traditional payment systems such as, lack of integration and interoperability, counterfeit money, convenience, Security

etc. With smart payment system those problems will be solved because all payment will be computerized. The main goals of our research are to analyze and evaluate existing payment system applied in different services and to propose a new effective integrated smart payment model in order to improve payment services in Rwanda. We will start by studying the development of a new form of money and the importance of integrated smart payment system (digital payment system), then we will analyze different issues related to traditional payment system in order to propose a new model that resolves different payment issues

**3.7 Proposed system**

The analysis of the existing payment system was conducted, based on the data collected from different beneficiary of payment system (customers, businessman and service provider) we realized that cash based payment is causing different problems as listed in the previews sections. Based on the result of the research conducted, the proposal of designing an integrated smart payment system was made to replace the existing payment. With the technology embedded in Mobile phone all payment are solution are going to be integrated in mobile phone to allow customers to connect and pay from where they are and this work only when money has become digital.

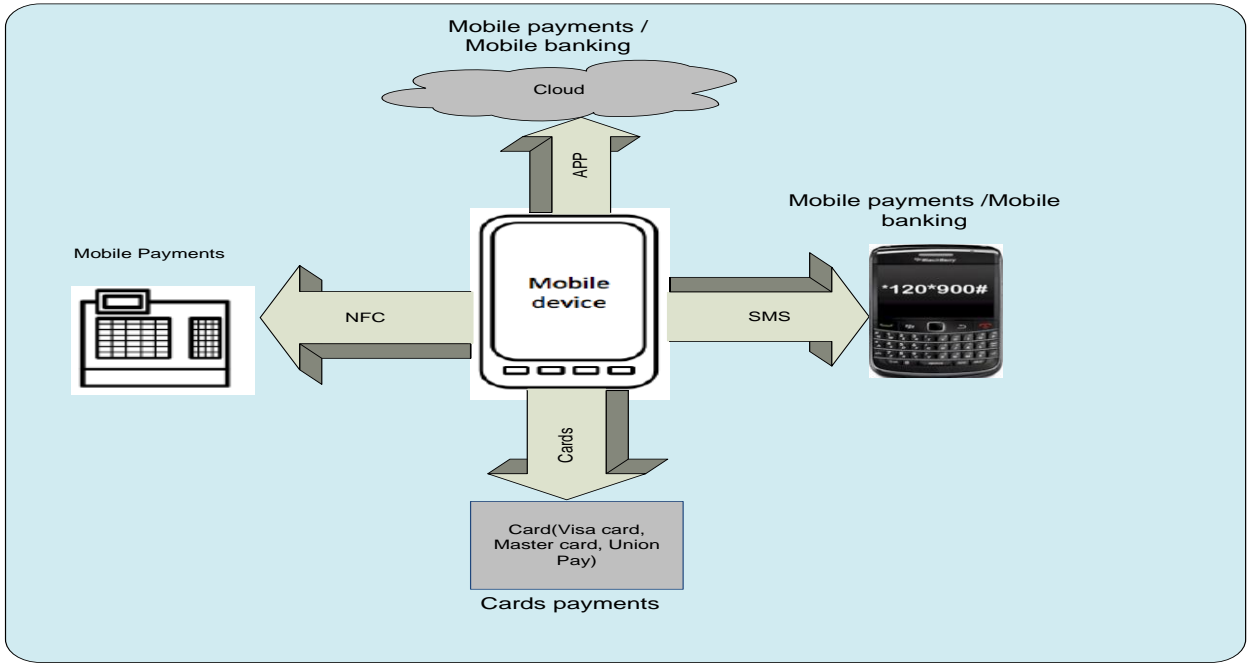


Figure 7 Proposed Interoperability smart payment system

Since money's destiny is to become digital and digital economy, different technology integrated in smartphone make mobile phones to become more intelligent and powerful than ever. The emerging technology made on mobile phones caused them to be multifunctional not only voice communication and text messaging capabilities. Previously several works could only be handled by computers, but with emerging technology mobile phone has become a powerful tool for business including payments in developing countries. While companies continue invest in payment technology security is still main concern for payment. The new model of payment will use different technology like Internet banking, POS, smart card and mobile technology with integration and interoperability capability. Most of mobile payment services make use of a combination of various Technologies. USSD, RFID, Bluetooth, Wap/Internet, Cloud/App, NFC and SMS. These are technologies that are most dominant technology and various operating system for cellphones and smartphones like Android, iPhone and blackberry.

### **3.7.1 Cloud /App**

Cloud computing and app provided to mobile devices are the present and most common way for mobile financial services, especially mobile banking service and mobile payments in general. Different Banks in Rwanda have their own mobile banking used on smart phone and tablet devices. Google as well has an app based for mobile devices called google wallet. Apps provide a customized user interface for end user, to access stored on cloud serve through their mobile device via mobile technologies such as WLAN and 3G/4G.

### **3.7.2 SMS Based**

SMS based structure is use mobile phone where a mobile phone users can buy and pay their vouchers. Mobile money services allow these small retailers to act like branches by allowing the customers to exchange cash to credit using mobile money account. Money transfers can be done via text messages to other registered mobile money users, who can exchange the credit for cash. Money can even be sent to unregistered users, who receive a text message with a redeemable code that can exchange credit to cash.

The relevance of SMS based structure is not as predominant in developed countries as it is in developing ones. SMS based payments are still offered in different financial institutions in the country. But with technology the main interest lies in apps and cloud computing. The diminishing

value of SMS based services is also evident from the discontinuation of Nokia Money and Ericsson Money, which was primarily SMS based services.

### 3.7.3 Near Field Communication

Communication in between devices will be done using near field communication. Near field communication is an implementation if ISO/IEC8192 standard as well as the ISO/IEC14443 wireless smartcard protocol. NFC is a short-range wireless connectivity technology that has evolved for combination of existing contactless and interconnection technologies. This communication between two devices occurs when they brought within four centimeter of each other and this technology follows universal standards.

NFC technology complements with existing technology using contactless card that enable a consumer to utilize one device across different systems by using integration and interoperability of different payment systems. The world's leading consumer electronics and mobile device manufacturers, semiconductor producers, network operators, service companies, and financial institutions, among other industries, support NFC leading to a complex value chain.

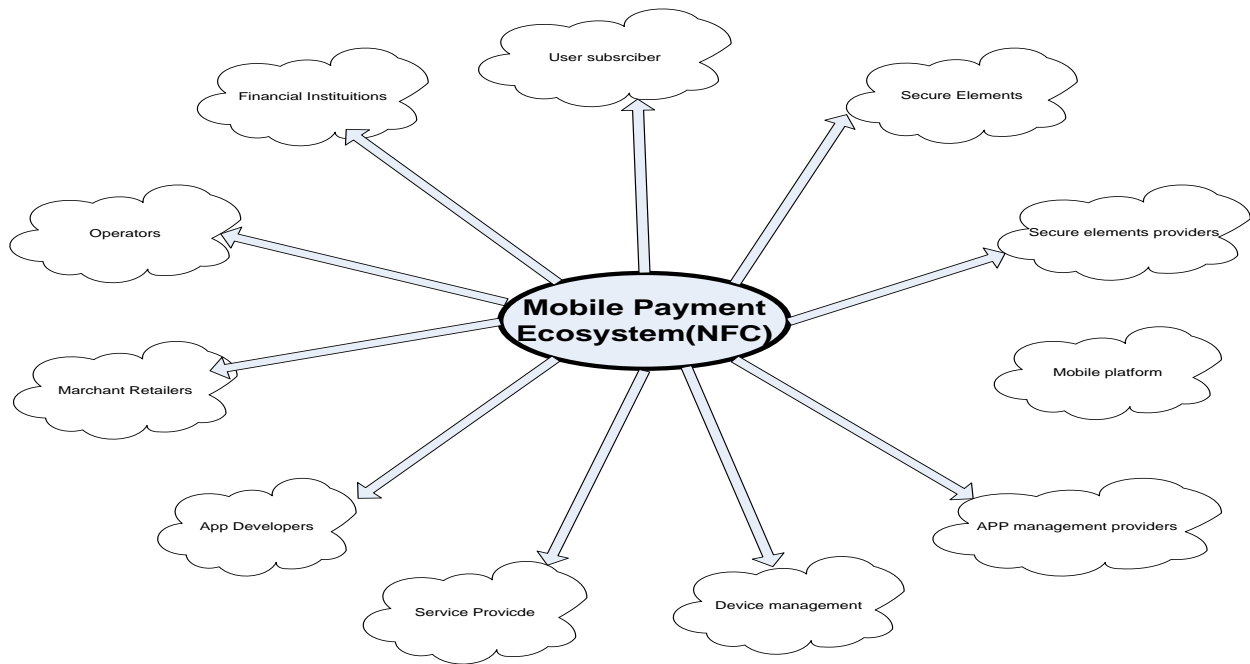


Figure 8 the NFC ecosystem (NFC Forum 2012)

The possibilities with NFC and the value it can generate go far beyond these contactless cards that people use today. NFC will be able to offer all the possibilities that the current contactless card can offer but NFC will also because of its short operational range offer the possibilities of payment. The financial industry has for some time been working on contactless payment and NFC has been identified as a key solution. With NFC implemented on mobile phones the versatile possibilities within payment and access will be unleashed and wallets and key will truly be only a memory from the past. Instead of using debit-card or cash based when completing a payment or purchase, people will only use NFC within their mobile phones. In this research all interviewed people and companies held an interest in smart payment using mobile phone and NFC Technology. NFC devices can support the interoperability of the existing payment systems through mobile phone.

### **3.8 Research analysis**

Both questionnaire and unstructured interviews (face to face) survey results were analyzed. There is a complex range of issues and interests surrounding payments system in Rwanda. Each interviewee was sent the interview question in advance. This give them the opportunity to prepare for the interview. The interviews were conducted one-on-one either in person or via mobile phone in English or Kinyarwanda, depending on the interviewee's preference. The questions focused on different aspect about payment system in Rwanda and were divided into three main sections: Firstly the current payments process, secondly the issues related with the current payment process in Rwanda, Thirdly pro and cons of mobile payment, lastly the survey result were analyzed to gather the information for the technical details to design a new integrated smart payment system.

Each interviewee received the same question form in order to provide the same starting point for interview. An emphasis was placed on what the interviewees had to say about their era of expertise. The interview questions can be found in appendix 1, 2 and 3.

To conduct this research we focused on five industries (Financial institutions, MNOs, retailers, public institutions and technology provider). By doing so, we improved the relevance of our study as well as the quality of our results.

Table2 describe the names of the companies participated in this research and these companies are the major stakeholders in Rwanda market. The experts representing these companies are the decision makers who will strongly influence the future of the payment market in Rwanda.



## List of the companies interviewed

Financial Institutions	Telecom	Public Inst	Retailers	Technology Provider
National Bank of Rwanda	Mtn	RURA	Cutomers	R-Switch
Equity Bank Rwanda	Tigo	RDB	Simba	Rwanda Online
Bank of Kigali	Airtel		Nakumat	
Cogebank				
I&M Bank				

Table 2 Names of the companies participated in the research

The results showed that cash based payment is very popular in Rwanda than any other payment method. Card based payments technologies are also preferred to phones for payment purpose. In general cash based and smartcard had a high ranking for payment industries in Rwanda. The position of digital payment can be confirmed by the statistic for BNR report on digital payment. The position of smartcard can be confirmed by shift from magnetic cards to more secured cards.

Table 3 comprises the alternatives technology we included in this analysis.

Technology	Description
Money	Regular cash (e.g. coins, bills)
Magnetic card	Plastic card with a magnetic stripe
Smart card	Plastic card with chip
Contactless card	Plastic card equipped with an RFID chip
Mobile phone “remote”	Mobile phone using a remote network (e.g. GSM, GPRS, UMTS) the payment transactions transit through a telco mobile network infrastructure. This could be done through SMS, USSD, and WAP.
Mobile phone “proximity”	Mobile phone using a proximity network (e.g. Bluetooth, Infrared, and RFI). The payment transactions transit through a locally established wireless network

Table 3 Alternatives technology we included in this analysis.

Concerning the contactless card situation and surprising as there are not yet any national payments schemes proposing contactless cards. Based on the result from the survey, after cash based payment, card based payment is ranked as second method used for payment in the country, thirdly is Mobile payment based and this could also open an opportunity for NFC technology.

However, the current phone based solutions remain in last positions of the most industry rankings. This could be explained in different points like applicability, usability, convertibility, privacy, reliability, security, trust and then culture of the nation and this could be explained as mobile phone-based payment are still in a very early stage of development. This means that there is still a progress to be made in terms of ease of use by allowing integration and interoperability payment systems on mobile phone, then user acceptance. Currently phone-based schemes already perform well in terms of flexibility and value proposition improvement. The three national mobile network operators consider value proposition improvement to be an important aspect, which explains why they believe that mobile phones have to be considered for future payment instrument in Rwanda. The analysis was conducted using an interview with different people from different domain as shown in table 1.

## Discussion of result/Findings

Table 4, 5, 6 showing how today's payments are ranked and how those technologies known in Rwandan society and what they think about new payment technology.

#	GENERAL QUESTIONS	# of Respondents	% Wise
<b>1</b>	<b>Have you made travel before, for payment of goods and services or any other payment?</b>		
	Yes	40	47.059
	No	45	52.941
<b>2</b>	<b>Do you ask someone to make payment for you?</b>		
	Yes	60	70.588
	No	25	29.412
<b>3</b>	<b>How often do you perform any payment on average (per month)?</b>		
	1= Once	10	11.765
	2= Twice	25	29.412
	3= Three times	30	35.294
	4= More than three times	20	23.529
<b>4</b>	<b>What methods of payments do you use to pay goods or services?</b>		
	1= Cash based	70	82.353
	2= Card based	7	8.235
	3= Mobile payment	5	5.882
	4= Internet banking	3	3.529
	5= Other methods (specify)	0	0.000
<b>5</b>	<b>How do you rate the process of making payment for cash based?</b>		
	1= Very Satisfied	2	2.353
	2= Satisfied	20	23.529
	3= Fairly satisfied	8	9.412
	4= Fairly Dissatisfied	47	55.294
	5= Very Dissatisfied	8	9.412
<b>6</b>	<b>How do you rate the speed and time spent for payment to get a service?</b>		
	1= Very Satisfied	1	1.176
	2= Satisfied	4	4.706
	3= Fairly satisfied	23	27.059
	4= Fairly Dissatisfied	32	37.647
	5= Very Dissatisfied	25	29.412
<b>7</b>	<b>Have you met any problems when you are doing payment at the bank?</b>		
	1= Yes	74	87.059
	2= No	11	12.941
<b>8</b>	<b>What problems have you experienced at the bank?</b>		
	1= Timing	31	36.471
	2= Long Queue	39	45.882
	3= network problems	14	16.471
	4= Money lost	0	0.000
	5= Holidays and weekend days	1	1.176
<b>9</b>	<b>What did you do when things go wrong at the Bank, e.g. when it is a holiday, no network or Weekend?</b>		
	1= To postpone	71	83.529
	2= To borrow from someone	3	3.529
	3= other (specify)	11	12.941
<b>10</b>	<b>How long does it take for you to go to the bank for payment?</b>		
	1= 5 minutes	2	2.353
	2= 10 minutes	6	7.059
	3= 20 minutes	35	41.176
	4= Longer than 30 minutes	42	49.412

Table 4 General questions result analysis

Looking at answers of general questions asked from different respondents who were interviewed, we have noticed that out of total 85 sample taken, 47 percent have at least made payment themselves to acquire goods or service. Whereas, 70 percent send someone to make some payment on their behalf. Eg: payment of utilities like electricity; entertainment subscription; water; etc. when it comes to how often interviewees make their payment on a monthly basis (average), it has been found that 35 percent usually make their payment to acquire goods and services.

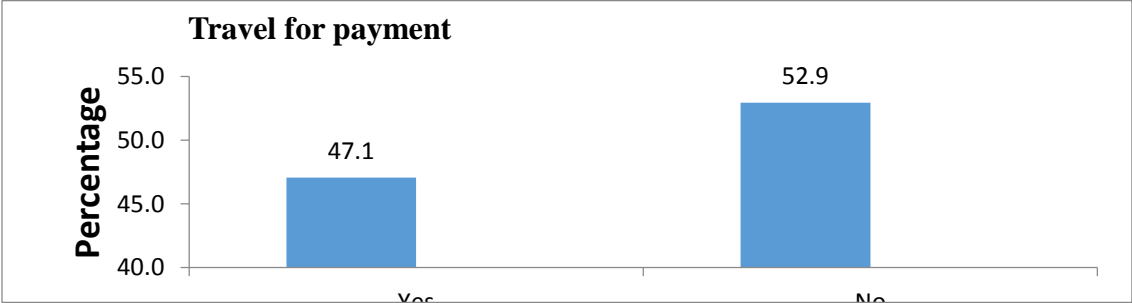


Figure 9 Travel for payment

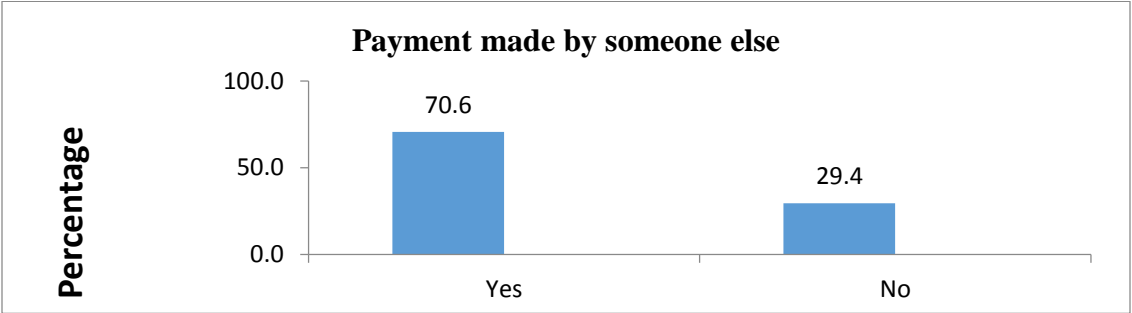


Figure 10 Payment by sending someone else

While trying to know the dominant payment method, it has come to our attention that cash based payment is still on upper rank at 82.3 percent of usage.

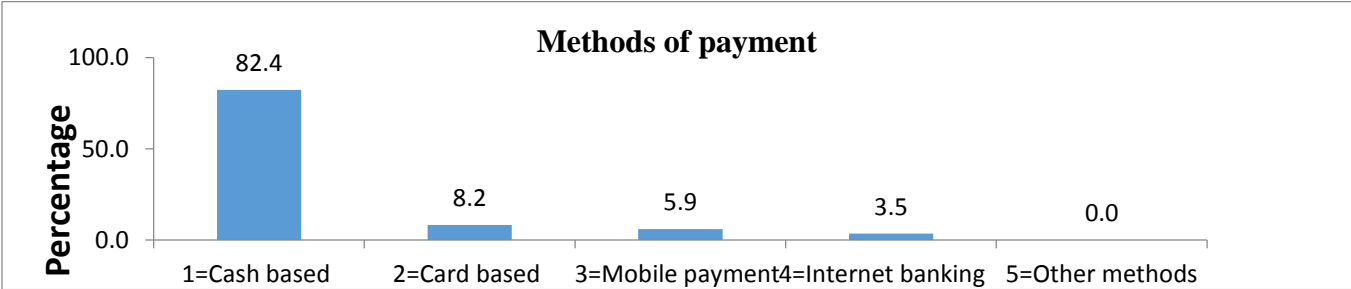


Figure 11 Ranking of methods of payment

When tacked on how convenient existing mode of payment is, we realized that cash based payment method is fairly dissatisfying at a high rate of 55 percent.

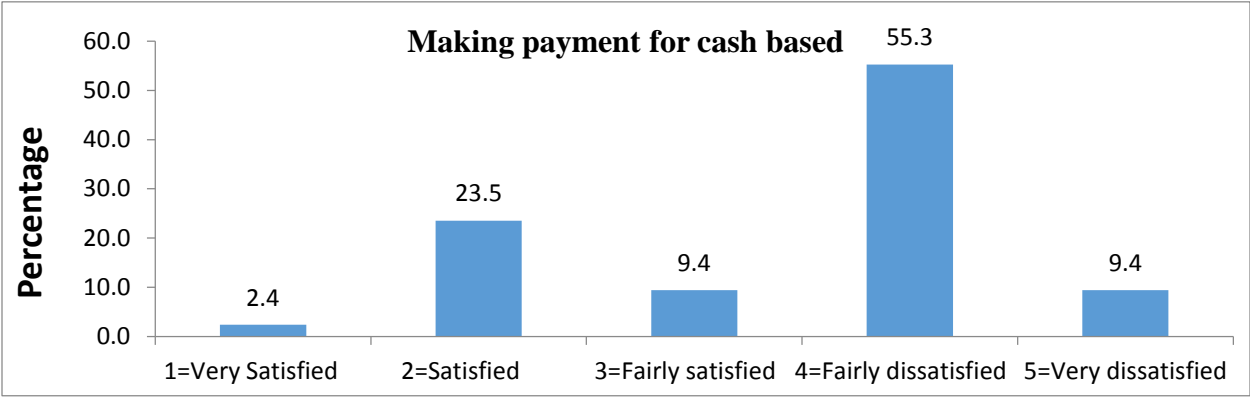


Figure 12 Cash based payment

Talking about how quick getting a payment done, out of 85 asked peoples, 32 peoples (that is 37.6 percent) have strongly argued that they’re fairly dissatisfying. Meaning they spent unacceptable time (which they wouldn’t opt for) to complete payment in order to get goods or services.

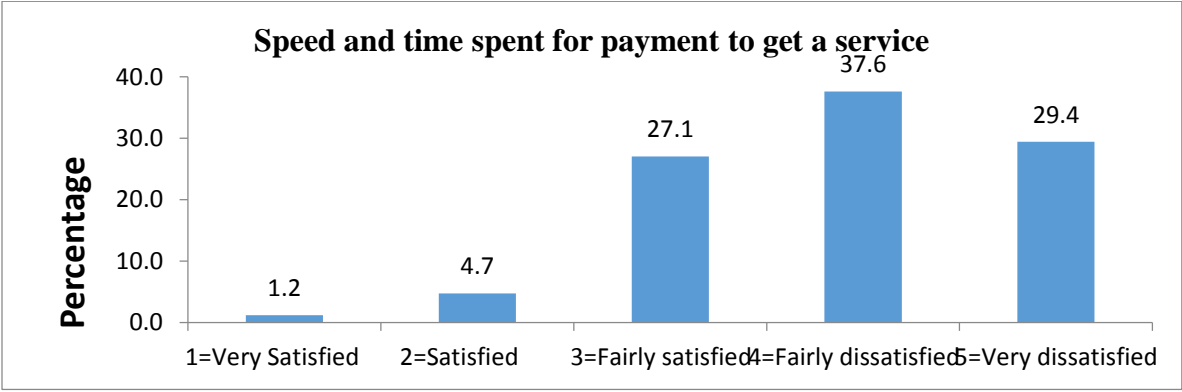


Figure 13 Payment speed and time spent

87 percent of interviewees confirmed that they all faced issues of making payment at the bank. The most problem that is used to be faced by interviewees is the long Queue at the rate of 45.8 percent.

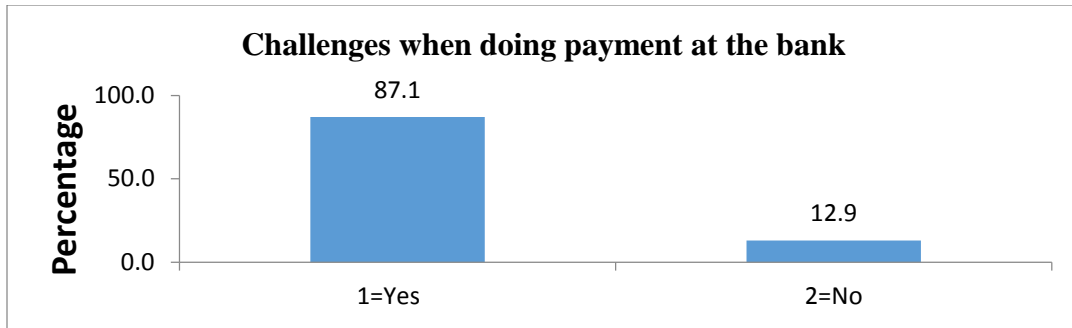


Figure 14 Challenges with bank payment

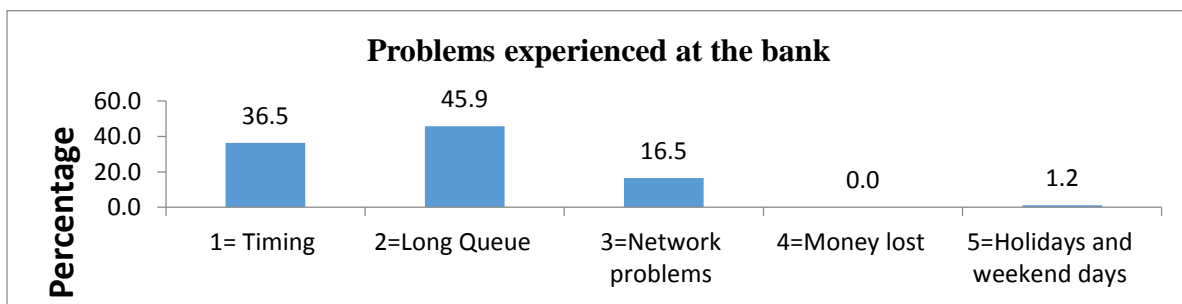


Figure 15 Problems met at bank

As the above problem arise, most peoples (at 83.5 percent) prefer to postpone their payment plan to some other time though 49.4 percent of interviewees confirmed that it takes them more than 30 minutes to reach at the bank for their next schedule.

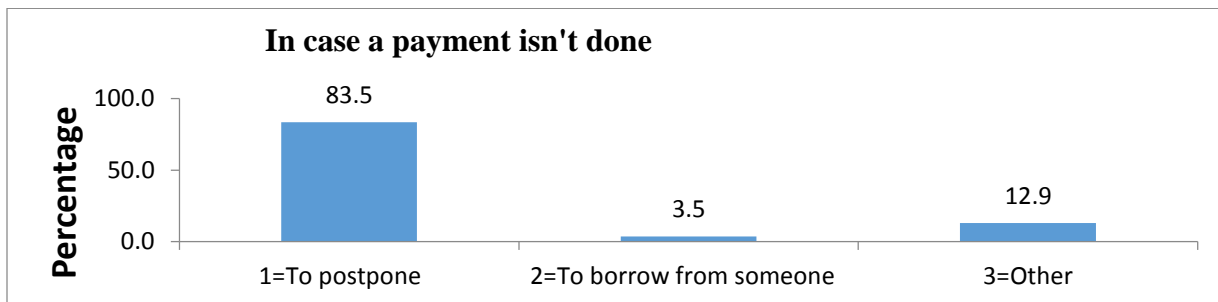


Figure 16 Alternative when payment failed

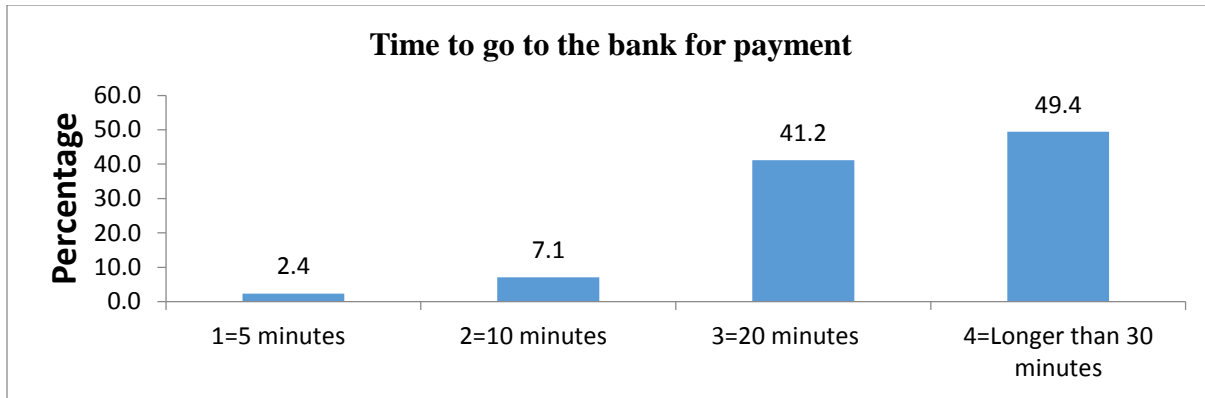


Figure 17 Time spent for bank payment

#	3. DIGITAL PAYMENT	# of Respondents	% Wise
<b>1</b>	<b>Do you know about Smart payments? (Mobile money, mobile banking, card based payment)</b>		
	1=Yes	82	96.4706
	2=No	3	3.52941
<b>2</b>	<b>Have you used any Smart payment before?</b>		
	1=Yes	81	95.2941
	2=No	4	4.70588
<b>3</b>	<b>How do you rank mode of payment that are being used today which one comes number 1,2,3...6</b>		
	1= cash based	41	48.2353
	2= smart card	19	22.3529
	3= Magnetic card	2	2.35294
	4= Contactless card	1	1.17647
	5= mobile phone	19	22.3529
	6= NFC Technology on mobile phone	3	3.52941
<b>4</b>	<b>Among listed mode of payments which one do you prefer for future? Rank them according to your preference of importance</b>		
	1= cash based	15	17.6471
	2= smart card	10	11.7647
	3= Magnetic card	0	0
	4= Contactless card	1	1.17647
	5= mobile phone	15	17.6471
	6= NFC Technology on mobile phone	44	51.7647
<b>5</b>	<b>What do you think would attract you to use smart payment system?</b>		
	1= Saving time	65	76.4706
	2=Saving money	13	15.2941
	3=Avoid counterfeit 4=(specify)	7	8.23529
<b>6</b>	<b>What do you think would make you give up using smart payment system?</b>		
	1=It is not secured	76	89.4118
	2=Cost	5	5.88235
	3=Others (specify)	4	4.70588

Table 5 Digital payment result analysis

The primary and driving factors in our analysis, is to compare the modern payment method (namely smart payment) with classic mode of payment (which is mostly cash based payment). Awareness of this modern payment method is virtual in order to phase cash based payment out. In that perspective, 96.4 percent confirmed to be aware of different modern way of payment though there are still room of improvement. On the same note, it has been found that most people (at 95.2 percent) are using mostly mobile payment and card based based payment at 22.3 percent.

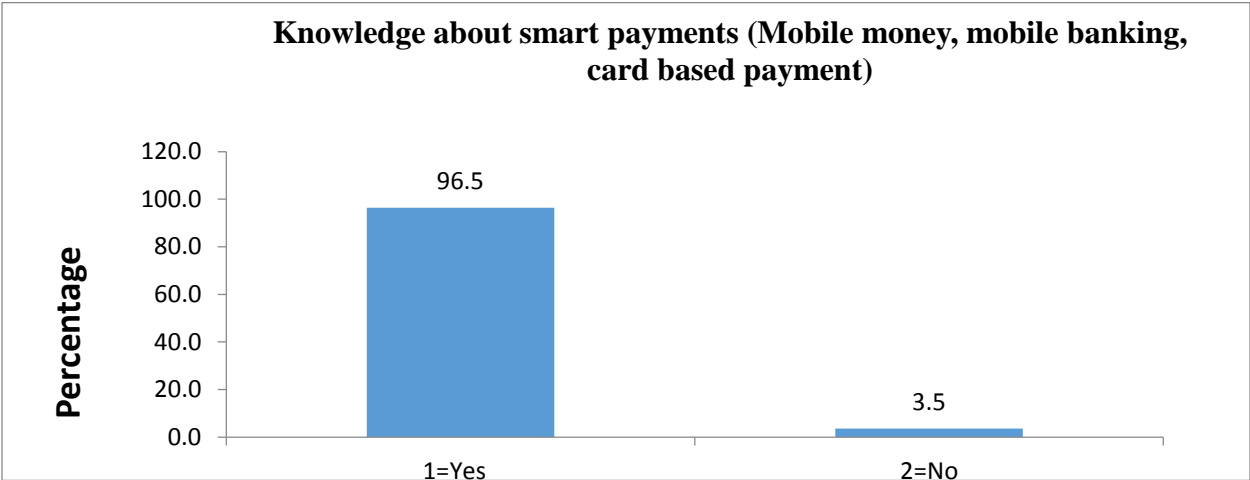


Figure 18 knowledge about smart payment

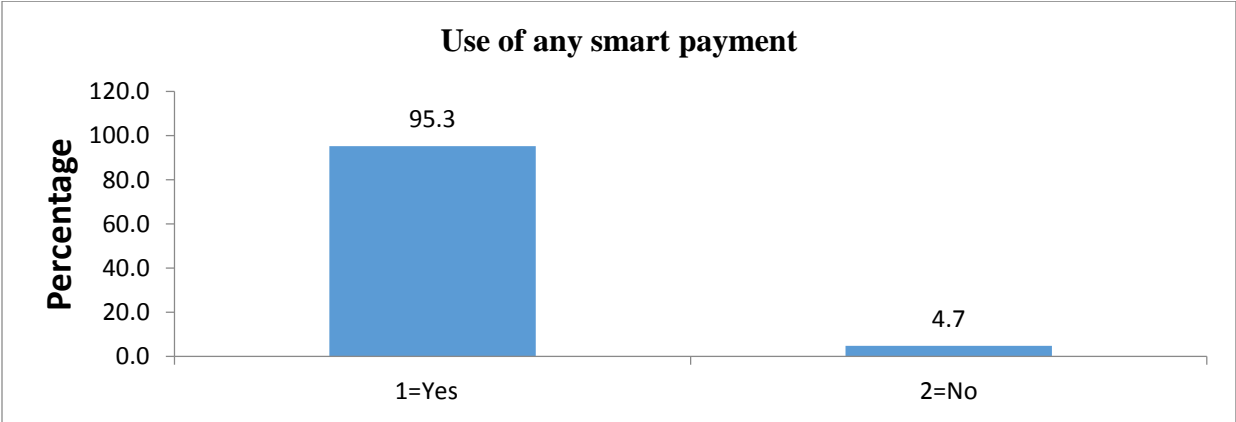


Figure 19 Use of smart payment system

Though mobile and cash based payment are simulary ranked at 17.6 percent, cash based payment is still of preference.



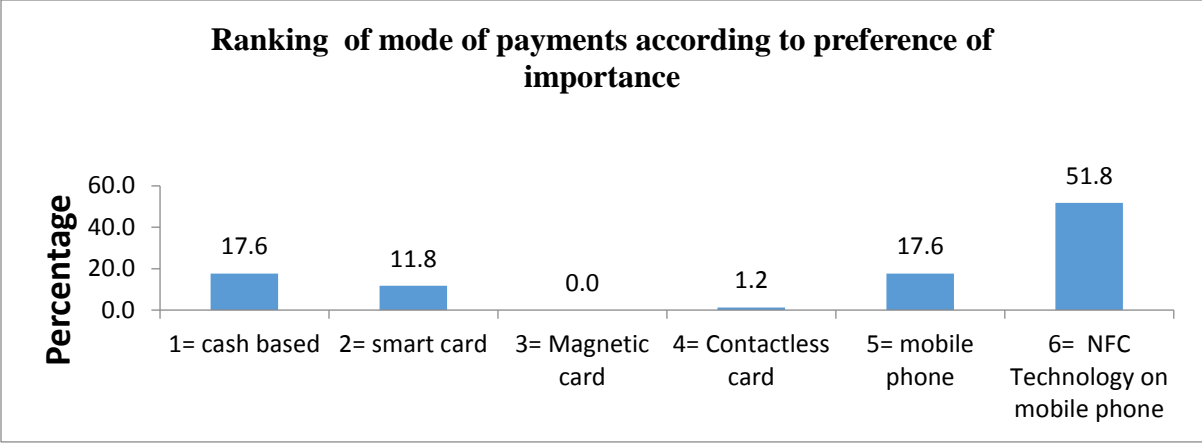


Figure 20 Mode of payment ranking

Based on the number of people interviewed 48.2% said that cash based payment is on top with 48.2% and 22.4 are using card based payment and mobile payment.

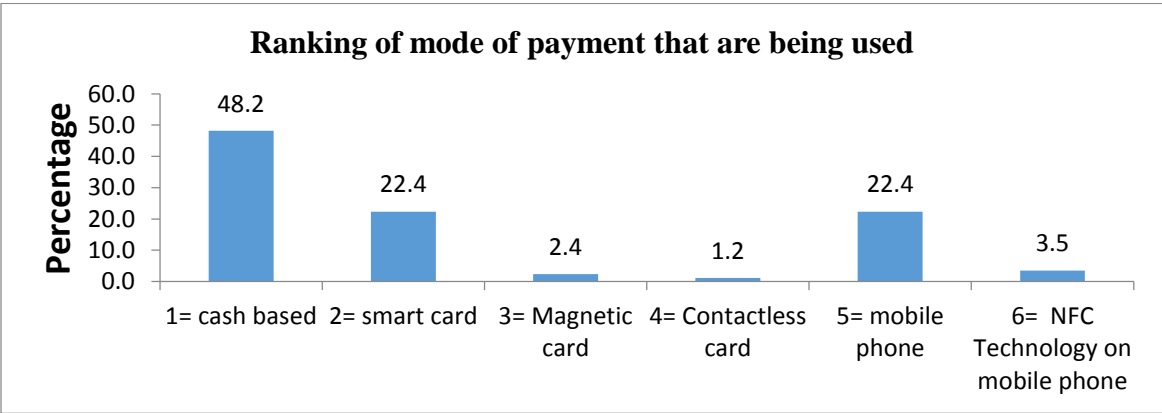


Figure 21 Current used mode of payment

In this dynamic economic, time has become prestigious asset for people. Hence, 76.5 percent would prefer opting for smart payment in order to save their time rather than running to bank for making payment.

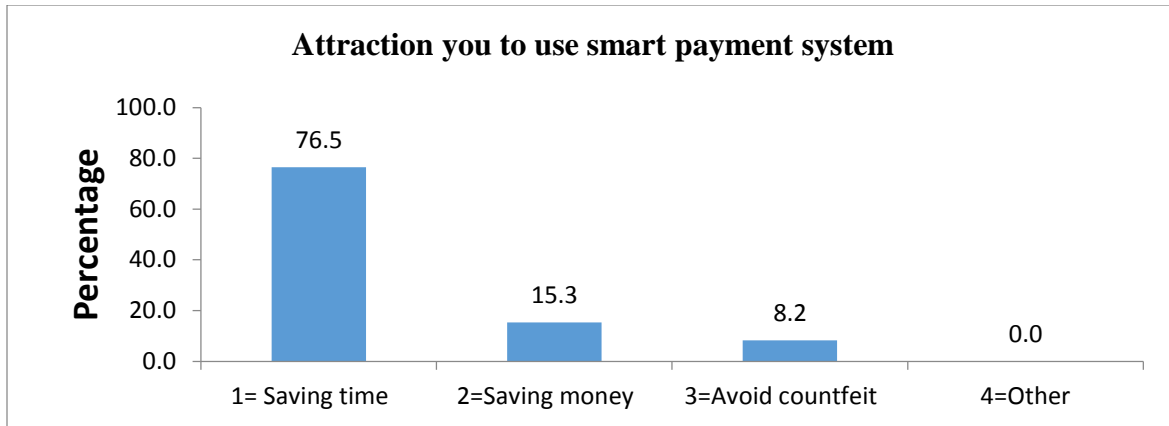


Figure 22 Smart payment attraction

Nevertheless, of how good any smart payment would be, most people 89.4 percent has argued that they don't trust in its security and privacy.

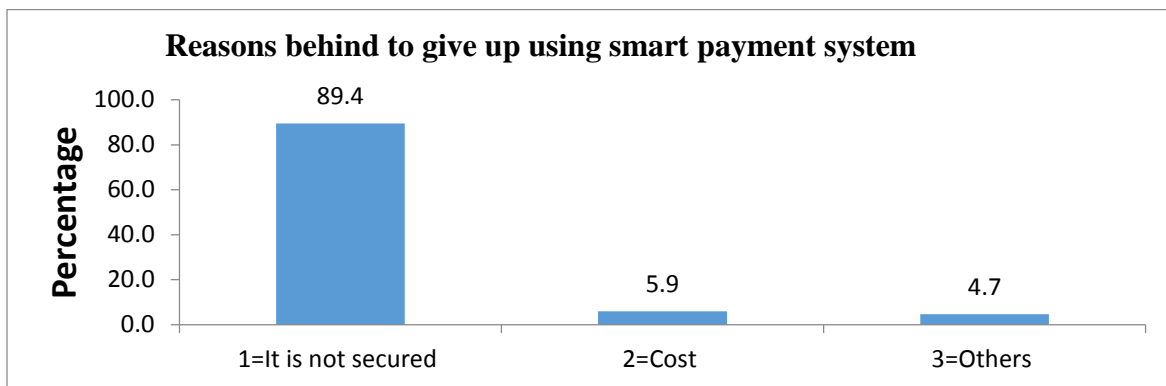


Figure 23 Smart payment system give up

#	4.Integration and interoperability	# of Respondents	% Wise
<b>1</b>	<b>How many accounts do you have from different banks?</b>		
	1= One account	23	27.05882
	2=Two accounts	41	48.23529
	3=Three accounts	15	17.64706
	4=Four accounts and more	6	7.058824
<b>2</b>	<b>How many cards do you have from different banks?</b>		
	1= One card	19	22.35294
	2= Two cards	27	31.76471
	3=Three cards	21	24.70588
	4=Four cards	14	16.47059
	5=Five cards and more	4	4.705882
<b>3</b>	<b>What do you think if you can access all your accounts through your mobile phone and make different payment from your different accounts</b>		
	1=Very Satisfied	79	92.94118
	2=Satisfied	6	7.058824
	3=Fairly satisfied	0	0
	4=No need of use	0	0
<b>4</b>	<b>When balancing the pros and cons of mobile payments services, which weighs more?</b>		
	1=pros	85	100
	2=cons	0	

Table 6 integration and interoperability result analysis

According to the above result from survey, People show the interest of have interoperability of different systems for payment purpose. Only 27 percent have one account, while others have more than one account in different banks.

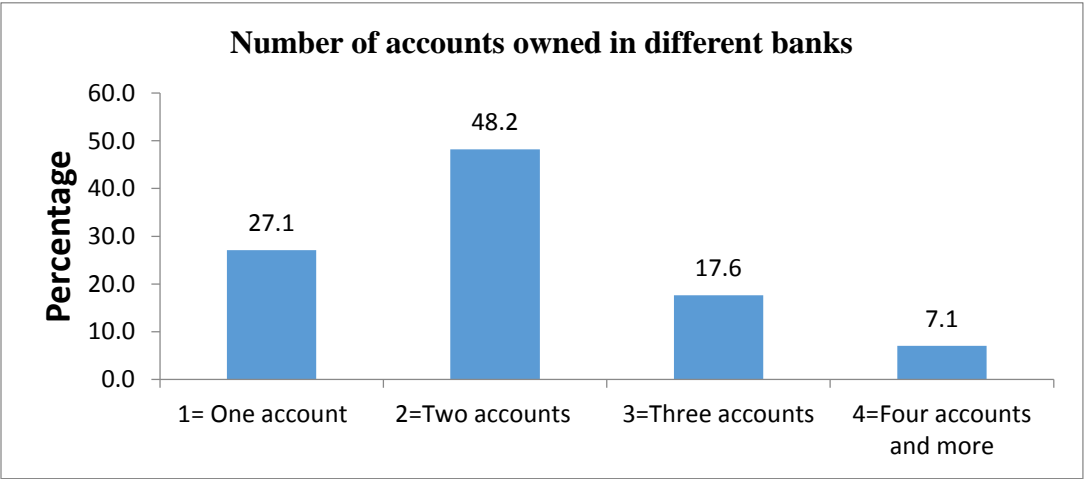


Figure 24 Number of account in different bank

Since 72 percent have more than one account in different banks that means the number of cards for payment are equal to the number of accounts customer has. And this is causing them uncomfortable since they are carrying out more than one card in the wallet.

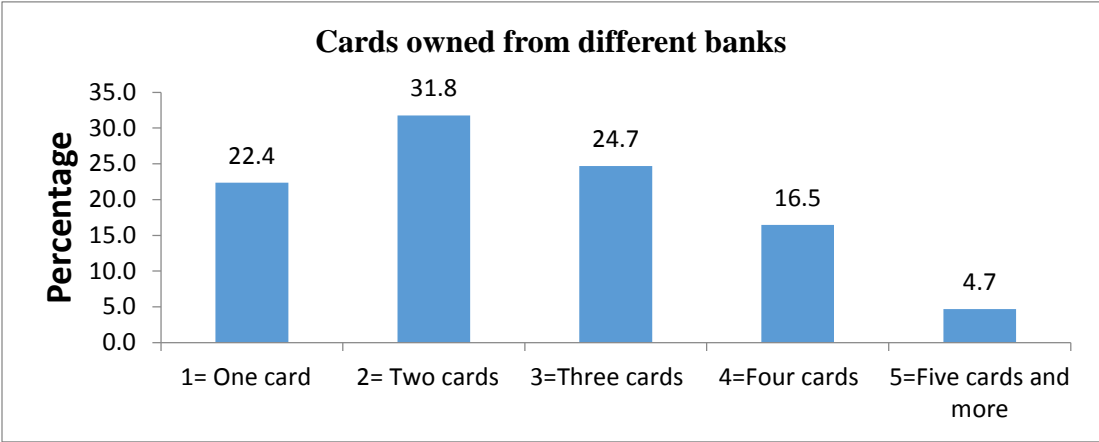


Figure 25 Number of card from different bank

About access of all accounts through mobile phone and complete payment, 92.94 percent responded that they are very satisfied of having such kind of payment system only 7.05 percent said different.

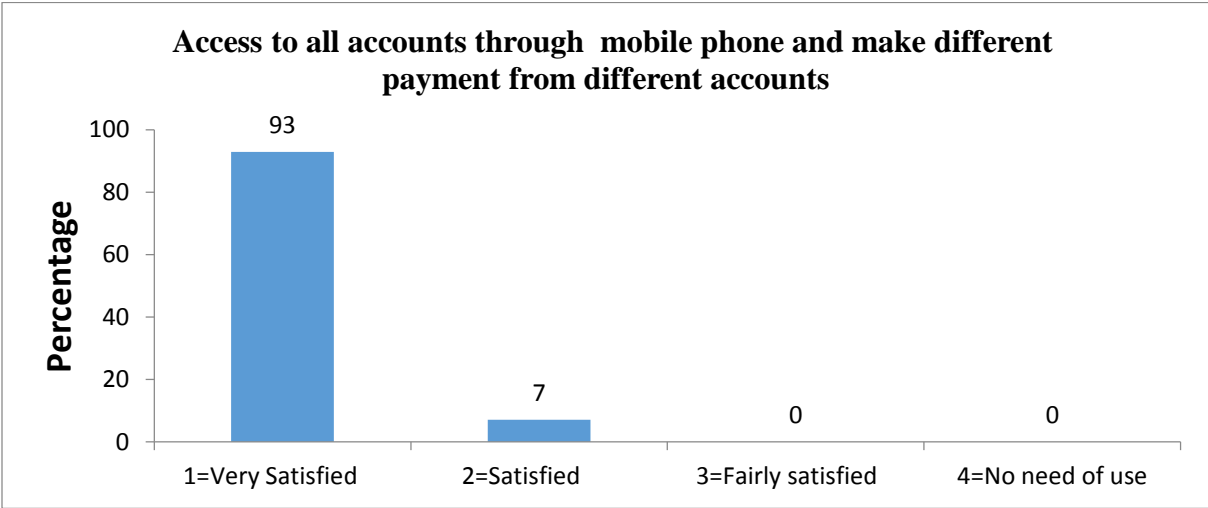


Figure 26 Integration of all account from different bank

Regarding pros and cons 100 percent of the people interviewed said that there are more advantages of using integrated smart payment.

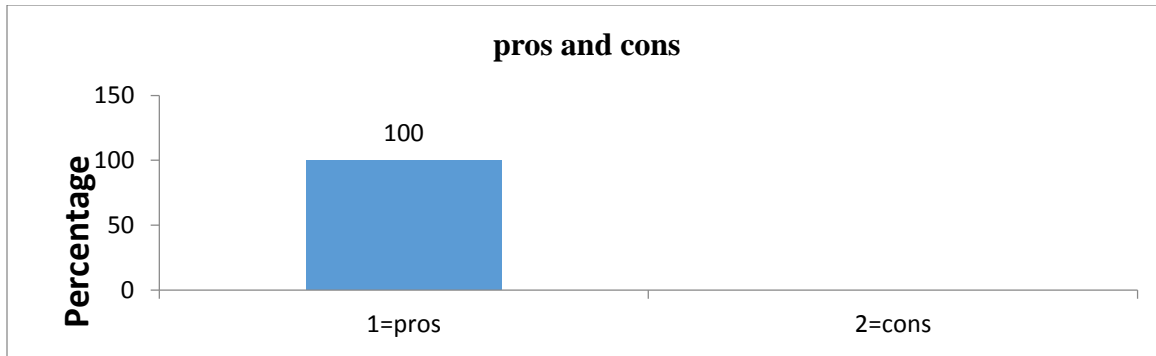


Figure 27 Pros and Cons

In Table 4, 5, 6 the result on smart payment analysis shows the capability of smart payment as useful or successful technology in the future. The significance of that can be interpreted as weakness of the current payment methods that is being used in the payment market today. Therefore, we can say that mobile payment using NFC technology will perform much better than other payment technologies in Rwanda.

Even though the result seems to be positive, we cannot confirm that smart payment based on mobile phone and NFC will be accepted. In contrast, the result shows that smart payment is a suitable and should be taken into consideration in the payment industry. Different stakeholder like MNOs and financial institutions were impressed to here that technology and they wish to see the proposed system being implemented, this was based on these results. On the other side, some companies were more reserved as the development and implementation of integrated and interoperability of smart payment system on mobile phone and NFC could bring issues related to interoperability, compatibility and security issues. Generally, all the people and experts that were involved seems to appreciate the technology and wish to see it on the market

### 3.9 Chapter Summary

Bringing Rwanda smart payment system into practice has a major impact in facilitating and improving payment system in Rwanda. In the study, it was discovered that Rwanda have policies and strategies that promote smart payment system or cashless society. In this chapter, we discussed the main issues of the research study, and describe the research methodology which was used to tackle the mentioned challenges. We also presented the collected data and discussed the findings. This will help us in the design of the new system that will address challenges existing in the current payment systems.

## CHAPTER FOUR : SYSTEM ANALYSIS AND DESIGN

### 4.1 Introduction

This chapter presents the proposed design of integrated smart payment system for Rwanda. Designing of an effective smart payment system in Rwanda allows the country to promote cashless society as we are moving from cash based payment to digital payment. Taking into consideration problems rose on the use of the current payment method, this research have proposed a new model that could resolve those problems and be able to facilitate digital payment implementation.

### 4.2 Cash based payment process

A cash payment refers to when customers pay using physical currency, such as notes and coins. This is a form of liquid funds given by a consumer to a provider of goods or services as compensation for receiving those products.

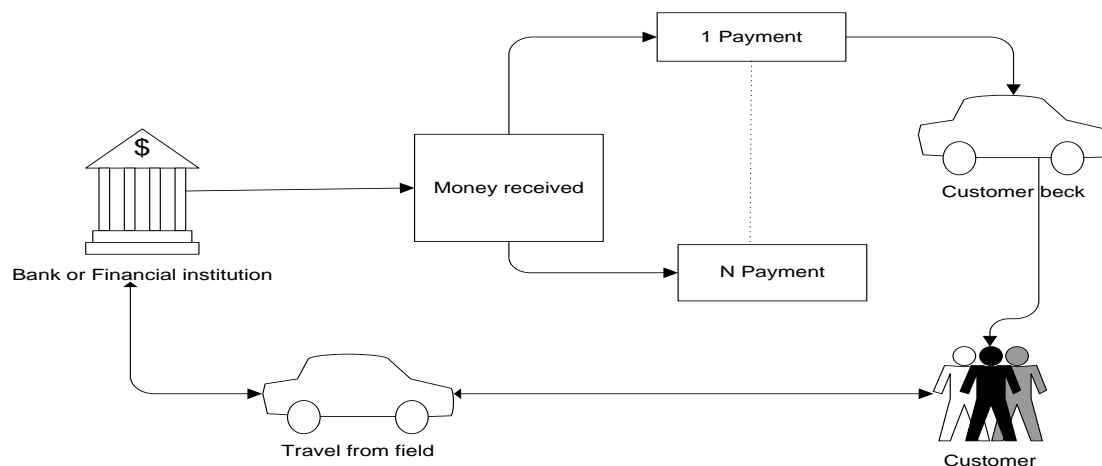


Figure 28 Cash based payment process

Today the existing payment that exist in Rwanda are standalone, without integration and interoperability between them. In the current payment environment, big number of payment systems are standalone like Bank account, Cards and mobile money account are not integrated while they are supposed to work together for better services to their customers. With the existing system we can list a number inconvenience caused by cash based payment or existing system are:

- People leave the field every time for payment or to be paid
- Significant time and cost
- Risk of handling cash

- Delay due to human error, Bank liquidity
- Meals and accommodation cost
- Counterfeit money

### 4.3 Improved payment system architecture

According to the problems raised in chapter one for the current situation, the proposed system could resolve those problems and facilitate in payment industry. The main problem that the proposed smart payment system architecture will resolve is to reduce cash based payment in Rwanda and non-interoperability of the systems. Smart payment system will be based on mobile phone and NFC technology and different stakeholders are involved including MNO, Banks and technology companies.

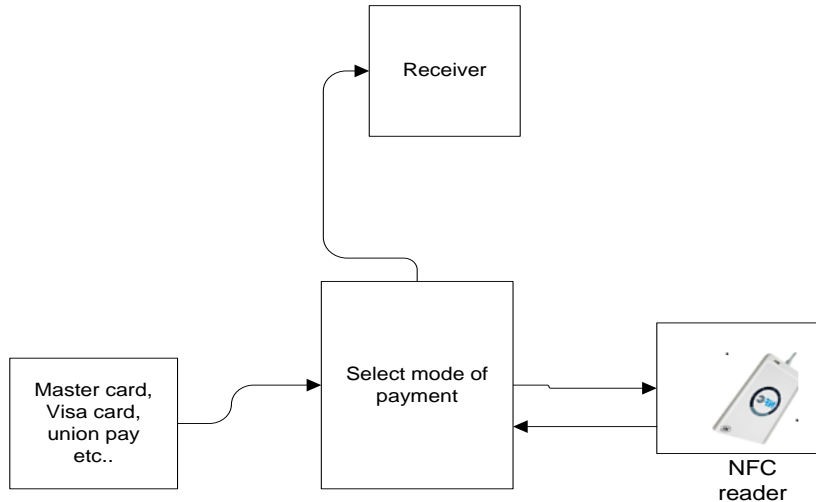


Figure 29 Mobile based payment with NFC Technology

The purpose is to present the necessary framework for the design of the new system. With the criteria cited in previous chapter, the design will base on the needs specified in problem statement and on development model. The approach used is based on UML notation, the functional processes are presented as use cases, and then the system is modelled as UML class diagrams. Actors are used to show the interaction between different parts of the system and UML sequence diagram is used.

#### **4.4 Functional requirements**

In this section we presents all requirements that the system should fulfill and there are two categories that have been considered relevant; first is functional, second is architectural. Functional category define what the system should be able to do.

The purpose of this thesis is to design a system that enable payments using mobile phone device. The criteria to be fulfilled by the system in terms of functionality are:

1. The designed system should implement electronic payment or electronic money.
2. Marchant, the Payer, the payee and the issuer are four actors to interact
3. The system should enable users to register her/his cards on the phone
4. The system should enable users to initiate a payment transaction in any commercial Bank, Microfinance Bank and other financial Institution or from digital wallet.
5. Sign into a single platform for access to all your bank accounts at once and no need for multiple tokens and view balance of all your multiple bank accounts on a single screen.
6. Make payments from multiple accounts and across multiple banks, in the same transaction.
7. Make payments to any Commercial Bank, Microfinance Bank and digital wallets
8. Customers should be able to make bills payment using mobile phone using NFC
9. The merchant should be able to query the status of a payment transaction request from the system
10. Merchant should be able to commit or reject the payment transactions, when the payers have authorized the transaction and the authorization is verified by the system.
11. Merchants should be able to query the status of a payment transaction request
12. The payers should be able to receive payment confirmation on the phone
13. Customers should be able to receive funds through Debit/Credit cards branches of all Banks nationwide

#### **4.5 Nonfunctional requirements**

Nonfunctional requirements architectural define how the system should be constructed, different point are considered in nonfunctional requirements: Security, scalability, performance, modularity and maintainability. The points cited above will be the foundation for the design of proposed system.



#### **4.5.1 Technical**

After functionality technical requirements should be fulfilled by the system to comply with standards of the customer organization and the payment industry in general.

1. The system should support existing merchant systems implemented using any relevant technology
2. The system should use oracle database 11g for security reasons
3. The system should be implemented using Java for integration purpose with other systems using the same platform
4. The client application shall run on a smart phone
5. Hardware, technology and algorithms that affect performance should be given a special interest.

#### **4.5.2 Security**

One of the most crucial and well researched issues in payment systems is security, since the internet is an open network with no centralized control, the infrastructure, supporting electronic payment and payment systems in general must be resistant to attacks from the hackers. Security can be viewed in two category. On one hand, users would like to be sure that their money is safe when paying using digital cash. On the other hand, banks and payment services organizations would like to protect themselves so that no money, financial, or personal information can be stolen or misused. Another worry of electronic payment is that cash can be spend twice, what cash transactions can achieve by the physical nature cash, is that money can be spent only once. EPS operator should ensure that electronic cash cannot be spent twice. In this aspect, security is often viewed.

#### **4.5.3 Scalability**

The system should be scalable. As the commercial use of digital payments grows, the demands of payment infrastructure will also need to increase and those infrastructure should be scalable.

Scalability also means, that it should be possible to increase the capacity of the system by increasing the capacity of servers that host the system, to be able to handle the addition of new users and merchants, so that the systems will perform with high speed without performance degradation to maintain the quality of service. System scalability can be done by increasing the processing capacity of each serves or increasing the number of servers running the software.

#### **4.5.4 Performance**

Performance of the system is a key point to check on, turnaround time or response time should be between 1 to 2 second. The performance should be illustrated by using UAT for the system before implementation.

#### **4.5.5 Interoperability**

An interoperable system can faster gain the necessary customer base for future development and will have a higher level of applicability. A payment system is interoperable if it is not dependent on one company, but is open and allows other interested parties to join. This can be achieved by means of open standards for data transmission protocols and infrastructure.

In the Past Time till present people use to carry out number of cards from different financial institutions to access their accounts, but several number of inconvenient are listed including risks of losing cards and security issues. Despite the potential advantages, interoperability does have some costs and potential disadvantages like security and privacy and technical part. The proposed system will eliminates all problems caused by the old payment system with integration and interoperable capacity.

#### **4.5.6 Maintainability**

The system administrators should be able to correct problems without outsourcing the experts from outside by some simple means and system should be easy to manage.

### **4.6 Smart payment system concept**

As stated in previous chapters, the goals of this thesis is to design an integrated smart payment system that enable customers to pay and receive payment with their smart phones using NFC technology. NFC is based on Radio Frequency Identification (RFID) technology. The motivating force for system arises from several factors. On one side, the feasible way to achieve to secure payment transactions with electronic cash through the use of mobile phone technology based on near field communication. On the other side, a clear demand was from different stakeholders in payment industry who was always look for a better system that can replace the existing payment systems with the security requirements built in it. Smart card, Contactless card, mobile wallet were used to solve the issue, but card readers need to be deployed that is where near field communication comes in. Figure 11 shows the concept of mobile payments as sequence diagram from the payer side. The objective is to move money from one entity's account to an entity for payment purpose.

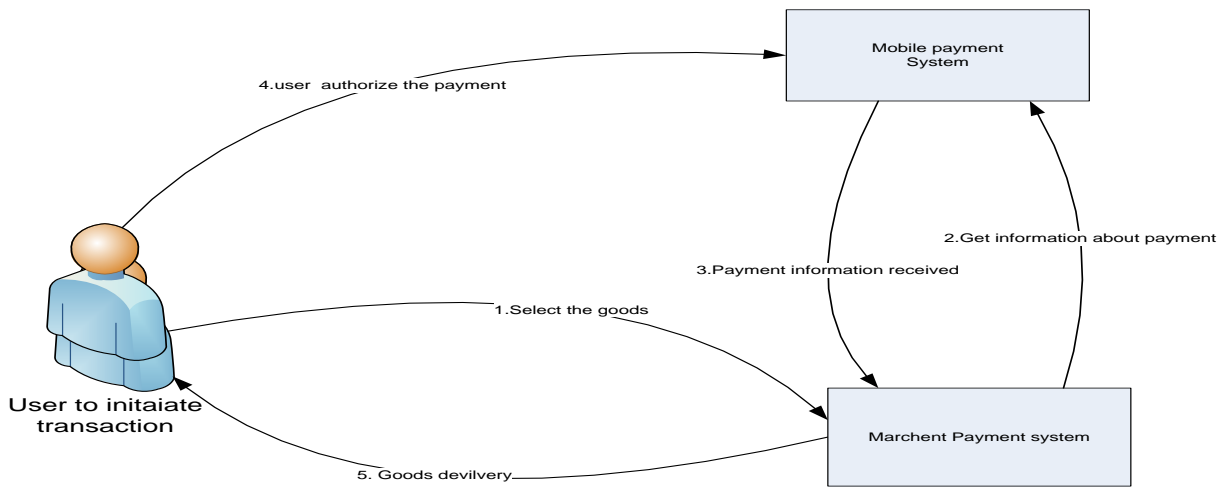


Figure 30 Mobile payment process

#### 4.6.1 Use cases for mobile payments

Mobile payments is presented in three core use cases namely payment request creation where a user initiate a transaction using his mobile phone, payment request authorization where a user must authorize the transaction created, and payment request committal. Bringing these three use cases together helps to complete mobile payments transaction. Figure 31 illustrates the sequential relationships between use cases in form of process chain.

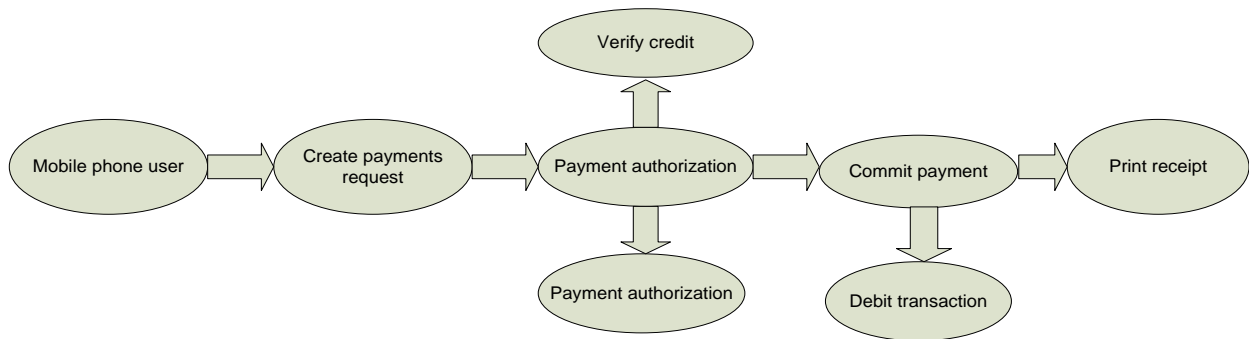


Figure 31 Payment process interaction flow

There are two main actors that participate in the use cases, which are payer and merchant.

The business processes of the merchant and the payer can, for instance, interact with each other in the following way.

- The payer sends an order message to the merchant (Place Order action).
- The merchant accepts the order message in the Receive Order activity.
- The order information is then extracted from the message, and order processing continues.
- The merchant sends an invoice (Send Invoice) and ships the ordered products (Ship Products).
- The payer receives the invoice in the Receive Invoice activity.
- The payer sends the payment in the Settle Invoice activity.
- Finally, the payer receives the ordered products in the Receive Products activity.

In the process described above, the payer may use different access channels for payments through mobile phone, NFC technology can be used to facilitate mode payment or direct transfer from one account to another. For mobile payment technology to be implemented in Rwanda, different systems need to interact for payment process and these are: Mobile payment system, Merchant system, Credit verification system, and Bank system. The Integration and interoperability of those different systems is an important element to consider in this payment process and the success of mobile payment system will largely depends on the interoperability of different systems. This will create an easy way for users to access their accounts (Bank account, Cards and mobile money account). To use payment services through mobile phone, different resources must be available for system to be scalable, robust, reliable, durable etc. The role of mobile payment system is to coordinates all payment transaction processed between actors and the system. Figure 13 illustrate the communication between actors, use case and systems.

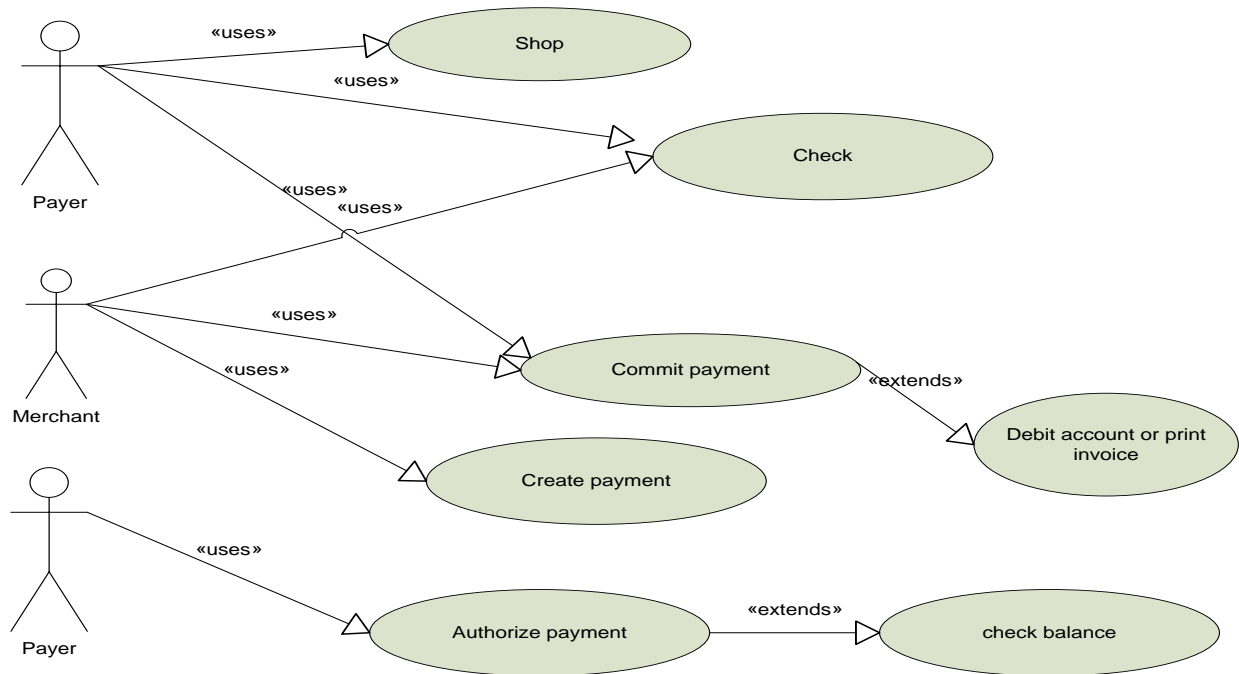


Figure 32 Use case diagram for payment system

Step one the payer has selected the goods, then he proceed with the payment step in the merchant payment system. Merchant payment system create a payment request data entity and submits the request to the mobile payment system for the payer and each payment request has a unique identifier on both side merchant side and payer side. Payment identifiers can be used later to reference the individual requests. Mobile payment system registers the all payment transactions for different purposes.

After payment request creation step number two is payment authorization, when the merchant has registered the payment request into mobile payment system, the payer should authorize the payment using his/her mobile device. After the payer has verified all payment information on the payment transaction (amount, credit account, and debit account) he commit a payment transaction and submit the payment using mobile device and the mobile payment system also verifies the creditability of the payer from the verification system.

After the payer has successfully authorized the payment request, the merchant needs to be notified about the payment by receiving the information in merchant system. After commit the commit the information are sent to external invoicing system and invoice is printed out.

## 4.6.2 Mobile payment integration to financial institutions

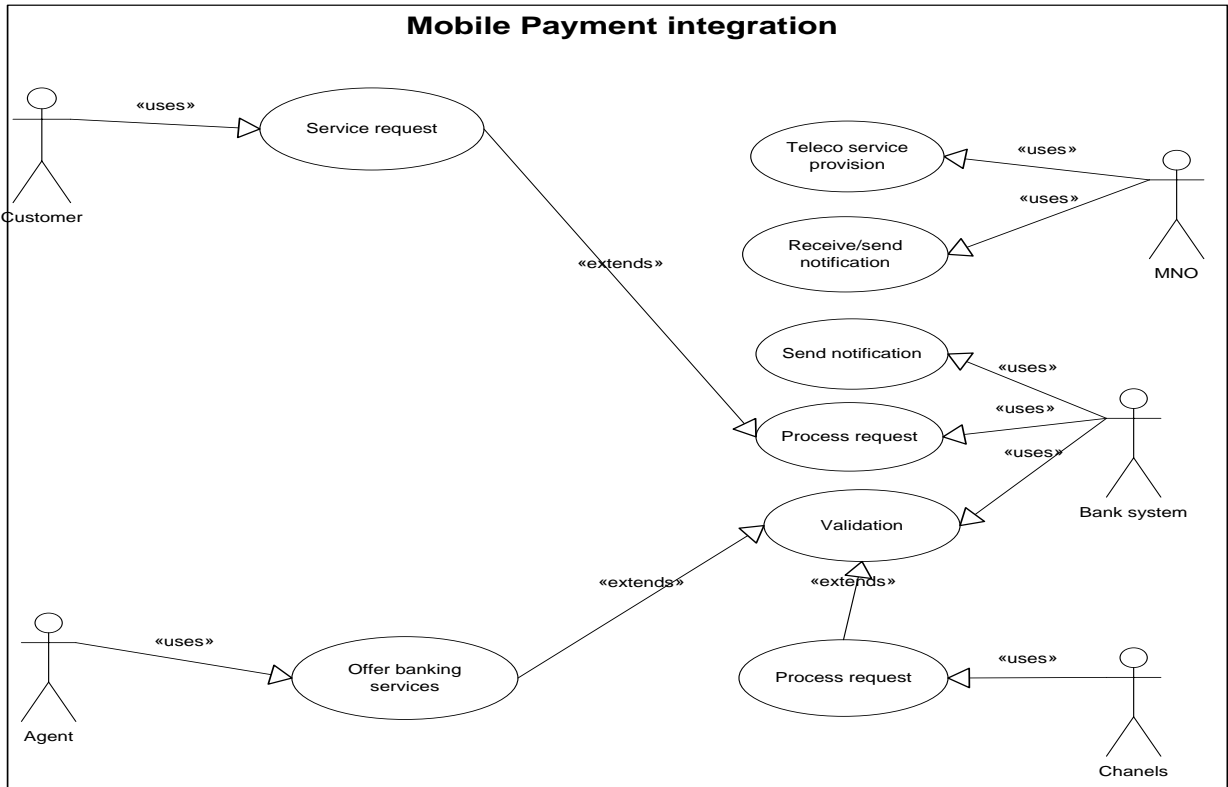


Figure 33 Use case model

As shown in figure 33, many phases and steps are involved in mobile payment integration with financial institutions. The payment interoperability between mobile money and financial institutions is playing key role in smart payment system we are designing. Customers will be allowed to move money from one entity A to another entity B within a second for better.

Since big number of customers in Rwanda are saving their money in financial institutions, for mobile payment to be implemented in the country communication between mobile payment and customer bank account is a key consideration. Figures below are showing payment process between bank and MNOs.

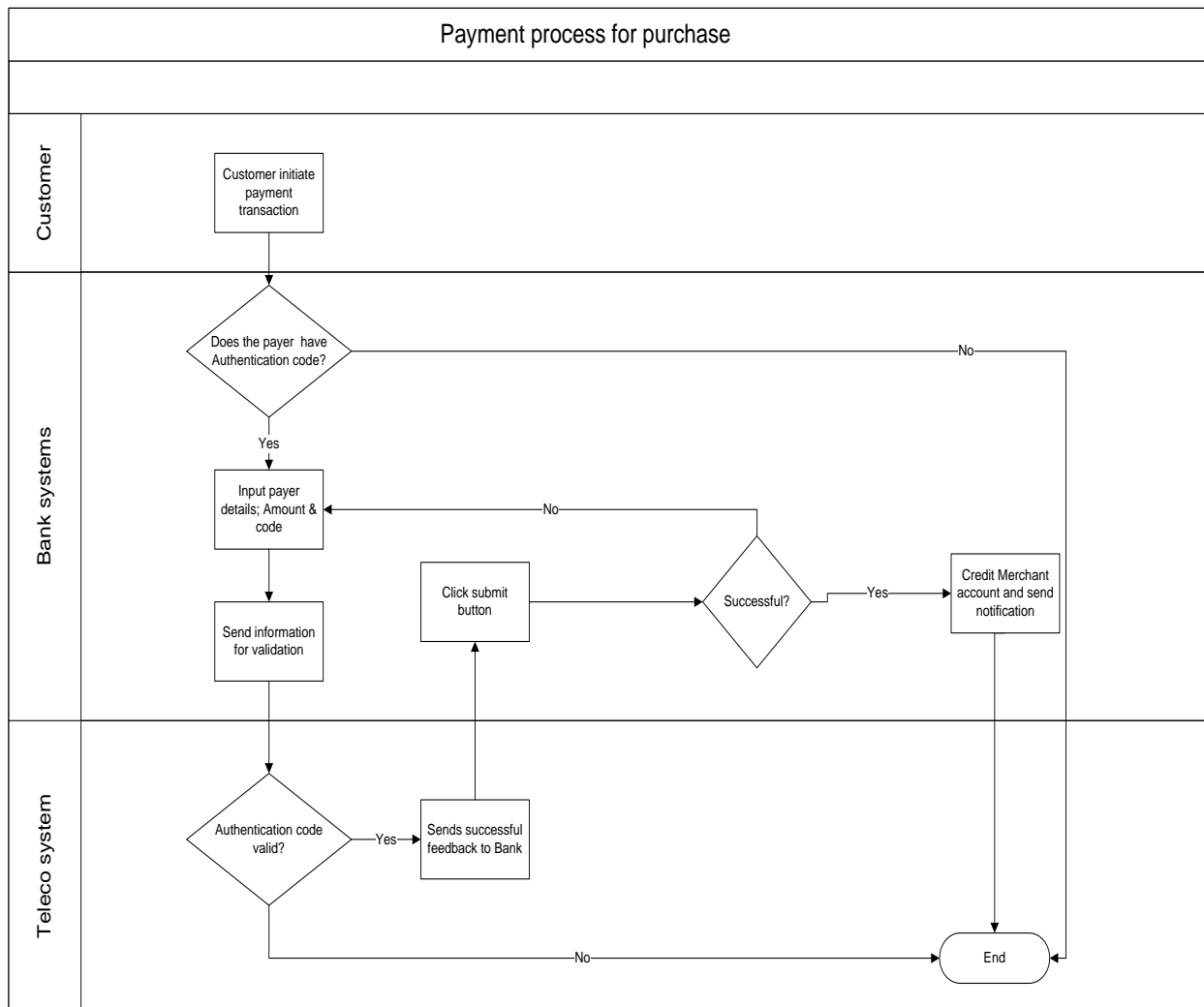


Figure 34 Payment process for customer to merchant

Figure 34 is showing payment process for purchase, customer initiate payment transaction and it is processed through the bank payment system.

The role of bank system is check and valid the authentication code of the payer, and put the details including the amount to be paid. Telecom system check the authentication code and send the successful message to the bank to credit merchant account. And both merchant and customers are notified for that transaction through notification system, then process is ended.

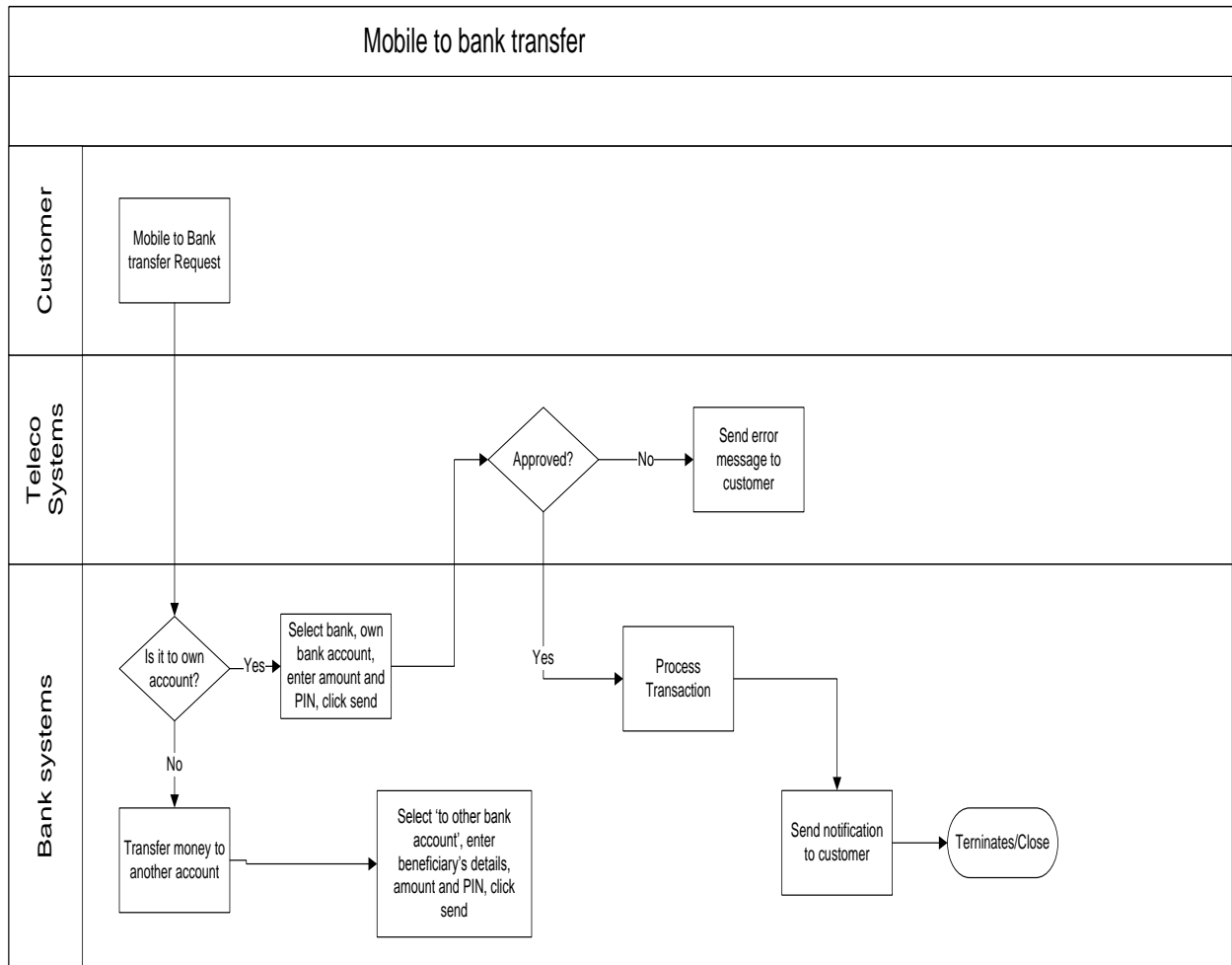


Figure 35 Transfer money from Mobile account to Bank account and vice-versa

Through integrated smart payment system customer is able to move money from mobile wallet account to bank account with full security. Customer create a transaction to debit his/her mobile wallet account and credit beneficiary account at the bank. Here interacting parties are customers, telecom system and bank systems.

When a transaction is initiated, customer should confirm if he/she is transferring funds to his/her own account or not then submit. Telecom system need to check the available balance of customer and approve or reject the transaction, when transaction is processed the sender and receiver are both notified of that transaction, then termination of transaction.



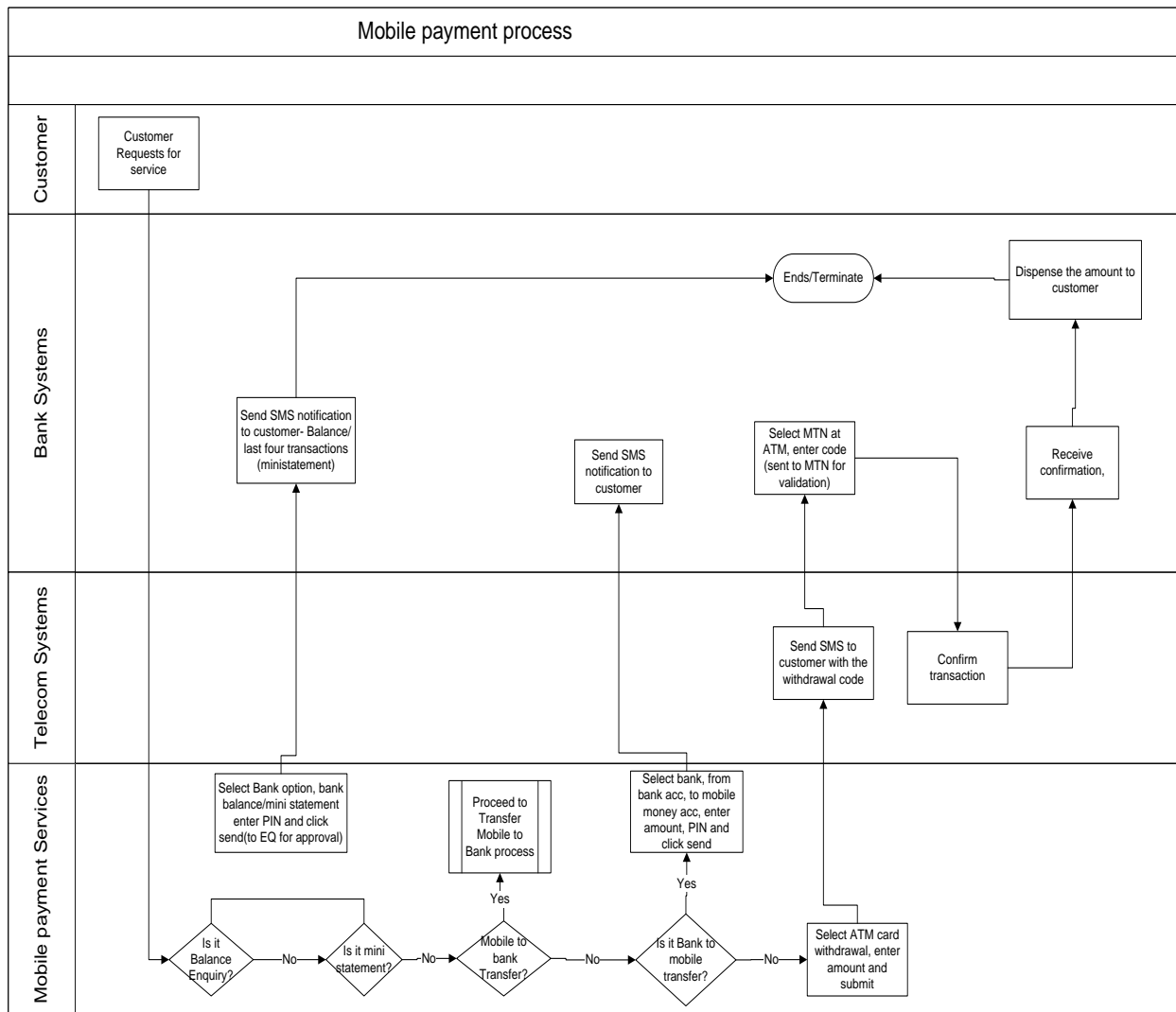


Figure 36 Process mobile payment services

Customer, bank system, telecom systems and mobile money payment system are four different systems to interact for mobile payment process. Integration and interoperability is key point to consider for this kind of payment.

Customer request for a services, balance inquiry, Mobile wallet account to bank account, Bank to mobile wallet and merchant payment for good or service. Through his/her mobile phone, customer will select witch account to debit and commit the transaction using mobile phone. Finally payee and receiver are notified for that transaction else transaction is declined.

## 4.7 System model

This section describes the system design model and we discuss major points that needed to design proposed system. The emphasis is to design the system, the implementation details are left out the discussion.

### 4.7.1 System structure

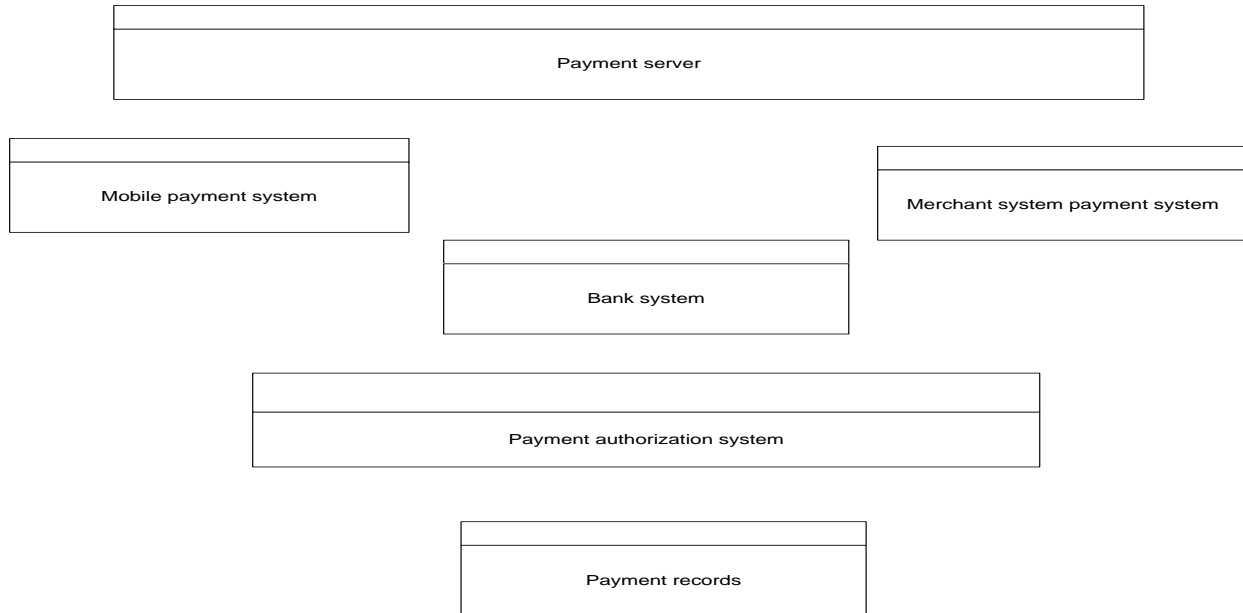


Figure 37 Classes for mobile payment process

Payment server is there to coordinate the transaction and submit all payment request initiated by the payer or the user and process them and it bring together different external systems that are involved for payment to be processed including invoicing system, interface system, authorization system and historical server. Payment interface allow customer to interact with the system when initiating transactions, after creating transaction authorization system is to authorize initiated transaction and print the invoice through invoice system. The payment record is saved in historical server.

### 4.7.2 The workflow

Figure 38 illustrate the workflow of payment transaction in the UML sequence diagram. The payer has two different role in the sequence diagram. Payer initiate the payment and indicate the payee to be paid and the payer performs the actual payment. In the sequence diagram the merchant represent the merchant system.

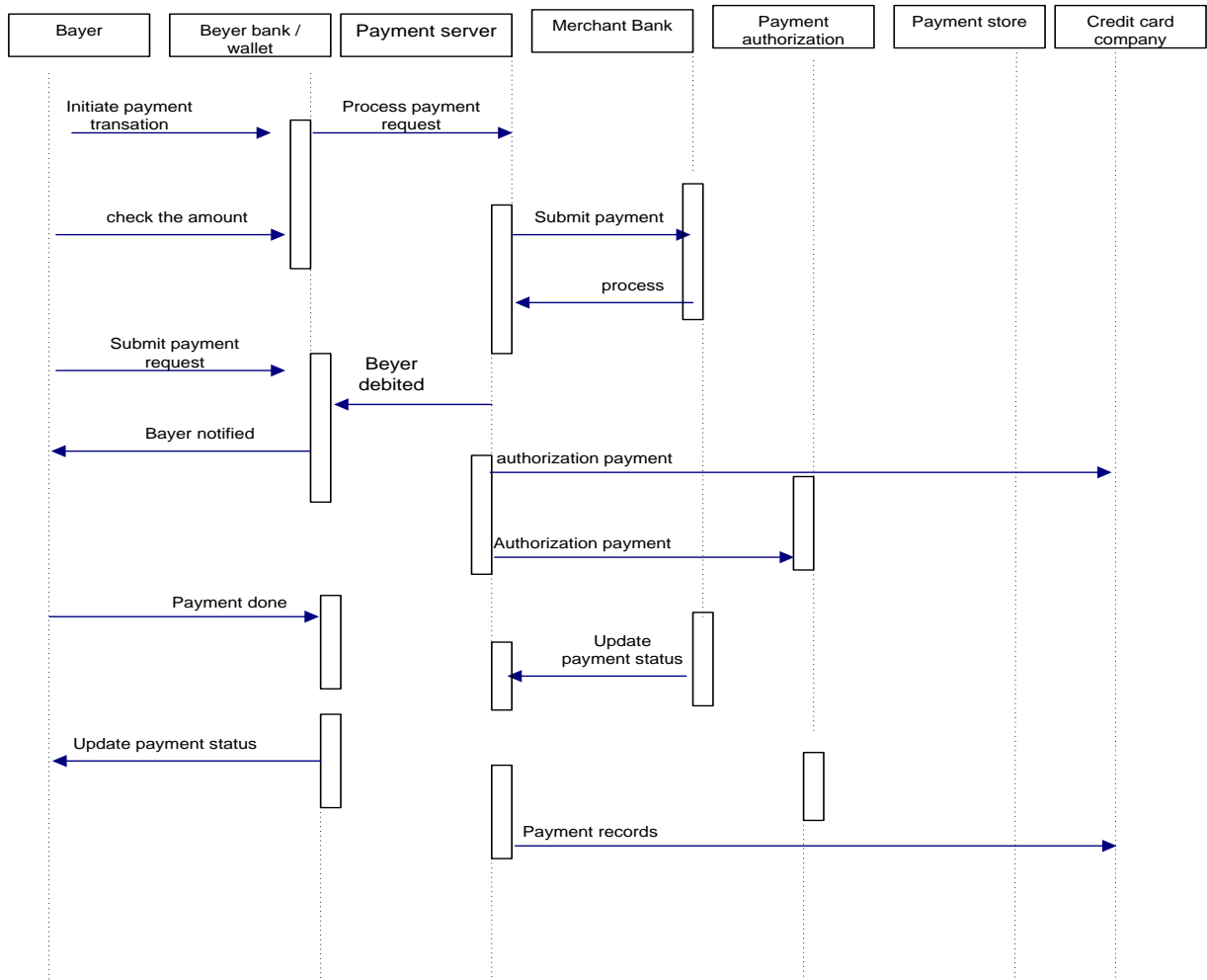


Figure 38 Sequence diagram for a user to pay through mobile phone

Payment transaction is completed through operability of different system integrated together. Payment server is there to controls the transactions, payment store to achieve the payment transaction, after a customer to initiate a payment transaction it goes to payment authorization and wait for authorization and then transaction is committed. Banks are also involved on both side, merchant and buyer. One bank is debited and another one is credited.

#### **4.8 Synchronization**

Mobile phone to complete a transaction different parties are involved especially mobile payment system, the integration and interoperability of all those parties are needed for payment to be completed and the purpose is to make a payment in the correct sequence and with little manual intervention for better service on both side payee and payer.

**Merchant and Payer :** Payment between merchant and the payer is conducted into different phases and merchant should be notified whether the transaction failed or was successfully by receiving automated message crediting his/her account and message to the payer debiting his/her account from the mobile payment system and the sequence of the process is shown below:

1. The payer create and submit a transaction using mobile phone
2. Mobile payment system verify submitted transaction using related parties of the systems
3. Payer confirm that the payment is done successful
4. Merchant system communicate with mobile payment system for verification

**Payer and Mobile payment system:** Synchronization of the systems is needed when payer send the payment information to merchant and mobile payment system should validate the information. Different channel and devices are used to perform and complete all these transactions from end to end.

**Merchant and Mobile Payment System:** The issue of synchronization between merchant system and mobile payment system should be considered for smart payment system, synchronizing the whole transaction of electronic payment like notification of each and every completed payment transaction from the Mobile payment System to Merchant system. Issue related to synchronizing payment systems could be solved in two different ways, one is to create interoperability or connection between merchant payment system and Mobile Payment System. This communication between the payer and payee (merchant) should always remain open for service, waiting for notification of payment completion. Then For security purpose the system on both side could have an option of reversal mechanism.

## 4.9 Interoperability

Synchronization to be implemented the modifications of the existing infrastructure for payment system is needed and different stakeholders are supposed to work together for this to happen including government, Business, individual.

### 4.9.1 Business model if interoperability

The diagram below illustrate the interaction between different stakeholders for smart payment system.

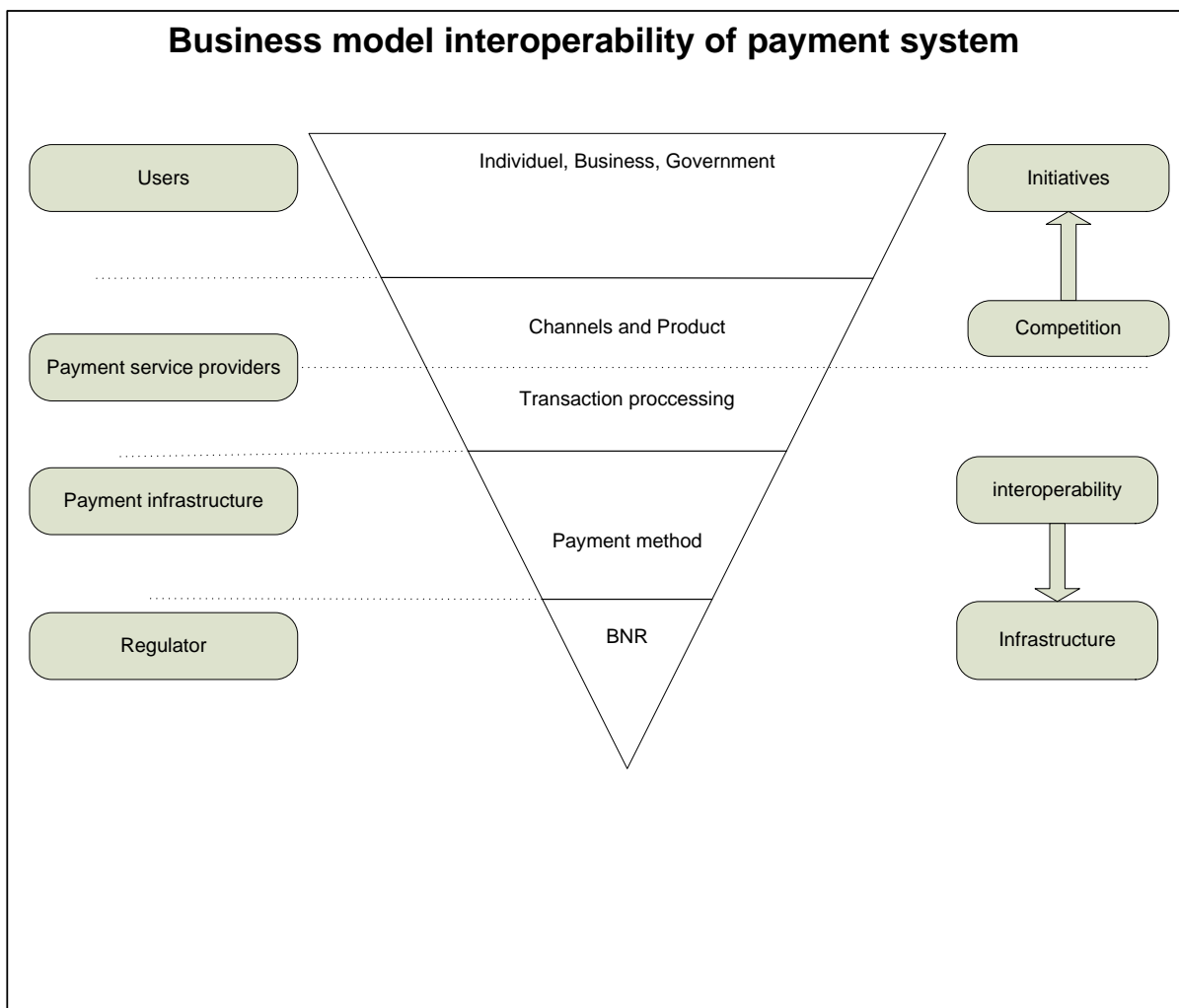


Figure 39 Interoperability Business model for payment system

Smart payment system to be developed different stakeholder will like (businessman, government and individual) need to come together to have common understanding on new mode of payment and clear guidelines that insure the smart payments will be nationally utilized. To maintain the consistence, this is built on a balance of co-operation and competition to create an efficient but innovative payments market is needed. This will facilitate economic activities in the country by providing safe and efficient mechanisms for making and receiving payment with minimum risks. Payment service providers and end users, extending the availability and usage to all sectors and geographies, banked and unbanked, and confirming to accepted regulatory, technical and operational standards.

**BNR:** BNR as regulator is there to produces Rules and Regulations to insure appropriate governance, management and operational of the payment system infrastructure and to set the tariff.

**Infrastructure:** Payments Infrastructure is a critical part of smart payment process with the Securities component. Infrastructure must be able to support all the payment and settlement methods required by the User Community.

**Initiatives:** National Bank of Rwanda can be a strong catalyst for the adoption of smart payments, and eight industry verticals have been identified as stakeholders for adoption of smart payment system. Banks, MNO and others service providers, will drive this adoption and success transfer.

**Competition:** Competition is key point to the sustainability of system more the competitors are many more you thing on how you system can be improved for better service. This will create an open market to encourage innovation and competition.

**Payments methods:** A new payment scheme, will enables turnaround time by allowing real-inter bank account-to account electronic fund transfers through the national bank of Rwanda. Following the development and release of mobile payments rules and regulation framework, the volume of mobile payments has grown rapidly since 2010 according to the RURA report the number of Rwandans owning mobile phones has increased up to 8.807 million, this force our society to think of mobile device as payment method to consider. And this will facilitate customers to send and receive money within second at lower cost compared to the existing payment systems.

### 4.9.2 Mobile payments channels and services

Diagram shown below explain the interoperability between different payment services through mobile phone. The diagram is showing mobile payments service channel, devices used and services offered using mobile technology.

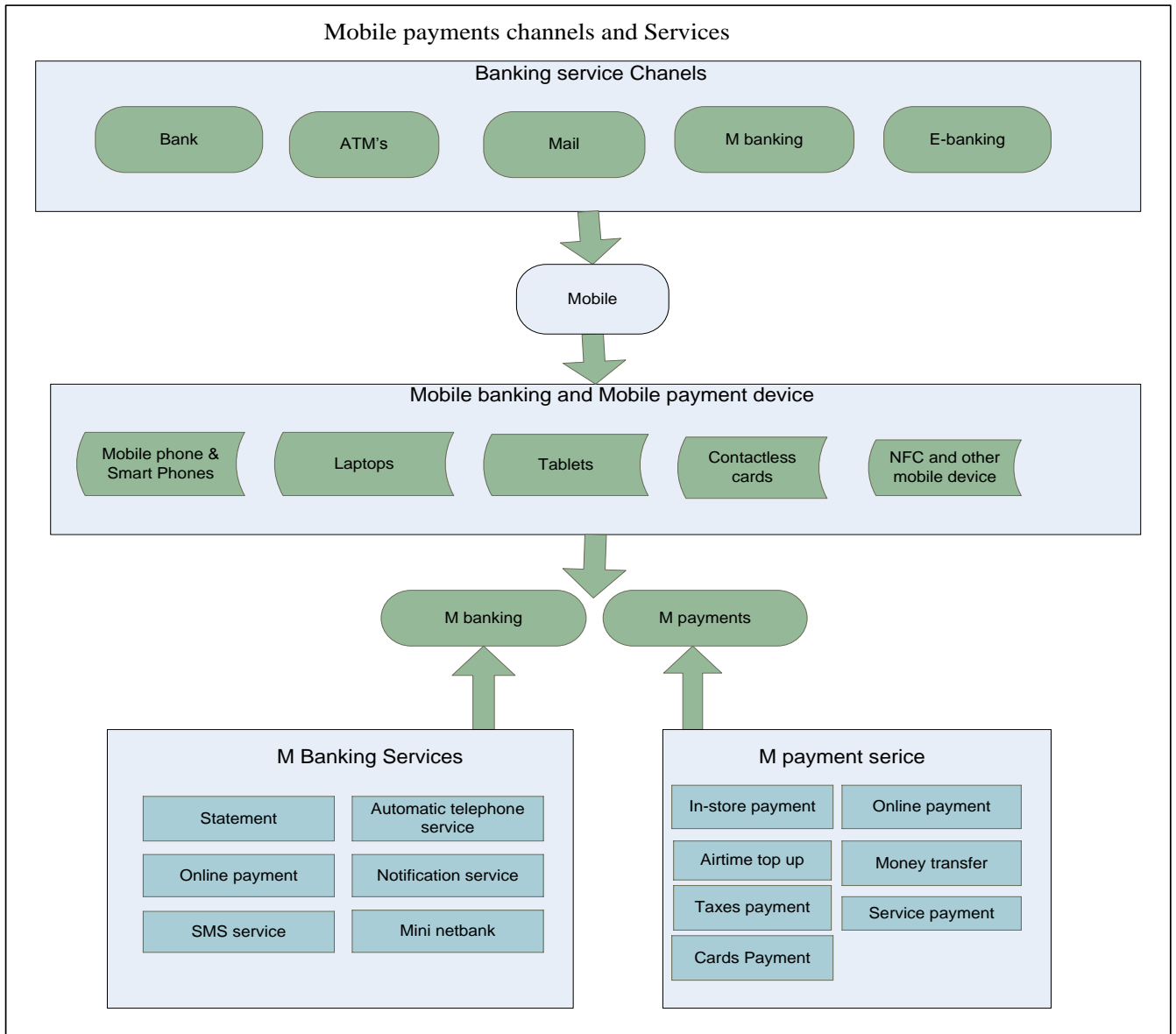


Figure 40 Mobile payments services and channel

**Service channels:** Time in past customers user to conduct their banking transactions through different channels and customers use to travel for banking services because the channels are stationary like to visit bank branch office or to go to the ATM location to get money and sometime

mobile phones were used to call for a service. Due to the emerging technology made on mobile phone, this has become a channel to conduct transaction for different services where mobile service channel has create new way and easy one to access financial services by providing safe and efficient mechanisms for making and receiving payment with minimum risks at anytime, anywhere and almost to any mobile device without visit bank branch or ATM location. Different channels are used to access financial services and to initiate payment transaction. Bank branches, ATM's, email, mobile payments and internet banking are different service channels to access financial services for payment.

**Mobile payments devices:** The Mobile payment system is a proven platform that empowers customers to access financial services through various channels (Mobile, Online, USSD, SMS...). This supports Social Banking, Merchant, Wallet, and Savings with access to Open APIs for Point of Sale terminals, NFC readers/writers, Bluetooth Printers etc. Mobile phones and smart phones are generally, but we can divided into four categories android (Mobile and Tablets), iPhone (iPhone and iPad), Windows Mobile (Windows Mobile and tablets) and Blackberry. However there are other devices that can understood as mobile give the same services as mobile phone. Laptops, tablet computers, contactless cards, and other different devices that allow payment service.

**Mobile banking services:** Mobile payments and mobile banking are two main group of mobile financial service (MFS).Every service between mobile payment and mobile banking are made up of several bundles of services as shown in the diagram.

Mobile banking service group together different services that can allow customers to send and receive money such us account balance, invoice payment, money transfer. All these services are accessed using mobile bank app on mobile device. With this bundles of service customer will be logging in to the application using MPIN and customer validated by MFS systems and conduct all financial transactions listed above.

**Mobile payment services:** The mobile payments service is grouped into seven categories as it is shown in figure 40. All those services are related to mobile money and mobile wallet services. This create an easy way to send and receive payment, mobile payment services are focused on ways to transfer money from one entity named sender to another entity called receiver using electronic cash.



Different actors have direct influence in the society like banks, mobile network operators, and technology companies (Master card, Visa card, Union pay etc...) and each actor involved has a specific role and tasks to fulfill as it is shown in figure 41. The Interoperability between different actors and stakeholders is critical on the exact roles and responsibilities each part have to play, otherwise smart payment through mobile phone and NFC will not be achievable.

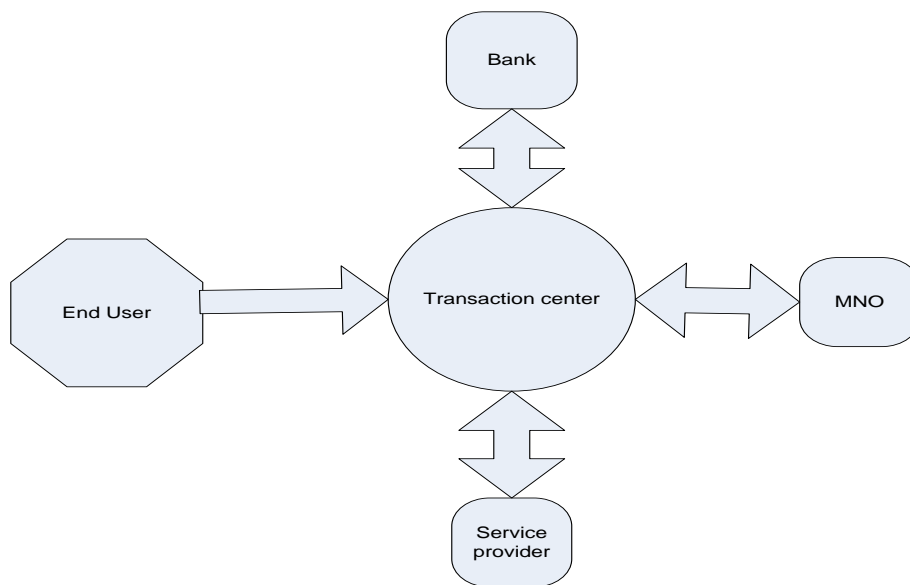


Figure 41 Transaction communication

**End user:** End user or customers are part of the actors to consider in designing of new payment system. Customers are the ones to use and benefit from the proposed system and accept to use it in their daily business because they are in the center of payment system, then the acceptance and adoption of the system is important for success. Ignoring end user role in payment industry, smart payment using NFC and Mobile phone technology will cause the fairly of technology no matter how good the technology is. Therefore for a system to be successful customer's role should be considered as an important part.

**Banks:** For smart payment to be implemented banking sector a part to consider as creditors actor who take the credit risk. In the proposed payment mode the bank is the center of all debit and credit transactions either payment using NFC or M-payment. Many customers have trust and confidence in the banks, therefore to build this kind of system bank is involved as actor, merchant and customers have confidence payments channeled through the bank that they will receive their money. When we talk bank as actor of the payment system we also talk about technology

companies that provide debit or credit cards for banks customers, cards are linked with customer account for them to transact. For this project to be successful cards issuer should totally involve.

For money to move from entity A to entity B a lot has to be done from the backend of payment systems. There are advantages of using banks as central payment of in modern payment using electronic cash, compared to the mobile network operators, based on the trust customers has in the bank industry than mobile wallet account because they are not yet trusted by the customers in payments. The issue of trust is challenge for MNO's while we are looking a way that every payment should be done through mobile phone. For this to come into to reality different stakeholders must take the responsibilities of how mobile phone can the can be used not only for calling but also for payments.

**Merchants:** As we discussed in previous section for electronic payment to be completed interaction of different parties in the business should be present, after bank, customers, merchants is also needed in this process. Merchants means any SP of goods and/or services that accept electronic transactions for payment of goods and services. The merchant will benefiting from the new mode of payment since the goal smart payment is to reduce the usage of cash in the Rwandan society. Cashless shopping is the desire of the merchant because of the security and cost spend on cash based payment, counterfeit risk, robbery and transportation of cash to the bank at the end of business are issues derive from cash based payment.

**Mobile Network Operators:** Without Mobile network operators the proposed payment technology is meaningless, the importance of MNO's in today's payments and future is remarkable. Today the variety of product and services available on mobile phones are increasing using different technology like NFC and many people see this technology will enable many innovative mobile services.

Looking at the development made on mobile phone today, customers are able get more than one service through mobile phone. This scheme comes with different benefit of using this than existing one. Some of the benefits are simpler and cheaper than the older methods using cards or banks payments. Even though benefits are many also downside are there and one of them is the limit of transaction.

#### 4.10 Design of integrated smart payment

Today consumers are using different means for payment, according to the survey conducted and result was show in chapter three cash based are mostly used for payment than other methods. By developing the other methods no doubt merchants and users will get benefits from using the new payment mean to replace cash and this will help customers to more easily and efficiently purchase goods without cash. With all these listed benefits from both customer and merchant side, cost reduction from merchant and customers do not have to worry if physical cash in wallet would cover the expenses.

##### 4.10.1 MNO's Payment

The MNO's have identified various types of interoperability that will allow customers to exchange money as follows:

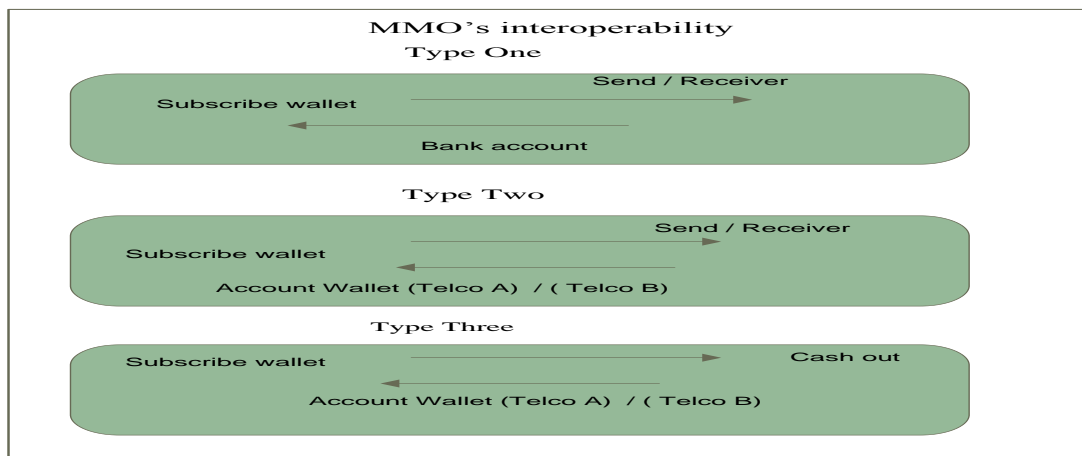


Figure 42 MNO's Interoperability

**Type one:** Subscribers can transfer E-Money from their mobile wallet to a bank account and from the bank account to the mobile wallet.

**Type Two:** subscribers of Telco A can Transfer funds to a subscriber of company B and subscriber of company B can transfer funds to subscriber of Telco A.

**Type Three:** Subscribers for telco A can cash in or cash out from an agent of telco B.

On the basis of the above three definitions the Telco's wishes to start working on the interoperability as this will drive access to finance for all.

### 4.10.2 NFC payment architecture

Figure 43 illustrate the NFC payment architecture of payment process using mobile.

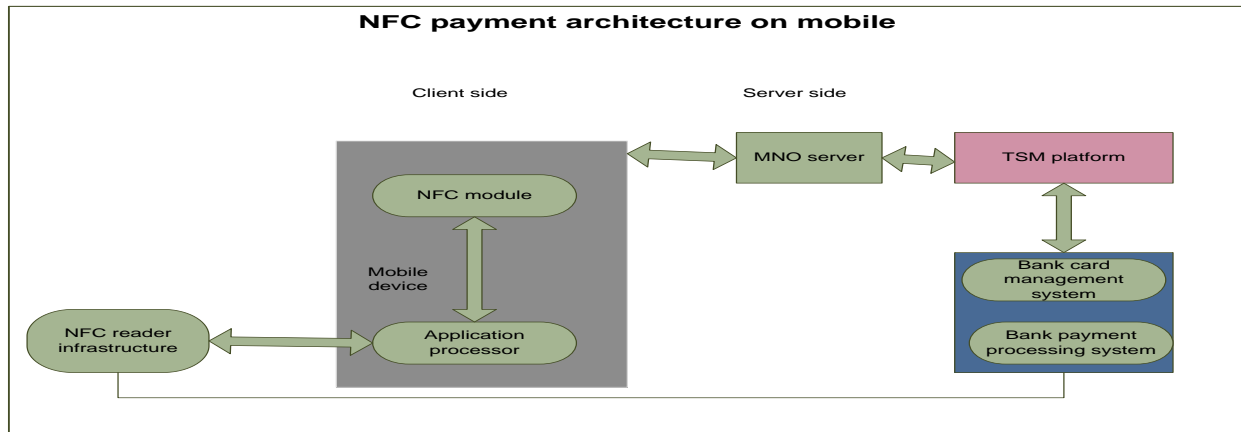


Figure 43 NFC payment architecture

As the proposed new payment service using mobile phone and NFC will increase the number of transactions. Interaction between banks, mobile network operator and other stakeholders will make the smart payment system to be successful and more profitable for the citizens. Mobile network operators have interest responsibilities of making this technology working properly, since this will expand their market in terms of customers. And they have to upgrade their systems to make secure payment through their network channels so that customers and banks can trust them for to make integration with their systems.

The Integration and interoperability of systems is key point to consider in payment process, payment system should not depend on one company but allows other interested parties to join.

### 4.10.3 Interbank payment

The success of any payment system will be based on interoperability of different systems. This will create an easy way for users to access their accounts (Bank account, Cards and Mobile money account) and to use payment services through mobile phone. Figure 44 illustrate the payment integration and interoperability between banks.

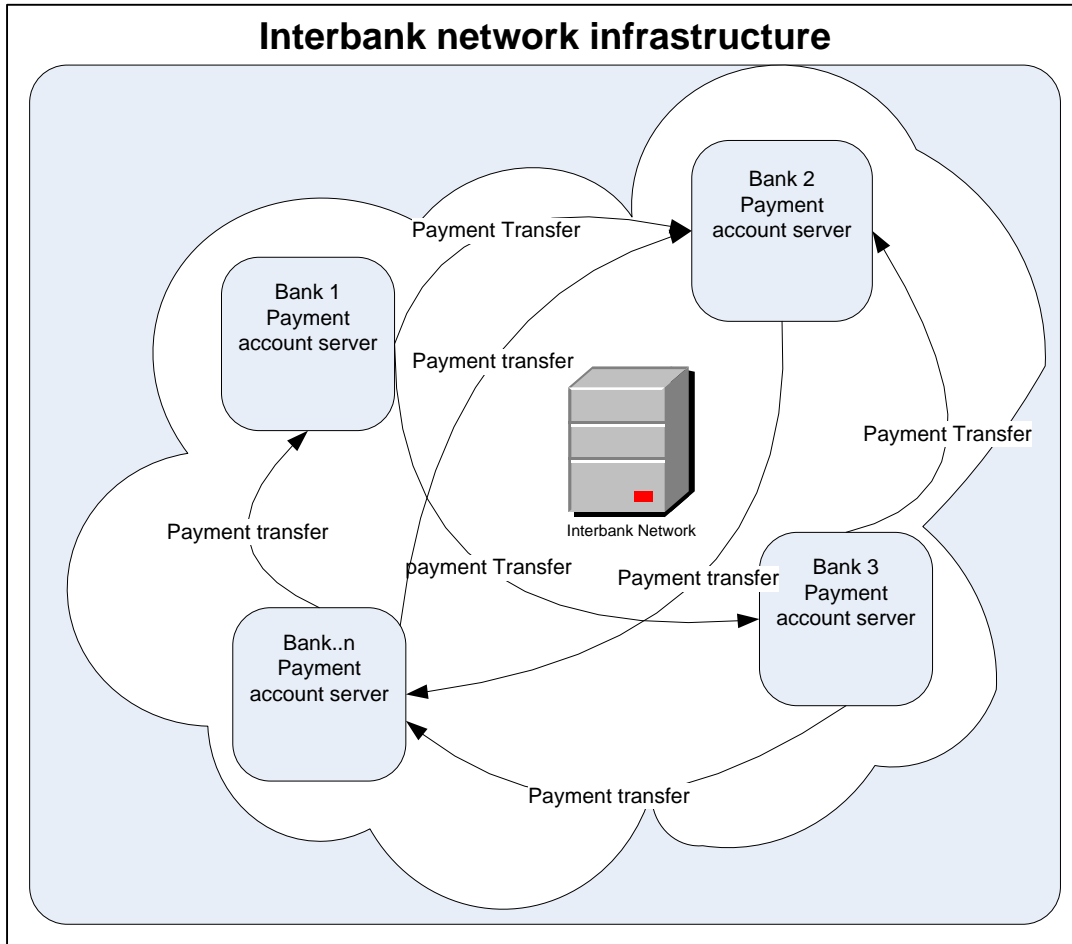


Figure 44 Interbank network infrastructure

Payment can be made by transferring funds within the bank or in different banks (interbank). An interoperable system can faster gain the necessary customer base for future development and will have a higher level of applicability. Many disadvantages of low interoperability between diverse payment systems.

## 4.11 System architecture

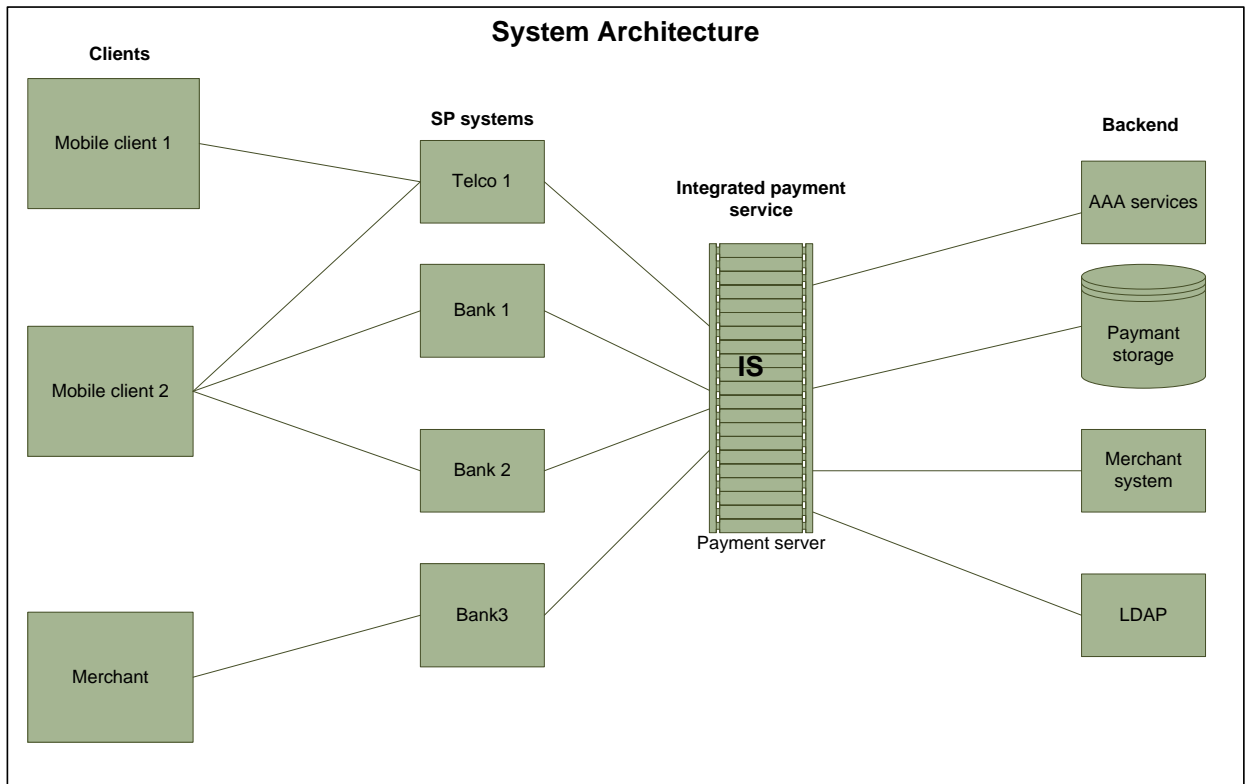


Figure 45 System architecture

The payment server is there to forward the transactions initiated by the clients and send that transaction to the correct receiver through payment system by creating connection between payers and receivers or merchant. For the security purpose all payment request initiated are encrypted through AAA services. Payment server does not store the transactions but is there to process the request initiated by the users and the records are stored in payment storage database.

Merchant system handles the transactions related to electronic payment and purchases, the merchant system implements electronic commerce protocol to insure a secure transmission between customers and financial institutions that integrated with other payment systems.

The integrated payment services contain user interface of mobile payment system and API for merchant systems. The function is to make things understandable by processing the user request to payment server and run different program on the server that host the applications used in payment system. When a user create a request the user interface is generated.

The database consists of both physical structure and logical structures. Because the physical and logical structures are separate, the physical storage of data can be managed without affecting access to logical storage structures. The database play an important role by managing the data efficiently and allow users to access the payment records are stored in the database and this allow to access data at any time wanted using SQL queries. Once transaction is created by a customer data are updated in the payment record store. The Automatic Storage Management (ASM) is used to facilitate the turnaround time by provides vertical integration of the all systems.

#### 4.12 Proposed high level smart payment system

Mobile phone, Wallet and of keys are three things find in pockets of every person today, this section describe the new proposed design and details the key player’s roles and responsibilities for smart payment system to exist.

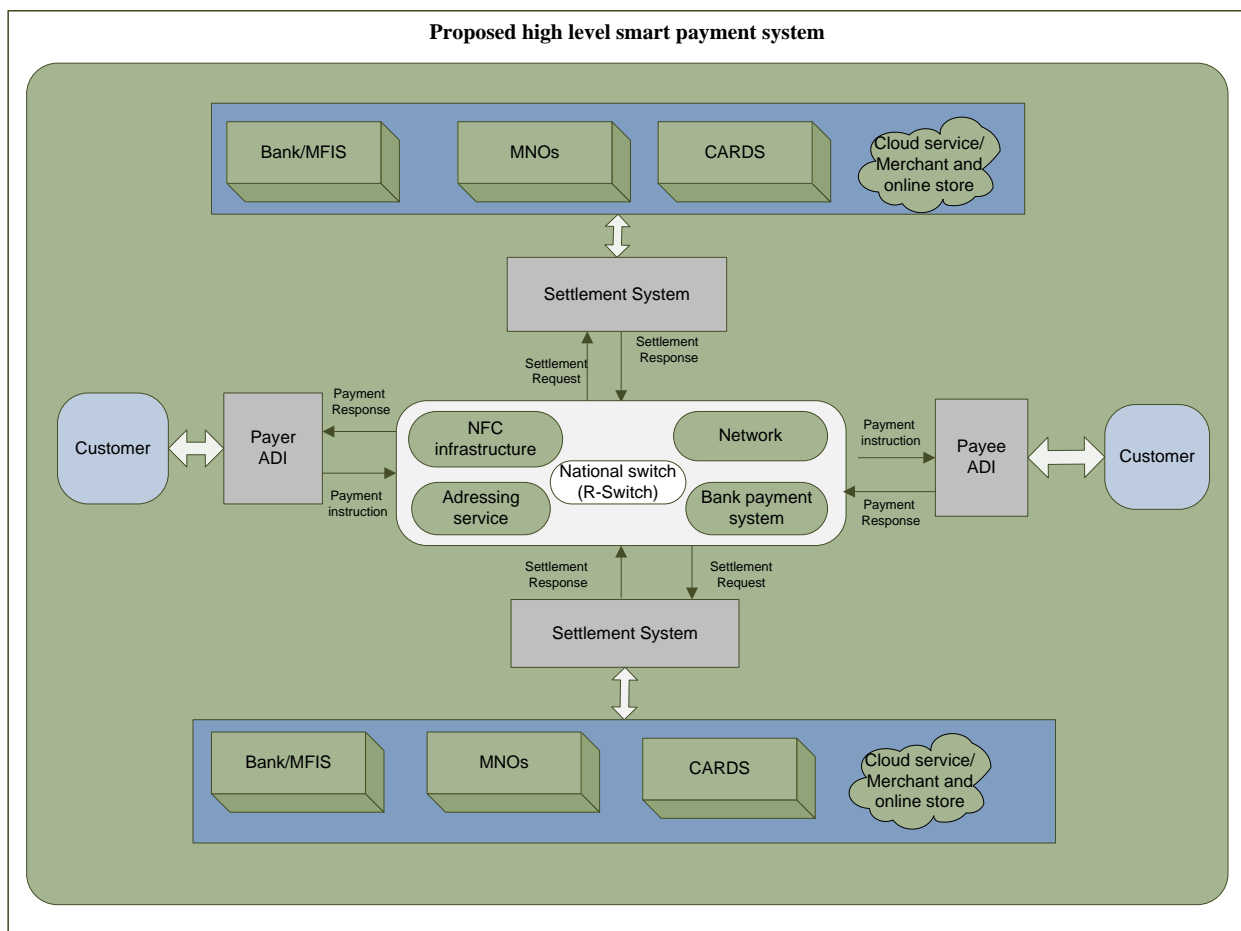


Figure 46 proposed high level smart payment system

As this thesis focus on smart payment system using mobile phone and NFC ecosystem; as shown in previous section different actors were involved to make this proposed system successful. This will create an easy way for users to access their accounts (Bank account, Cards and Mobile money account) and to use payment services through mobile phone.

NFC and Mobile are technologies used for proposed new payment system. With your mobile phone you can make payments to any commercial bank, wallet account using single platform and be able to pay goods and services using your smart phone. For this to happen we need fast to register our ATM cards on mobile phone and when you are doing payment you select among the list of accounts and choose one to debit and credit merchant or he payee.

Diagram 47 is showing the high level of interoperability between different parts that are concerned in payment process. The process begins with the consumer creating a payment request through mobile phone device. Two mode of payment were proposed in the thesis one is exchange money using transfer from bank account to another one, from wallet account to wallet account or from wallet account to bank account and vice-versa. The second mode of payment is NFC payment, through this technology customer can pay goods from merchant using mobile phone by selecting account to debit and credit merchant account without using cash.

Despite the potential advantages, interoperability does have some costs and potential disadvantages. With this new proposed mode of payment customer does not need to carrier a number of cards from different banks in your wallet, because all the cards will be registered on your mobile phone and access them form mobile phone. Therefore when you want to pay or to send money you will need only to select the card or account you want to pay with.

**Settlement:** Today everybody is connected via networks, through mobile phone customer is able to do settlement within one financial institution, interbank payment to send and receive money by debiting customer and crediting beneficiary account from bank account or wallet account.

**The interbank settlement:** the interbank payment transfer and settlement should be seen as important part in payment industry for modern society. Interbank payment to happen we need universal account means all the banks should have the standards account for interbank settlement.



In figure 47 the payer initiate transaction by sending the instruction to his/her bank to credit the beneficiary's bank through mobile phone. With interbank network the beneficiary bank receive the payment and payment notification is send to both the sender and receiver, otherwise the debit transaction is reversed.

The interbank payment is the most convenient and efficient method, the process of payment is done through Rswitch. Rswitch generate settlement files to be sent to BNR containing net position of each bank.

**Inter MNOs payment /Transfer:** Figure 42 is showing the interoperability between MNOs. For customer to move money from his/her mobile wallet account to another mobile user, e.g. (Mtn to Tigo, Tigo to MNT, Mtn to Airtel, etc...) a trust account in the bank is needed. The settlement is done via the banks (with the net position), Rswitch is to send settlement to BNR.

To move money from mobile wallet account to the bank account the settlement is done between bank and MNO trust account and Rswitch to send settlement report next day. Figure 15, 16, 17 is showing the process of moving money to mobile wallet account to Bank account and vice versa.

**NFC payment:** In figure 47 the diagram is showing the high level interoperability of payment system, NFC is one of the technology proposed for smart payment system. The circle as described in figure 24. The payment process starts between merchant and customers. (1) Merchant display the amount to pay on NFC reader. (2)The customer taps on his phone to activate NFC App. (3) the customer select the payment channel to be used. (4) Through the national switch forwards the transaction to the paying financial institution (Bank/MNO). (5) The paying institution authorizes the transaction. (6) After authorization through the national payment switch, Rswitch initiate the credit transaction and forwards it to beneficiary institution (Bank/MNO). (7) When credit transaction is successful customer and merchant are notified otherwise Rswitch initiates reversal.

**Transfer Mobile App :** After NFC payment, mobile App transfer is the second module of the proposed payment system with NFC customer can by goods and pay through his/her mobile phone using the said technology in the merchant shop. But this is not enough since customer need to send and receive money from different places. Figure 42, 44 illustrate the payment process between the sender and the receiver, moving money from entity A to entity B without basing on the beneficiary account. Because with the new module of interoperability money can be moved to any bank/ wallet

account and be credit to any bank/wallet account within a second. (1) Customer selects the wallet to be used (card / e-wallet). (2) Select the beneficiary institution (Bank/MNO). (3) Enter the transfer details

(Amount, reason, account bank/wallet). (4) Confirmation/validation. (5) Rswitch forward the transaction to the paying institution. (6)Paying institution authorizes the transaction (Debit)

(7) After authorization Rswitch forward the credit transaction to the beneficiary institution. (8) If the credit transaction is successful, the ordering customer and beneficiary are notified otherwise the debit transaction is reversed.

#### **4.13 Benefits and Barriers**

Smart payment system using mobile phone have a list of benefits as well as barriers, many aspects of the list apply to technologies of smart payment system. Therefore, the benefits and barriers of smart payments are examined through those of NFC and Mobile payment.

- **Benefits**

A central driver in the adoption of smart payment is the decreasing cost of payment and exchange of money. NFC chips into handsets and mobile devices is technology to be used for implementation. With this technology this will use an open platform necessary for interoperability.

- **Barriers**

**The cost of implementation** is one of the most significant barriers standing in the way of banks as moving forward to smart payment, this requires heavy investment in products, services, infrastructure and a client base. Without engagement of all related parties, this will not be achieved.

**Co-operation and splitting profits and costs among value chains members** is also, a difficult hurdle to overcome. With a large value chain it becomes increasingly difficult to co-ordinate operations and responsibilities, as well as, to divide the profits and costs among each member.

**Trust** is an essential point to consider in payment services. This is reason why customer give banks and other financial institutions their money. Trust was is also an important point in technology acceptance. Another important issues is concerning the attitudes of customers.

**Security** issues is also central issue to consider as barriers in implementation of smart payment

#### **4.14 Chapter summary**

There this chapter covers the analysis and design new proposed smart payment system that using digital money. The evaluation of existing payment Systems and existing infrastructure was reviewed in previous chapters. The new integrated smart payment system is solution to the number of problems caused by the existing system. Since smart payment is very wide topic, we cannot cover everything in this research, therefore recommendations are proposed in next chapter.

## **CHAPTER FIVE : GENERAL CONCLUSION AND RECOMMENDATIONS**

### **5.1 Conclusion**

This research focused on the smart payment system as a proposed mode of payment to replace cash based payment. The target was to design an integrated smart payment to facilitate customers to easily send and receive money. The stakeholder in payment industry face problems in using cash based payment by using standalone systems for payment. In payment industry in Rwanda, there is difficulty in integration and interoperability of payment systems from various companies and this was identified as blocking issue. The current payment process is cash based payment and other issues that were highlighted by respondents were the lack of efficient integrated payment system that can allow them to send and receive money from where they are in a more safe way.

The proposed integrated and interoperability smart payment system will reduce the issues faced by payment industry in Rwanda in payment process and provide many benefits such as creating cashless society, turnaround time in payment process, security and increase effectiveness of service. Because of time and resources limitation, the scope of the project was limited only on payment using local currency between only four actors Bank, Merchant, MNO's and Customers. Based on the results from conducted survey, this research contribute to assess the potential of smart payment in Rwanda. Results show that smart payment based on mobile payment solution in Rwanda will resolve many issues caused by cash based payment. As the skilled people in the technology industry, we have designed the next mobile payment solutions in Rwanda. This research exposed the new opportunities that are useful in future smart payment.

Even though smart payment on mobile phone and NFC was evaluated, it does not mean that mobile payments will leave the ground in Rwanda. There are still a large number of problems to be solved. The success of mobile payments system needs some experts in payment industry. The high ranked companies and government should be involved and support the project, otherwise no chance of success. The existing infrastructure of both consumer and merchants cannot support smart payment or contactless payments in Rwanda at the moment.

## **5.2 Recommendations and future directions**

When looking at the issues related to the current payment system in Rwanda, smart payment system might bring some solutions. Therefore, it is recommended that smart payment might contribute in solving some issues raised in the survey of this research. It is also important to investigate on the technology to be used in this mode of payment which was not performed in this research. For further research, it could be relevant to study the security aspect of smart payment, barriers and issues related. It is also important for the next research topic study the economic impact of smart payment. With the above mentioned recommendations, the complete development and implementation of an integrated smart payment system in future will provide many benefits for payment industry in Rwanda as it was mentioned earlier.

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## **APPENDICES**

### **Appendix A: Questionnaire**

1. IDENTIFICATION			
1.1. Sex: 1=Male 2=Female	__	1.2. Age: 1=Under 18 years 2=18-25 years 3=26-35 years 4=36-55 years 5=56-65 years 6= over 65 years	__
1.3. Profession: 1= student 2= teacher 3= manager 4= worker 5= stay-home 7= retired	__	1.4. Education: 1= high school 2= college 3= graduate school	__
1.5. Working institution:	.....	1.6. Position	.....
2. GENERAL QUESTIONS			
2.1. Have you made travel before, for payment of goods and services or any other payment?			
1=Yes 2=No			
__			
2.2. Do you ask someone to make payment for you?			
1=Yes 2=No			
__			
2.3. How often do you perform any payment on average (per month)?			
1= Once 2=Twice 3=Three times 4=More than three times			
__			
2.4. What methods of payments do you use to pay goods or services?			
1=Cash based 2=Card based 3=Mobile payment 4=Internet banking 5=Other methods (specify)			
__		..... in case filled 5	
2.5. How do you rate the process of making payment for cash based?			
1=Very Satisfied 2=Satisfied 3=Fairly satisfied 4=Fairly Dissatisfied 5=Very Dissatisfied			
__			
2.6. How do you rate the speed and time spent for payment to get a service?			
1=Very Satisfied 2=Satisfied 3=Fairly satisfied 4=Fairly Dissatisfied 5=Very Dissatisfied			
__			
2.7. Have you met any problems when you are doing payment at the bank?			
1=Yes 2=No			
__			
2.8. What problems have you experienced at the bank?			
1= Timing 2=Long Queue 3=network problems 4=Money lost 5=Holidays and weekend days 6=Other (specify)			
__		..... in case filled 6	
2.9. What did you do when things go wrong at the Bank, e.g. when it is a holiday, no network or Weekend?			

<i>1=To postpone 2=To borrow from someone 3=other (specify)</i>	
__	..... in case filled 6
2.10. How long does it take for you to go to the bank for payment?	
<i>1=5 minutes 2=10 minutes 3=20 minutes 4=Longer than 30 minutes</i>	
__	
<b>3. DIGITAL PAYMENT</b>	
3.1. Do you know about Smart payments? (Mobile money, mobile banking, card based payment)	
<i>1=Yes 2=No</i>	
__	
3.2. Have you used any Smart payment before?	
<i>1=Yes 2=No</i>	
__	
3.3. How do you rank mode of payment are using today which one comes number 1,2,3...6	
<i>1= cash based 2= smart card 3= Magnetic card 4= Contactless card 5= mobile phone 6= NFC Technology on mobile phone</i>	
1.  __     2. __     3. __     4.  __     5.  __     6. __	
3.4. Among listed mode of payments which one do you prefer for future? Rank them according to your preference of importance	
<i>1= cash based 2= smart card 3= Magnetic card 4= Contactless card 5= mobile phone 6= NFC technology on mobile phone</i>	
1. __     2. __     3. __     4.  __     5.  __     6. __	
3.5 .What do you think would attract you to use smart payment system?	
<i>1= Saving time 2=Saving money 3=Avoid countfeit 4=(specify)</i>	
__	..... in case filled 4
3.6. What do you think would make you give up using smart payment system?	
<i>1=It is not secured 2=Cost 3=Others (specify)</i>	
__	..... in case filled 3

**4. Integration and interoperability**

4.1. How many accounts do you have from different banks?

*1= One account 2= Two accounts 3=Three accounts 4=Four accounts 5=Five accounts and more*

|\_\_|

4.2 .How many cards do you have from different banks?

*1= One card 2= Two cards 3=Three cards 4=Four cards 5=Five cards and more*

|\_\_|

4.3 What do you think if all you can access all your accounts through your mobile phone and make different payment from your different accounts and Banks or from you mobile wallet account to bank and vice-versa?

*1=Very Satisfied 2=Satisfied 3=Fairly satisfied 4=No need of use*

|\_\_|

4.4 When balancing the pros and cons of mobile payments services, which weighs more?

*1=pros 2=cons*

|\_\_|

4.5 What other feedback would you like to give us on this needs assessment questionnaire?

.....  
.....  
.....