

**TO DEVELOP A MOBILE APPLICATION THAT WILL ENABLE
INTEROPERABILITY OF MOBILE MONEY SERVICES FOR
ILLITERATE USERS IN ZAMBIA**

BY

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for the award of the degree of Master in Information and Communication Technology
Engineering

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Dedication

I dedicate my dissertation work to my family and friends. A special feeling of gratitude to my loving Mother, Beauty Chanda whose words of encouragement and push for tenacity ring in my ears. My sisters Clerit and Candy have never left my side and are very special. I also dedicate this dissertation to my Brothers Chrysly, Curthbert and Jones who have supported me financially throughout the process. I will always appreciate all they have done. I am also grateful to my friend Chembe for helping me develop my programming skills, Aggrey for the many random educative sessions of how the mobile money systems work and Moses for encouraging me to always work hard.

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I Paul Chiluba Cheche, do hereby declare that the content of this document is my own and all other works by other people have been duly referenced, and that this work has not been previously presented to another university for the same purpose. All that is borrowed from other scholars has been acknowledged and well cited in the place where they appear.

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Date

Certificate of Approval

This dissertation of Paul Chiluba Cheche has been approved as fulfilling the requirement for the award of Master of Engineering in Information and Communication Technology by The University of Zambia.

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Abstract

This research presents the design and development of a mobile money solution that targets illiterate people, applying user-centered requirements gathered in a Zambian context. Existing mobile money platforms have text-based interfaces and target literate people. Illiterate people, without the assistance of literate individuals, cannot use such platforms. Emphasis is given to how illiterate users deal with hard cash in their everyday life and how such practices can be mapped into financial technology design. Given the ubiquity of mobile telephony the solution in this paper is based on the widely available, relatively inexpensive, and open-source Android mobile platforms.

Results of the proposed system show that illiterate individuals can now count money bills, while providing the facility to accept and make payments. In doing so, the mobile application provides an example of how a pervasive technology can empower a hitherto often neglected user category of illiterate users in Zambia.

Keywords - *Android, API, illiterate, Interoperability, Mobile money.*

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List of Abbreviations

API: An Application Programming Interface

BAMOS: Base Architecture for Mobile Applications in Spontaneous networks

BAZ: Banker's Association of Zambia

BOZ: Bank of Zambia

FSD: Financial Sector Deepening

GUI: Graphical User Interface

GSS: Group Support System

HTML: Hypertext Markup Language

IMPS: Immediate Payment Services

ICT: Information Communication and Technology

JS: JavaScript

MMT: Mobile Money Transfer

MTN: Mobile Telephone Network

MMP: Mobile Money Providers

MM4P: Mobile Money for The Poor

MMID: Mobile Money Identifier

NEFT: National Electronic Funds Transfer

NFIS: National Financial Inclusion Strategy

PAYZ: Payment Association of Zambia

P2P: Peer to peer

P2B: Person to a business.

PIN: Personal Identification Number

RTGS: Real Time Gross Settlement

SMS: Short Message Service

UI: User Interface

USSD: Unstructured Supplementary Service Data

UNCDF: United Nations Capital Development Fund

UPI: Unified Payment Interface

XML: Extensible Markup Language

ZAMTEL: Zambia Telecommunications Company Limited

ZECHL: Zambia Electronic Clearing House Limited

ZICTA: Zambia Information and Communications Technology Authority

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1. CHAPTER ONE: INTRODUCTION

1.0 Introduction

This chapter presents a general introduction of the study. It includes the background, the statement of the problem and the purpose of study. It also includes the research objectives and research questions. The chapter also contains the significance of the study, delimitation of the study, the conceptual framework, the timeline, and the budget of the research.

1.1 Background of the study

The use of mobile smart phones has increased over the years amongst Zambians, this is non-exclusive to rural areas where electricity is scarce and network connectivity is not as good as the urban areas. The growth of the telecommunication industry has enabled mobile smart phone users to save time and money spent on various day to day activities like transportation to meet families in distant places and other various goods and services. Users are aware of the importance of smart phones and those that do not own one easily describe how they would make use of it if they had one. However, these smart phones require some level of literacy to operate them effectively. Many elderly people of today generally need the assistance of younger people to operate a smart phone. Currently, there is a huge population of the adults living in both rural and urban areas of the country who are functionally illiterate and uneducated. A good number of them have no level of textual literacy, and they have no prior exposure to information communication and technology. As described, Africa is a success story for mobile telephony. In the space of a generation, Africans throughout the continent have adopted the technology, across all strata of society, rich and poor. The success of mobile telephony has led to various added services like mobile money which according to GSMA [1] report of 2018, the region added over 17.5 million new active accounts in 13 African countries with an estimation of over a third of adults being active mobile money users.

Ubiquitous computing is computing that happens everywhere and anywhere. However, this does not necessarily mean that it will be embraced by everyone or that it will be user friendly for everyone. Indeed, many mobile applications available nowadays assume some degree of user literacy in their design and implementation. Moreover, in respect of some category of mobile money applications in our case, the implicit assumption of the interface is that users will be literate. What happens with illiterate users? Adding complexity to the problem of illiteracy, there are many languages in Zambia i.e., Bemba, Nyanja, Tonga, Lozi, Chewa, Luvale, Kaonde etc. A feature which challenges digital communication. For example, while transacting, a Bemba speaker can communicate with a Tonga speaker through symbols like

“showing money bills” or through some intermediaries that speak both languages. Colour and materiality of money notes has a dual purpose to identify among currency notes by illiterate individuals and as a means of communication when people speaking different language meet for a business transaction. A salesman who is unable to say that the price of an item is K100 can pick up a K100 banknote and show it to a customer. This enables the customer to understand what the salesman is trying to say. Thus, the physicality of money bills also enables illiterate individuals to move money around and undertake simple mathematical operation. Illiterate users everywhere in the world are excluded from accessing mobile money applications through the lack of an appropriate interface. Some mobile money applications such as M-PESA in East Africa and GCASH in the Philippines, [1] have been particularly successful in employing a pervasive technology to enhance the levels of financial inclusion, especially in rural areas with little or no banking/financial infrastructure being available. [1] Mobile money services are being deployed rapidly across emerging markets as a key tool to further the goal of financial inclusion. Financial inclusion, the development of innovative methods to enable individuals at the base of the pyramid to access formal financial services and become part of the formal financial system, is considered not only a fundamental prerequisite for eradicating poverty amongst the Zambian people but also important for economic growth. Kenya was the first African country to offer mobile money services in 2007 through M-PESA “M” which stands for “Mobile”, “pesa” for “money” in Swahili, a popular mobile money service offered by a local mobile network operator called Safaricom. Since then, the mobile money industry has expanded rapidly across many other countries, particularly in developing economies in Africa and South Asia. The definition of “mobile money” varies across the communication industry as it covers a wide scope of overlapping applications [3]. Generally, mobile money is a term used to describe *electronic financial services performed via a mobile phone*. There are three main types of mobile money services and these include Mobile banking, Mobile payments, and Mobile money transfers. It is worth noting that the term Mobile banking is often used interchangeably with the overall category of mobile money in research and literature. However, mobile banking is only one type of mobile money service, it allows customers of a financial institution to access their accounts and to perform transfers and payments. This service is therefore only available to people who possess a formal bank account. Mobile banking is a financial service which is mostly available in developed countries and not in most developing countries due to the low level of financial inclusion through official financial systems and banks. In the case of developing countries, other mobile money services are mostly used by people who do not have personal bank accounts. Indeed, customers often

rather use mobile payment and mobile transfer services, which are available from their mobile phones without the need for a bank account. In practical terms, these two services are accessible from an electronic account, linked to the SIM card in the mobile phone. This electronic account is known as mobile wallet and is protected by a personal identification number (PIN), with accounts debited or credited as soon as the transaction takes place. To transact, mobile phone users need to deposit cash into their mobile wallet at the outlet of an agent of a local mobile telecommunications company. The agent will get the money from the customer and transmit it to the company through his/her own mobile phone. If mobile phone users wish to withdraw cash from their mobile wallet, they also need to go to a mobile money agent outlet. In the framework of these mobile money services, the sender's and receiver's mobile wallets are not linked to their individual bank accounts but to their SIM cards. The balances of all their mobile wallets are maintained by the mobile network operator. Mobile payment (also known as "m-commerce") is a service allowing unbanked people to purchase or sell goods and services at a merchant shop/store (or remotely) using their mobile wallet through their mobile phone, instead of cash. Unbanked mobile phone users can also pay utility bills via their mobile wallet. In the case of a face-to-face payment at a merchant shop, mobile financial transactions are done in the following manner: first, the customer gives the merchant his mobile phone number. The merchant then requests payment via the telephone service provider website or by SMS with the customer's mobile number. The telephone service provider then sends an SMS to the customer with a Bill Reference Number. The customer authorizes the payment by replying to the SMS with his customer 6-digit Security PIN and the Bill Reference Number. Finally, the telephone service provider sends a payment notification with details to both the merchant and the customer. Mobile transfer (also known as money transfer "person-to-person" "P2P" or "mobile remittances") is a service that allows unbanked people to send or receive small sums of money to/from any other mobile phone user (even if they are subscribed to different telephone service providers) across the country, from urban to remote rural areas, and across international borders. In practical terms, the customer must first deposit cash into his mobile wallet. Then, on the phone menu, the customer selects the option Send Money, and enters the recipient's phone number, the amount he wishes to send and his 4-digit Security PIN. The sender can confirm that all the information entered is correct. The receiver will get a text message that he can show to a local mobile company agent to receive the money in cash.

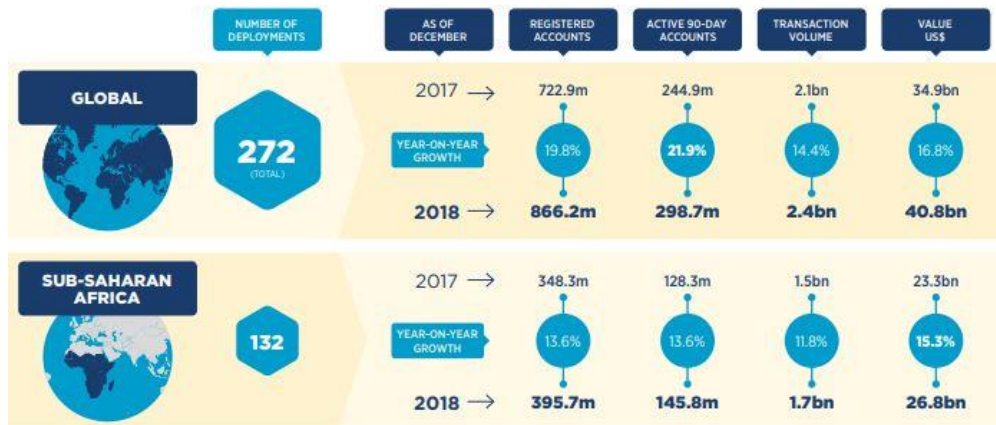


Figure 1.1 Growth of Mobile Money Services [7]

1.1.1 Global and Regional Perspective

The evolution of banking over the years has paved way to using smart phones to replace bank services previously carried out in the bank. Reaching the unbanked populations through mobile money services has led to a widespread of the unbanked populations carrying out financial tasks despite difficulties related to using technology, poor infrastructure, illiteracy and inaccessibility to receive banking services. The following are some of the global and regional perspectives.

A. Mobile based money transfers

Mobile telephony has taken over and has allowed people to do various activities from financial services, social networking, online education, research, online shopping etc. Mobile money being one of these favourable features, allows individuals to bank using their mobile phones even in unserved and underserved areas of the developing world. Not only are people able to carry out their financial related activities through mobile money services but the feature has also played an important role in helping to develop digital finance and banking. Indeed, it has proven to be one of the most effective forms of banking. This is mostly in the developing countries, where there is little or no access to internet connections and existence of poor infrastructure that have crippled developments in reaching the unbanked populations [6]. Another upside of mobile money transfer is that in contrast to the formal banking system, this form of banking in general requires little operational knowledge and has less strict rules. For instance, formal banking has this “know your customer” rule which did not necessarily apply

to mobile money services before, even though mobile money service providers are now introducing it as it is very important especially on the security aspect of the services. Previously, little information about a user was required from the subscribers who only agreed to the terms of use as per the contract of the subscription.

B. Depositing money

Mobile money users can deposit money to their accounts as they would normally do in a bank. This process is made possible with the help of the agent who operates as a teller and does the transaction for the user. Once the money is deposited with the agent, a confirmation of the transaction is sent via SMS to the user with information of the balance in the account.

C. Mobile money transfers in Africa

The use of mobile phones for mobile money services is not a strange topic in the business world today. This phenomenon is fascinating as it is breaking boundaries and geographic constraints to reach borders with unbanked populations. The actualization of mobile money in Kenya, some parts of Africa and Asia is a significant progress to better lifestyles of people in the developing world. [40] talks about mobile banking and states that it has staged a true “revolution” in access to finance. He adds on to state that mobile money transfers introduced by mobile service providers are bringing the unbanked populations in rural Africa into the formal economy using mobile phones. Despite the challenge of illiteracy in the rural African areas, mobile phones are more accessible and easier to use [5], therefore promoting the rapid spread of financial aptitude among users in the rural areas. The ubiquity of technology in Africa is limited due to poverty and other factors limiting the effective use of technology. However, use of mobile money is not only evident among the poor populations in Kenya and South Africa but also in Tanzania, Zambia, Uganda, Zimbabwe, Nigeria, Democratic Republic of Congo (DRC) and many other more. The following are some of the other mobile money services in Africa.

- **M-Pesa:** M-Pesa is a mobile phone-based money transfer, financing, and microfinancing service, launched in 2007 by Vodafone for Safaricom and Vodacom, the largest mobile network operators in Kenya and Tanzania.
- **MTN mobile money:** To mean Mobile Telephone Network is a service provider with its head office in South Africa. It operates in 21 countries across the Middle East and Africa.

- **CelPay:** This is a mobile banking company operating in Zambia, Zimbabwe and Tanzania.
- **Msente:** This is a mobile money transfer service similar to M-pesa operating in Uganda.
- **Orange Money:** Orange Money is the mobile money service of Orange S.A., available in most of the group's affiliates in Africa.

1.1.2 Mobile Money Services Architecture and designs

A. Money Representation Style

The way existing mobile money solutions represent money in mobile phones (as a positive rational number) is an obvious barrier to illiterate users. This is compounded by the fact that each country in the world has money bills with different metadata elements embedded in them. Metadata elements have different purposes and functionalities, which vary from country to country. For example, in Zambia money bills are color coded and enable illiterate individuals to differentiate between the various denominations of the bills. Moreover, countries can embed images or icons reflective of their respective national identities.

B. Banking Infrastructure

Existing architectures require transacting parties to have bank accounts, which is not the case in many rural areas, Zambia being no exception. Most of the Zambian people, in urban or rural areas, as well as most rural people have no access to financial institutions like banks, microfinance organizations, and insurance companies. In addition to this, using bank accounts for micropayments is infeasible and inappropriate [4].

C. Digital Liquidity

One of the key requirements for the existence and flourishing of a mobile payment ecosystem is digital liquidity, which is the ability of the local economy to support mobile money service platforms and making sure they *stay digital*, without converting it into cash and then into digital money. For this to happen and to ensure that it remains the norm, the ecosystem demands various requirements; a dramatic increase in the number of places where a mobile money user can make deposits and withdraws, more places where a mobile user can make mobile payments without the need to convert to cash, the ability to transact with digital money irrespective of their digital literacy, and that such transactions are done easily and at minimum cost.

D. MNO-centric payment models

Existing bank account and mobile network operator (MNO)-centric payment models and architectures are also inappropriate for proximate (face to face) payments. The cost of subscribing to payment service providers (mobile network operators, banks, or any other third party) can also be a discouraging factor for people, particularly as most live on less than \$2 a day [27]. Moreover, there is no need to incur SMS costs for proximate (face to face) payments, as well as micro-payments and transfers that happen, say, in shops.

1.2 Statement of the problem

Illiteracy is a major challenge in developing countries like Zambia. The adoption and use of ICT based applications by the illiterate people of a developing country (like Zambia) is very essential to reduce the digital inequality and the digital divide for the social and economic development. Interoperability is the ability of users of different mobile money services to transact directly with each other. Given the technical, strategic, and regulatory complexities that such transactions entail, no mobile money platforms are fully interoperable with each other yet. However, many mobile money services allow users to send money to nonusers (who receive the transfer in the form of cash at an agent). Mobile money service was developed with the goal to provide banking services to the less privileged people in developing countries that cannot afford to own or maintain a bank account. With an increase in the demand for mobile banking services, there has been massive innovation to make sure that the demand is met and to ensure that users are fully satisfied with the service. Modern mobile money applications are not user friendly for users who cannot read and write, they find it difficult to use mobile money service applications and currently, users do not have a platform that enables the ability to send money to other networks and the receiver being able to receive funds directly credited in their respective mobile money accounts to which they are registered. The three main Mobile money service providers in Zambia are Airtel Money, MTN Money and Zamtel Kwacha. To Send Money from one service provider to another, one must visit an agent registered with the other service provider and physically deposit the money into the account of the receiver on a different network. It is therefore important that a system is developed to enable interoperability of mobile money service providers. Thus, this study focuses on the development of an android mobile application that enables the service of transferring money to any mobile money service provider and the receive being credited fund into their account instantly.

- i. To Send Money from one service provider to another, one must visit an agent registered with the other service provider and physically deposit the money into the account of the receiver on a different network.
- ii. Mobile money platform allows customers to send money to other networks via the “Send to unregistered subscribers” option, However, Recipients still must use the network of the sender to cash out the money.
- iii. Current system does not allow the recipient to receive money directly in their registered mobile money account. There is a latent demand for cheap and reliable money transfer services [2].

1.3 Purpose of the study

The purpose of the study is to develop a mobile application that will enable interoperability of mobile money services for illiterate users in Zambia.

1.4 Main Objectives

The objective of this research is to develop a usable and adaptable mobile application focusing on interoperability of mobile money for illiterate people in Zambia. To achieve this objective, firstly, a conceptual framework will be proposed based on the findings of the literature survey and a need finding study, while the need findings study will be replicated with 20 illiterate people. Secondly, an android based mobile application with user-intuitive user interface will be developed. To make the interface intuitive for illiterate people, it will encompass icon, pictography and a minimal text-based displays.

1.5 Specific Objectives of the Study

1. To investigate the type of money transforms available in Zambia and ascertain number of users on those platforms.
2. To develop an Android mobile application that will enable all users including illiterate users of all walks of life to send money instantly between two or more mobile money service providers.
3. To integrate the mobile money application with Zamtel Kwacha and MTN Money.

1.6 Research questions

The study will be guided by the following research questions.

1. What type of Mobile money transfer platforms are currently in existence and what is the number of users that can use the current mobile money platforms without challenges?
2. What policies exist currently that hinder advanced innovation of interoperability among the mobile service providers? And what can be done to improve the available mobile money service platforms to accommodate users who cannot read and write?
3. What programming languages will enable the designing of a fully developed system to enable interoperability of mobile money services.

1.7 Significance of the study

Access to basic financial services is a major challenge in developing countries like Zambia. The majority population do not have access to financial services to allow for sending and receiving money for their immediate use like medical emergencies and other urgent matters that may arise. The importance of this study is that not only will it offer a more efficient way of transferring money across other networks, but it will also lead to more innovations in improving the services of Inter- Mobile Money transfer which will enable illiterate users to benefit from the service. This will create convenience for mobile money users, lower cost of transaction, increase service reach, reduce reliance on cash, 24/7 access to funds in wallets and drive financial inclusion through industry collaboration [1].

1.8 Conceptual framework

Interoperability gives mobile money users the ability to send money directly from their wallet to the receiver's wallet in real-time thereby cutting out intermediary steps. This entails that a user can send money across mobile money networks seamlessly, making it very convenient and cost-effective. On the other hand, interoperability gives service providers the opportunity to increase digital transaction volumes, improve the sustainability of their mobile money services and to contribute towards an open digital ecosystem which promotes financial inclusion.



Figure 1.2 Conceptual Framework

The mobile application will be designed in such a way that the user interface will accommodate illiterate users. From figure 1.2 above, John wants to send money to Nancy using the mobile application, He will be able to select which network he wants to send money to as shown, In this case, Nancy is on MTN Money therefore, MTN logo will be selected. A display with kwacha notes and photos of recipients will appear, John must drag the kwacha note he wishes to send to Nancy and drop it on Nancy's photo. A display for confirmation will appear and upon confirming, Nancy will receive money into her MTN mobile money account directly.

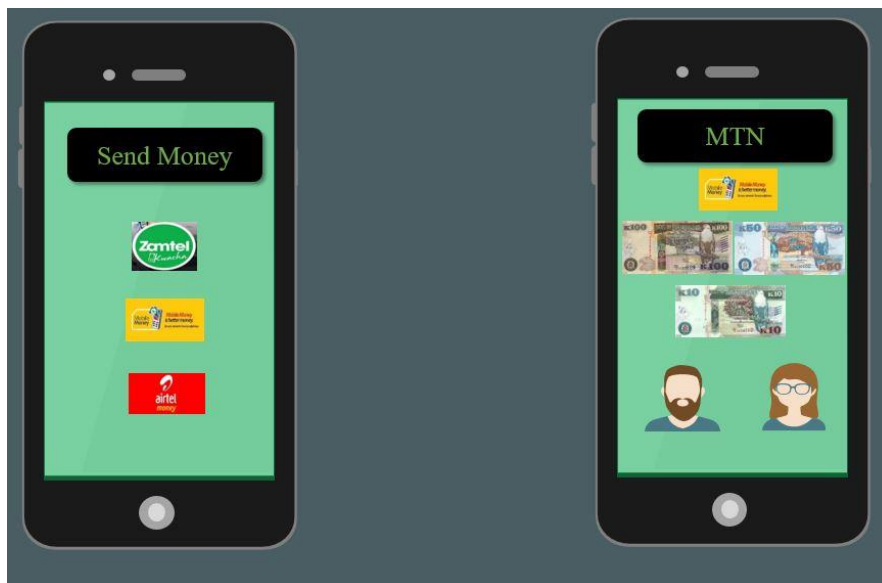


Figure 1.3 Inter-Mobile money transfer between John and Alice

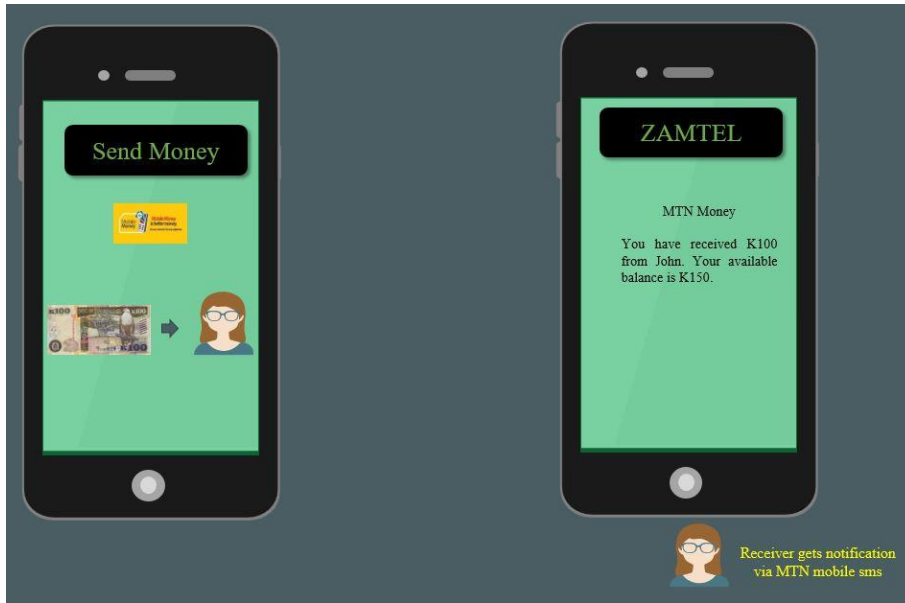


Figure 1.4 Inter-Mobile money transfer between John and Alice Notification

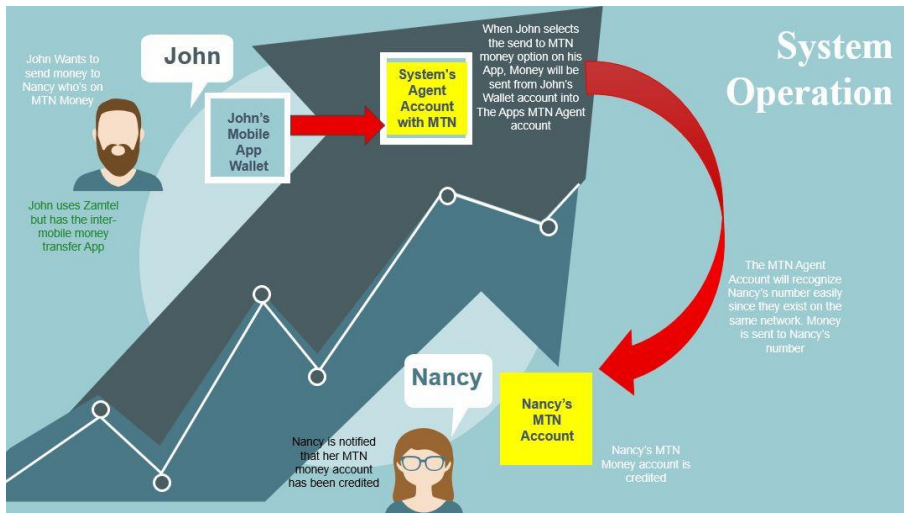


Figure 1.5 Conceptual Design of the system

1.9 Scope of the study

The scope of the study will focus on Zamtel kwacha and MTN money which are mobile money services owned by telecommunication companies ZAMTEL and MTN Zambia respectively.

1.10 Delimitation of the Study

The study will be limited to demonstrating interoperability of mobile money services between the following two mobile money service providers;

1. Zamtel
2. MTN Zambia.

This study will focus on developing a system that is user friendly enough to accommodate illiterate users in Zambia.

1.11 Operational Definitions

Unless otherwise stated, the following are the meanings for the key terms that will be used in this study;

Agent: A person or business contracted to process transactions for users.

Interoperability: The ability of users of different mobile money services to transact directly with each other.

Know your customer (KYC): Procedures taken by the service provider to identify a customer.

Mobile money: A service in which the mobile phone is used to access financial services.

Mobile money account/ mobile wallet: An e-money account that is primarily accessed using a mobile phone that is held with the e-money issuer.

Mobile money transfers: Transaction made from a mobile wallet, accrues to a mobile wallet, and/or is initiated using a mobile phone.

Mobile network operator (MNO): A company that has a government-issued license to provide telecommunications services through mobile devices.

Mobile payment: A transaction made from a mobile wallet, accrues to a mobile wallet, and/or is initiated using a mobile phone.

P2P: A transfer made from one person to another person.

P2B: A transfer made from one person to a business.

Unbanked: Customers, usually the very poor, who do not have a bank account or a transaction account at a formal financial institution.

Underbanked: Customers who may have access to a basic transaction account offered by a formal financial institution, but still have financial needs that are unmet.

Unregistered Users: Customers who use mobile financial services primarily over the counter.

1.12 Chapter Summary

This chapter presented an introduction to the study, background of the study, statement of the problem, aim of the study, research objectives and research questions. Additionally, it explained the significance of the study and delimitations. More so, the conceptual and operational definition of terms, the conceptual theory and summary of the chapter.

2. CHAPTER TWO: LITERATURE REVIEW

2.0 Overview

This chapter focuses on the literature reviewed and all the related studies to this research in Zambia, the Sub-Saharan region and the rest of the world. Firstly, we explored an extensive review of the origin of mobile money services in Africa and the impact it has had over developing countries across the continent and Asia. The review begins with looking at the available literature on the topics from outside Zambia and further focuses on the African continent and Zambia in particular. This was followed by the review of the interoperability of mobile money services in Africa, the status quo in Zambia and the organisations involved in bringing the concept of interoperability to life. The review also looked at how the concept of mobile money services work and some of the major challenges and opportunities that it comes with. The chapter closes by looking at factors that influence the choice of mobile money services and the conceptual and theoretical framework used in this research.

2.1 Introduction

The lack of access to basic financial services is a contributing factor to poverty throughout the world [17]. Many people live without access to basic banking services such as saving and electronic payments, simply because they live hours or days away from the nearest bank. Lack of these services makes it very difficult for the poor to send, receive funds and also to save for future or prepare for unforeseen circumstances. Accordingly, providing banking through mobile phone networks providers offers the promise of dramatically improving the lives of the world's poor. The M-Pesa system in Kenya [14] pioneered the mobile money service model, in which agents (usually local shopkeepers) act as intermediaries for withdrawals, deposits, and registrations. Both agents and users interact with the mobile money system via USSD (Unstructured Supplementary Service Data) and SMS (Short Message Service) or a special application menu enabled by code on a SIM card, enabling users to send money, make bill payments, top up airtime, and check account balances. The key feature of M-Pesa and other systems is that their use does not require having a previously established relationship with a bank. In effect, mobile money systems are bootstrapping an alternative banking infrastructure in areas where traditional banking is impractical, uneconomic due to minimum balances, or simply non-existent. M-Pesa has not yet released a mobile application but is arguably the most impactful mobile money system and highlights the promise of branchless banking for developing economies. Mobile money has become ubiquitous and essential. M-Pesa boasts

more than 18.2 million registrations in a country of 43.2 million [13]. In Kenya and eight other countries, there are more mobile money accounts than bank accounts. As of August 2014, there were a total of 246 mobile money services in 88 countries serving a total of over 203 million registered accounts, continuing a trend [16] up from 219 services in December 2013. Note that these numbers explicitly exclude services that are simply a mobile interface for existing banking systems. Financial security, and trust in branchless banking systems, depends on the assurances that these systems are secure against fraud and attack. Several of the apps that we study offer strong assurances of security in their promotional materials.

2.2 Mobile Money

Mobile money is a service that allows users to send, receive, save and make payments using a mobile phone. The service is available to both mobile and non-mobile users. Statistics show that a high percentage of Zambia's population are "unbanked" meaning they conduct their transactions outside the banking sector with no access to financial services. Products like "mobile money," that enable safe and secure money transfers without the use of a bank account, could have a major impact on this unserved segment of the population. Mobile money gives anyone with a mobile phone the ability to transfer money, make cash payments and conduct other financial transactions over the phone. According to the 2019 annual ZICTA report [7], the value of mobile money transactions more than doubled from ZMW 22.2 billion recorded at the end of 2018 to ZMW 49.6 billion at the end of 2019 reflecting an increase of 123.4 percent.

In many cases, as is the case in Zambia, the perceived lack of financial service provider presence (bank branches, ATMs, PoS, etc) in deep rural areas, low levels of cash circulating in rural areas, poor power supply, limited retail presence and the high cost associated with investing in alternative technological solutions such as smart cards, fingerprint biometrics and even "banks on wheels" combine to leave governments and funding agencies with few reliable choices for digital financial services at a national scale. However, over the years, mobile money, has emerged as a key and promising system for both banking and payments across Zambia and the rest of Africa. The rapid growth of Zambia's mobile money agent network is helping to fill gaps in the provision of financial services and increase financial inclusion across the country.



Figure 2.1 Mobile Money Booths [29].

According to UNCDF State of the Industry 2018 (Zambia), mobile money operators report that the percentage of adults with an active Digital Financial Service (DFS) account grew by 89% from 2017. This includes active mobile money users. The number of active mobile money agents also more than doubled from 22, 965 in 2017 to 46,747 in 2018. Despite this giant leap, there is still a need to improve access to and usage of DFS among new and existing customers with what promises to be a new frontier in the fast-growing digital economy: mobile money interoperability. Presently, mobile money users can only transact with others on the same platform. This proves to be a challenge when a mobile money user would like to transact with another who is on a different platform or when they are in an area where only certain mobile service providers exist. Hence lack of interoperability has been cited as one of the major barriers to the advancement of mobile money and subsequently, financial inclusion. Zambia's effort to enhance payment systems through implementation of a National Financial Switch (NFS) is one step towards extending access to digital financial services and enhancing financial inclusion. Low-value accounts examined in many Sub-Saharan countries found that effective interoperability in digital financial services depends on doing three things well [28];

- **Governance and operating rules.** Rules should be in place to establish how respondents in the interoperability arrangement will make decisions, jointly manage operations, and consider risk.
- **Business agreements and incentives.** Agreements should balance the economic interests of respondents, from pricing to brand marketing, to incentivize the exchange of payments.

- **Technical integration.** The technical infrastructure connecting respondents, anything from a payment switch or bilateral connection to a third-party service, should be sound.

2.2.1 Types of Mobile Money Services in Zambia

In Zambia, some telecommunication companies mainly operate Mobile Money. These include Zamtel, Airtel and MTN. Apart from telecommunication company mobile money services, Zoono is another mobile money transfer service that was among the first ways of money transfers in Zambia. Mobile Money operates under each company through brand names like Zamtel Kwacha, MTN Mobile Money and Airtel Money. Most of these companies' partner with banks to undertake the service. It operates through authorised merchants and agents who facilitate the service on behalf of the partner bank.

2.2.2 How Mobile Money Works

Mobile money is a new mobile financial services product that allows you to use your mobile phone as a mobile account. It provides an affordable, fast, convenient and safe way to send and receive money, buy airtime credit, pay for goods and services using a mobile phone anywhere in Zambia. Customers can deposit and withdraw money from their mobile phone with any of our authorized Agents of the various service providers. Customers are not required to hold a bank account to use the service. The steps involved in any mobile money transaction at any of the network operators' agents are as follows:

- Customers must first sign up for the service at any Agent for their network. They sign up using their phone numbers as their new mobile money accounts and sometimes an ID card will be requested.
- The customer would be required to get a pin number for the account, which is usually a set of four distinct numbers. This number would be known only to the user of the account and would provide entry into the account.
- After the account is activated, customers can deposit cash into the account at zero cost or for free depending on the network providers. With money in their account, the customer can use their mobile phone to send money, buy airtime credit or pay bills at any time, from anywhere and to anyone in Zambia.
- To withdraw money from the account, the customer visits a mobile money Agent or their network provider's service centre and withdraws cash from his or her account.

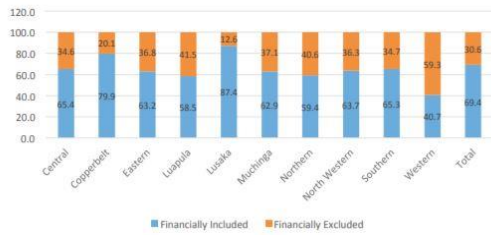
2.3 Financial Inclusion in Zambia

Financial inclusion is providing financial services to the commercial and retail customers who are excluded from the system at a cost which is affordable and easily available to them. Financial services are delivered primarily by banks along with other financial institutions like mobile money, supermarkets, post office, insurance companies, brokers, investment funds etc collectively known as the financial sector. This financial sector development brings down information and transaction cost playing an important role in mobilizing savings, disbursing credit, facilitating payments and risk management to enhance economic growth leading to reduction in poverty [44]. The overall goal of this study is to develop a system that will contribute positively to financial inclusion in Zambia.

2.3.1 Bank of Zambia Finscope 2020 survey topline

The Financial Scoping (FinScope) Survey is a research tool developed by the FinMark Trust to address the need for credible financial sector information. The aim of the survey was to provide strategic information regarding market opportunities, challenges, and financial services, thereby enabling providers to extend their reach and broaden the range of services they offer. Implementing FinScope surveys over time further provides the opportunity to assess and measure the level of financial inclusion in a country. The Bank of Zambia implemented the FinScope 2020 Survey, in collaboration with Financial Sector Deepening Zambia (FSD Zambia), Rural Finance Expansion Programme (RUFEP), German Savings Banks Foundation for International Cooperation (SBFIC), United Nations Capital Development Fund (UNCDF), Ministry of Finance, Pensions and Insurance Authority (PIA), and Securities and Exchange Commission (SEC). The Fin-Mark Trust provided advisory support whereas the Zambia Statistics Agency (ZamStats) provided technical expertise and the structures for data collection. The main objective of the Survey was to determine the levels of access to and use of financial products and services by the adult population and provide policy information needed for the development of the financial landscape [8].

Financial Inclusion by Province (Percent)



At provincial level, financial inclusion was highest in Lusaka (87.4%) and Copperbelt (79.9%) provinces and lowest in the Western Province (40.7%).

Trends in Financial Inclusion (Percent)



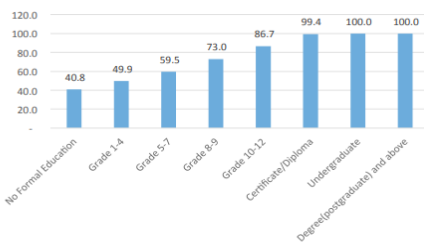
Financial inclusion rose by 10.1 percentage points to 69.4% (6.4 million adults) from 59.3% (4.8 million adults) in 2015. Financially excluded adults decreased to 30.6% (3.1 million adults) from 40.7% (3.3 million adults) in 2015.

Figure 2.2 a) Financial Inclusion by province

Figure 2.2 b) Trends in Financial Inclusion

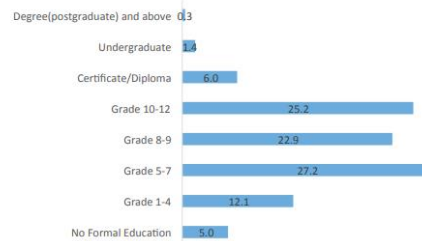
Figure 2.2 (a) shows the financial inclusion at provincial level, financial inclusion was highest in Lusaka (87.4%) and Copperbelt (79.9%) provinces while recording the lowest in the Western Province (40.7%). Figure 2.2 (b) shows the financial inclusion trends by percentage, the rise by 10.1 percentage points to 69.4% (6.4 million adults) from 59.3% (4.8 million adults) in 2015. Financially excluded adults decreased to 30.6% (3.1 million adults) from 40.7% (3.3 million adults) in 2015 [8].

Financial Access Strands by Level of Education (Percent)



Financial inclusion was highest for adults with tertiary education; while Adults with no education had the lowest level of financial inclusion at 40.8%.

Distribution of Adults by Level of Education (Percent)



Of the adult population, 48.1% (2015, 44.7%) had secondary school education and 39.3% (2015, 37.8%) had primary education: and Only 7.7% (2015, 11.1%) had tertiary education.

Figure 2.3 a) Financial Access

Figure 2.3 b) Adults by Level of Education

The financial access by level of education illustrated in figure 2.3 (a) shows that financial inclusion was highest for adults with tertiary education while Adults with no education had the lowest level of financial inclusion at 40.8%. Of the adult population, 48.1% (2015, 44.7%) had secondary school education and 39.3% (2015, 37.8%) had primary education: and Only 7.7% (2015, 11.1%) had tertiary education as shown in figure 2.3 (b) [8].

2.3.2 Interoperability

Interoperability refers to the basic ability of computerised systems to connect and communicate with one another readily, even if they were developed by widely different manufacturers in different industries. Being able to exchange information between applications, databases, and other computer systems is crucial for the modern economy [29]. FSD Zambia has been supporting the BoZ to implement interoperability [29] since 2016. This support has seen the formation of the Payment Association of Zambia (PAYZ) aimed at bringing together all MMOs. Zambia Electronic Clearing House Limited (ZECHL), the interoperability Project Manager will deal with non-bank participants in phase II and PAYZ will work at self-regulation within its membership like the Banker's Association of Zambia (BAZ). From the developments laid out above, interoperability is in its advanced stages towards implementation. Seeing that the first phase is almost completed, careful attention should be given to supporting non-bank participants in achieving connectivity into the NFS. In countries like Tanzania, Kenya and Uganda, the wave of interoperability began with agents becoming interconnected, meaning a customer could transact at any other operators' agent without restriction. It is yet to be seen how mobile money interoperability will be rolled out and how quickly benefits will be seen but the prospects of having this interoperability happen is an exciting phenomenon for FSD Zambia in its quest to support increase in financial inclusion; and more so for mobile money users who will now have an opportunity to transact across different providers and wherever there is a mobile money agent. With this in place, we can expect Zambia to be well on its way towards a new wave of increasing financial inclusion through mobile money. Further, as the National Financial Inclusion Strategy (NFIS) targets an overall increase in financial inclusion from 59% to 80% by 2022, this can be achieved by government migrating key payment streams (notably government-to-person (G2P) and person-to-government (G2P) onto such mobile platforms in order to increase usage and demand. This is one step towards making this a reality.

2.3.2.1 Significance of interoperability to mobile money customers?

Interoperability solutions make it possible for users to access services from two or more service providers under one platform. In simpler terms, interoperability of mobile money services enables users to send money between any two or more service providers. Greater interoperability of financial services, including across mobile money accounts, stands to accelerate growth in Africa. The objective of interoperability of mobile money services is to

encourage the everyday usage of mobile money by unlocking access to a diverse payment ecosystem beyond the individual user's own provider.

2.3.3 Related Works

Researchers have performed some studies which have findings relevant for this research. The following are some of the important findings:

a. Mobile solutions for illiterate users.

A 2015 research study was conducted in Ethiopia that illustrated the importance of accommodating illiterate users when designing mobile solution platforms. The research revealed that by applying user-centered requirements gathered in an Ethiopian context, a design of a mobile money solution that targets illiterate people was developed. The research particularly emphasized on how illiterate users deal with cash money in their everyday life and how such practices could be mapped into financial technology design. The mobile solution proved to be a relatively inexpensive and open-source android mobile web platform. The proposed system enabled illiterate individuals to count money bills, while providing the facility to accept and make payments [47].

b. Uses of Mobile Money:

A 2012 survey conducted among 2,980 households in Tanzania revealed that the general perception about mobile money usage by registered users both in the urban and rural areas is that the service is for sending or receiving money. Interestingly, 55% of nonusers also think the service is for sending or receiving money only. Despite the general belief that mobile money is used for transfer and receiving money, it is the second most popular means of savings in Tanzania and in Kenya [55]. Aside using mobile money for remittance purposes, in Tanzania 14% of the 2,980 households surveyed use it for non-remittance purposes such as school fees payments, government fees and taxes, utility bills, and salaries. This is followed by 12% of users who use the platform to purchase goods and services in shops [56]. The general uses of mobile money in the middle to high income countries such as Brazil, Sri Lanka, Thailand, and USA are for transport fare payment. Mobile money transfers (P2P) is considered the least usage [57].

c. Mobile Money Transactions

Another study in Kenya [58] revealed that to do mobile money deposit (cash, in this instance) or transfer funds through an agent, the user must provide a form of an ID, as a way of “know-your-customer” (KYC).

d. Educational background of mobile money users:

From a study conducted in Kenya [55], it was concluded that mobile money users are more likely to be literate than non-users. This was also confirmed in another study conducted in Tanzania, which revealed that the more educated individuals are, the more likely they are to use mobile money. Out of the 2,980 households surveyed, 65% had primary education, 22% had secondary education while 14% had no formal education [56].

e. Mowali

Orange Group and MTN Group, two of Africa’s largest mobile operators and mobile money providers launched a joint venture called Mowali, to enable interoperable payments across the African continent. With over 338 million registered accounts, mobile money is the most widely held type of digital financial service account in Sub-Saharan Africa. The ambition of Mowali is to build on this success, helping Africans to gain access to best-in-class digital financial services through the convenience of their phone [32].

2.4 User Interfaces and Integrated Development Environment

2.4.1 Types of User Interfaces

The user interface is a computer-mediated means to facilitate communication between human beings or between a human being and an artifact [47], it consists of information output from the machine, as well as a set of control elements for the user to perform certain actions. These interactions enable an efficient system where machines aid the user’s decision-making process and, in turn, the user can effectively operate it. When building the UI, the goal is to make it self-explanatory and user-friendly so that users can quickly achieve the desired results. The growing dependence of many businesses on web and mobile applications places an increased priority on designing good UIs.

The following examines the relationship between users and different types of interfaces to help us understand where to use a specific kind of UI.

I. Graphical User Interface

Advantages of a Graphical User Interface

- i. Suitable for non-technical users
- ii. The complexity of actions is hidden from the users.
- iii. Enhanced by attractive visuals.
- iv. Immediate visual feedback
- v. Leverages models and imagery from the real world
- vi. Enables usage of multiple input devices.

Disadvantages of a Graphical User Interface

- i. Requires power and memory resources.
- ii. Might have low discoverability.
- iii. Might overwhelm users with the growing amount of control elements.
- iv. Hidden commands need to be searched intentionally.

This type of UI often contains multiple menus and other elements that are unique to the GUI, such as keyboard and mouse interactions. It should work quickly and consistently, take up an adequate amount of system resources, have predominantly understandable elements to inexperienced users, and meet several other requirements. It should have an extensive manual dedicated to the program's functions [46].

Here are the features that will be useful:

- i. Tooltips on menu items and button icons.
- ii. A global search for functions and settings.
- iii. Separation between program functions via different types of menus (pop-up menu with a right-click, quick-access buttons, drop-down menu).

II. Touchscreen Graphical User Interface

The Touchscreen Graphical User Interface requires users to interact with the device with their fingers. It has become a commonly used option due to the popularity of portable devices. The main differences from ordinary GUI are the support of swiping, hold click (often equivalent to the right mouse click), and some other features like a two-finger-tap gesture to zoom/rotate an

object. Overall, there are multiple pointing actions that users can utilize: length of motion, change in direction, change in velocity, lack of motion, path start and endpoints, pointing, tapping, looping, and time-based motions.

Advantages of a Touchscreen Graphical User Interface

- i. Easier and quicker than manipulating a mouse or typing.
- ii. Avoids external devices such as a keyboard or mouse.
- iii. Possibility of adding various motion actions.
- iv. Accessible to children and elders.
- v. Zoom-in gestures promote accessibility for visually impaired.
- vi. Adaptable to a wide range of devices.

Disadvantages of a Touchscreen Graphical User Interface

- i. Control elements size is limited by mobile display size.
- ii. Additional motions may not be easy to discover.
- iii. May be unnecessarily activated by stray touches.

Touchscreen Graphical User Interface can be used in a variety of ways, except for the forms that involve entering a lot of text, which is highly inconvenient for users. Use UI elements like drop-down select and bullet-select, switch, or others similar that act like a button.

Appropriate scaling is also important. UI elements should not look huge on bigger displays; at the same time, users should be able to press the buttons comfortably on smaller devices. Make sure to space out buttons to prevent accidental clicks. Lastly, use touch-related design patterns such as swipe-to-delete or a shortcut to the menu by swiping from the left [46].

III. Menu-Driven Interface

The menu-driven interface employs a series of screens, or “menus”. When a user selects by clicking/tapping on the list format or graphics, it takes them to the next menu screen until they complete the desired outcome. An example is the settings menu on a mobile phone. All that one can do is scroll the menu and tap items; no other interaction is available. Accordingly, it is

used in applications with a familiar, limited, and uniform set of functions. One could put them all under subheadings like “Camera Settings”, “Display Settings”, etc.

Advantages of a Menu-Driven Interface

- i. Handy for computer beginners and novice users.
- ii. Low cognitive load on users.
- iii. Familiar interface across different platforms.
- iv. A developer is in-charge of creating an order and a hierarchy for user pathways.
- v. More control over user interactions.
- vi. Simple to implement in various kinds of devices.

Disadvantages of a Menu-Driven Interface

- i. Limited menu options.
- ii. Sub-menus might be difficult to find.
- iii. Risks of taking up a lot of screen space or being too small.
- iv. Requires unnecessary actions for a simple task.

Menus are a very intuitive interface because of its limitations. One can scroll through the top completely and get a rough idea of what one can do. However, this is what one can build theoretically. In practice, one could mess it up. One could create a menu consisting of headings like Settings, Parameters, Tools, Customization, which absolutely won't be helpful to users. There is no indication of what a heading does and why one needs four separate ones for what seems like the same action. The menu interface should be well-thought-out so that one can understand what the titles will lead to. Otherwise, the UX will suffer, and one will force the users to click through all the menu items to find the right one [46].

IV. Command Line Interface

A Command Line Interface (CLI) is a text-based user interface used for entering commands or for interacting with PC on a low abstraction level [46]. Generally, this type of menu is not intended for the average user. It is mostly used when working with cloud services or carrying out system administrators' responsibilities. Many programs and services often have a CLI in addition to a GUI to facilitate automation of tasks. When using bots or communicating across

programs, it might be inconvenient to press buttons in the graphical interface. It is much easier to instruct the computer to run a specific console command. An example of CLI that people are most familiar with is a terminal of any operating system (Windows, macOS, Linux).

Advantages of Command Line Interface

- i. Faster than other types of user interfaces.
- ii. Less CPU processing requirements.
- iii. Works with a lesser resolution screen.
- iv. Easily scales in size.
- v. Possibility to convert repetitive tasks into one command.
- vi. Ability to trigger cross-application interactions to perform complicated actions.

Disadvantages of Command Line Interface

- i. Requires experience and/or programming skills.
- ii. Typos in command syntax result in errors.
- iii. Usually accepts only keyboard input type.
- iv. Not intuitive – requires reading the manual before using it.

When building a CLI, the developer must keep in mind of the target audience, those who have some experience working with the console. Members of the target audience include programmers, system administrators, and regular users of Unix-based systems. However, even experienced users will need some guidance to figure out how to operate the program. CLI is considered the least intuitive type of UI, so the developer must make sure that the console commands include manuals and instructions. Also, it is important to ensure correct error handling. If the user submits insufficient parameters to the command or makes a syntax error, it should return an error message. The message should contain enough information to indicate where the problem occurred and offer a manual reference with an example of how it should be used.

V. Conversational UI

Modern technology is mostly visual, but conversational UI takes advantage of words and language-based communication being as useful, if not more. Conversational UIs allow users to

interact with computers simply by telling them what to do. It can be verbal or voice-controlled or written. To employ the first type, the software should have voice recognition capabilities. Depending on the complexity of a given tool, it could support rather structured input such as “set a reminder for tomorrow morning” or more casual queries such as “I need something to entertain a group of kids for three hours”. The invention of this technology signified that users have the option to hold a human-like conversation with their device instead of using computer-specific language. This interface is powered with learning and self-teaching abilities that make them more useful the longer one uses them [46].

Advantages of a Conversational UI

- i. Versatile in applications.
- ii. Can be integrated into existing applications.
- iii. Voice provides a realistic feel.
- iv. Connects with users on a personal level.
- v. Responds with context to build interactions.
- vi. Adapts to gender, tone, accent, and pace of speech.

Disadvantages of a Conversational UI

- i. Limited amount of visual and textual clues.
- ii. Articulating commands might be complicated.

One needs to prevent any conversational dead-ends. Otherwise, the user will feel discouraged because of their inability to operate the software, or they will be frustrated that the developers did not account for all conversation outcomes. In either case, they are less likely to use the service again. It is therefore encouraged to make messages concise. Even if one is tempted to answer with exhaustive information, it is better to base the conversation on turn-taking that will smoothly progress the dialog. Leverage the tone and personality characteristics in the words and actions of the UI. Indirect characterization makes the interface more inviting for users. Since people are hardwired to assign persona.

2.4.1.1 Summary

A good User Interface should be easy to use, have intuitive user pathways, allow users to try different options, look pleasing, use suitable colours for key areas, and contain help documentation. To make the right choice, consider what the users need and what will simplify the processes within the application. Plus, assess what the users will be most comfortable with. For some, it might be syntax-specific commands or clicking icons, whereas others will find that talking is the most convenient way of interaction with a computer.

Many developers make the mistake of making application technological in nature without including any social aspect to the interaction. A conversational UI, on the other hand, gives the privilege of interacting with the computer on human terms [46].

2.4.2 Previous Works on User Interfaces for illiterate users

Several researchers have looked at designing user interfaces for illiterate and semi-illiterate users. One paper examines the use of numbers among subjects who are illiterate but not innumerate, and bases menu item indices on numbers [22]. Two pieces of design research make broad user-interface suggestions for illiterate subjects in the absence of a concrete application [12][24]. Finally, one group has looked at designing mobile interfaces for data entry for rural microfinance [21] and another at the interface for a mobile computing device for data entry for health work [23]. Most related work immediately concludes that minimal of text is sensible [12][24]. This is frequently accompanied by audio output [12][22], graphic elements [20][21][42][23], and animation into images to tell a better story [12]. A few also note that numbers need not be taboo, as many illiterate subjects can read numbers fluently [20][21][22]. And, because illiterate users are also infrequent users of computers, some work emphasizes the need for highly relevant content [24] and easy navigability [12] 20][21][23]. This study builds on many of these findings from previous work, but also evolves the ideas further, particularly in approach, design elements, and final implementation. Because this is a relatively new area of research for user-interface designers, interaction with the target user groups is essential. Using contextual design methods like that used by the research in rural microfinance [20][21], the researcher also spent a considerable amount of time with our users.

Most mobile applications pose an accessibility barrier to those who are unable to read fluently. The heavy use of text on everything from menus to document content means that those who are illiterate or semi-illiterate are not able to access functions and services implemented on most computer software and mobile applications. The basic features of what we call a text-free user interface are simple to understand: liberal use of graphics and photographs for visual information, and voice for providing information normally provided via text. Aman and Kentaro [9] presented a user interface designed such that even novice, illiterate users required absolutely no intervention from anyone at all to use, their take was that if the User Interface were designed well, users would not require formal literacy, computer skills, or any external assistance to operate the application. Their research presented two applications which were designed to ferret out the requirements for a text-free user interface. In the first, an employment-search application, the intent was to provide job information to a group of domestic labourers. In the second, a text-free User Interface for maps that allowed illiterate users to answer questions having a geographic dimension. The approach was one of contextual or ethnographic design [10] [11], in which intense interaction with a target community was sought to gain a thorough understanding of their real needs, real traits, and real responses to the interfaces that was designed.

2.4.3 Design Principles for Text Free User Interfaces

The following are some design principles as guidelines for achieving a text-free User interface. We explain these with examples elucidating each principle:

a) Avoid text.

Clearly, less text makes sense for users who cannot read. However, Aman and Kentaro [9] discovered that some users could easily recognize numerals, these numerals could remain in the user interface (at least for certain target users). This is consistent with advice in some earlier work [20] [21] [22].

b) Use semi-abstracted graphics and increase photorealism with deeper interaction.

Aman and Kentaro [9] also agreed that information on the applications had to be in graphical form, since their target users were not generally literate [12][20][21][23]. Frequent iterations with the target community are necessary to ensure that graphical elements are interpreted the way they are intended. Observation was made that users recognized semi- abstract cartoons and more photo-realistic graphics much better than

complex abstract graphics. As users delve deeper into an object to get more information, the representation can become more photorealistic to provide more specific information. In general, users were able to identify both photographs and pure cartoons, but there was a general preference for semi-abstract cartoons. Some actions may require a visual representation, or they would be taken as static representations of location or object [12] it was discovered that they were better able to identify activities as actions when the cartoon included standard visual cues for indicating motion.

2.4.4 Integrated Development Environment (IDE)

Android is perceived as the best mobile operating system by many developers. It is easy to work with, highly customizable, supported by a large community, and most smartphones operate on it. Despite the popularity, there are no signs the demand for Android apps will decrease in the future. As a result, the demand for using different Android IDEs (Integrated Development Environments) for mobile application development is similarly high. Fortunately, there are many tools and platforms available in the market that can help one build incredible mobile applications. An IDE is an application suite comprised of basic tools that help software developers get the work done consistently and quickly throughout the software development life cycle. Every IDE is a framework that enables developers to build, run, and test applications on mobile devices running Android. The design of IDEs also enables a very comfortable and effective workflow for developers [44].

IDEs can contain a compiler, which translates the language you are coding into Android's Java, and a debugging console, all usable through the same graphical interface. This is where a developer does most of the programming activities like creating, designing, testing, and polishing the mobile application. The following are some of the IDEs used for android mobile application development.

1. Android Studio - The official IDE, based on the community.
2. Eclipse - Before Android Studio, this was the official Android development environment. Used to code Java but can be expanded to other languages via plugins, it is still a powerful tool.

3. IntelliJIDEA - Android Studio is based on this, and this IDE is not only extremely useful, but has a massive number of community-created plugins, making it highly customizable.
4. DroidEdit -An Android text and code editor to use on Android platforms.
5. Android-IDE - A complete web and Android development environment, it also allows one to edit Java and PhoneGap applications.
6. Cordova - Mobile applications with HTML, CSS and JS, it is one of the best tools if one wants to create hybrid applications. Free and open source.
7. Corona - A 2D-development platform with a specific focus on games but can be used to create other types of mobile apps too. One of the best for cross-platform development and 100% free [45].

Most IDEs provide an environment that features a text editor, compiler, debugger, and simulator which are all integrated into one application. They have evolved throughout the years, adding more features (e.g., GUI designer, version control, etc.) that would help the developer in accomplishing their tasks in the most efficient way. For mobile applications development in particular, examples of IDEs that allows plugins for mobile application development are the NetBeans, Eclipse and XCode development environments. A problem with IDEs for mobile application development though is that different mobile phones have different application programming interfaces and platforms. Thus, creating a common application that would run on different platforms of mobile phones tends to get tedious and redundant since developers must develop different code for each of them. One solution to this problem is by applying the model-driven approach in which models are used to describe the application and through transformation tools, these models are transformed to code that would run on specific platforms [48]. An example research that applies MDD is the Multimedia Modeling Language (MML) which is a platform-independent language used for the model-driven development of multimedia applications [49]. MML models are transformed into Flash models which can then later be loaded into the Flash authoring tool for further completion of the application [50].

2.5 Mobile Application Platforms

The two most popular platforms or operating systems that exist for mobile application are the iPhone operating system (IOS) and the Android operating system. When building an application, one must put into consideration which platform will be the best for the application being built. While the goal may be to launch on both platforms eventually, it is risky and expensive to build an application for both iOS and Android simultaneously. Mostly, developers choose to build an application for one platform and then launch the application on the other platform later. There are pros and cons to both platforms, some factors that are considered on choice are audience, revenue goal, desired feature, and budget for maintaining the mobile application. According to Statista [68] Android represents 71.93% of the world market share in terms of mobile operating systems. It has been ranked 1st above iOS, which has the best penetration around the world thanks to the high number of devices constructed. The application in this study will be developed for Android devices.

2.5.1 Overview on Android

Android was originally owned by Android Inc. firm. The company launched their activity in 2003 and aimed at creating a mobile platform that would be more aware of the user's preferences and location. In 2005, Google Inc. acquired Android Inc., which became a subsidiary. In 2007, Google decided to add the open-source characteristic to the Android project by founding a consortium of developers called Open Handset Alliance.

Android has been designed to improve the user experience by being:

1. Free: Android is free of charge as well as its SDK and Eclipse IDE is available on every desktop OS.
2. Complete: it is secure, robust, easily upgradable, developers can fully blend their applications into Android.
3. Open: Android has Apache licensing terms, meaning that developers have access to all features of Android and the device they use [69]

The android system is a Linux-based system while the android operating system is a stack of software components which is divided into five sections and four main layers as shown in figure 2.4.

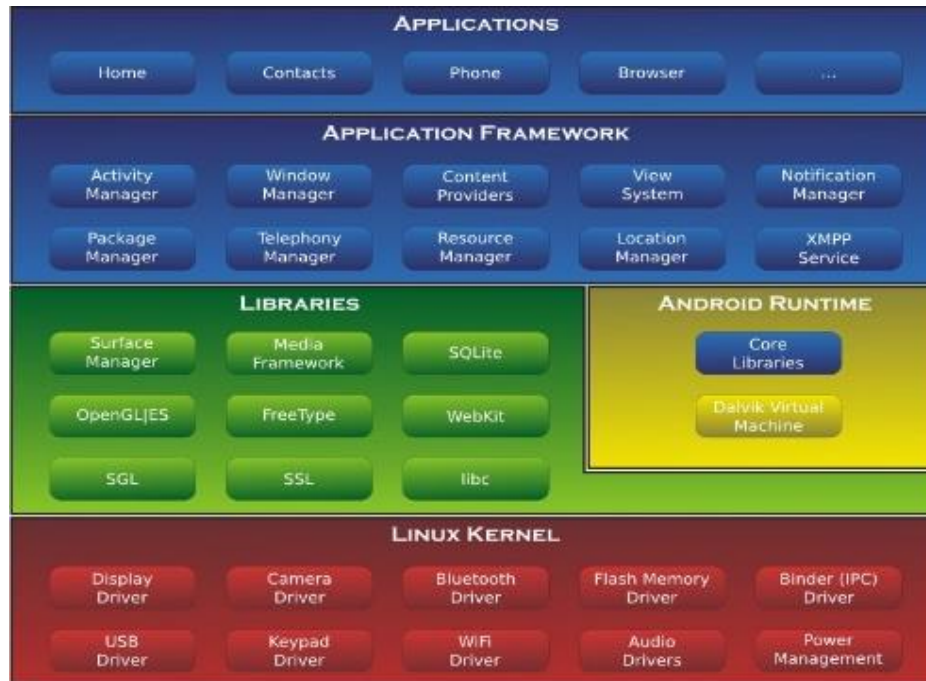


Figure 2.4 Android Architecture Diagram [51]

2.5.1.1 Applications

Android applications are found at the top layer, when one wants to install or write their own application code then they can do it on this layer. Examples of such applications are Browser, Location share, Share Application and Games etc.

2.5.1.2 Application Framework

All the API framework of the core programs can be easily accessed by developers and they can also modify it according to their need. The application framework makes it easier to understand the reuse of its components. If one want to access the functional components of other android application, then they must check whether the Application has released it or not and they have to follow the security of the framework. In a similar way the users can be able to replace the program elements with this reuse mechanism [51].

2.5.1.3 Libraries and Android Runtime

The library is divided into two main elements, the Android Runtime and Android Library. Android Runtime is made up of a Core Java Libraries and Dalvik virtual machine (The Dalvik VM executes files in the Dalvik Executable (.dex) format which is optimized for minimal memory footprint). Most functions of the core java libraries are provided by Core library. The Android system library is also a main connection linking between application framework and Linux Kernel. This system library is enlarged in C or C++ language. These libraries can also be used by the different elements in the Android system [51].

2.5.1.4 Linux Kernel

The Last layer of the android architecture is the Linux kernel. This layer gives a level of speculation between the device hardware and it carries all the required hardware drivers like display, camera, keypad etc. Also, the kernel take care of all the things that Linux is good at such as networking and a huge array of device drivers, which take the burden out of interfacing to peripheral hardware. The kernel system provides the operations like internal storage, process management, internet protocol, bottom-drive, and other core related services [51].

2.6 How Mobile Applications are tested.

Mobile application testing is an activity which is aimed at evaluating quality of a program and for improving it, by identifying defects and problems [66]. In 2020, Android's Google Play crossed two million and seven hundred available applications [68], due to the large number of application users and their expectations from the application to be error free, it is very important to meet the quality criteria of an application.

Following are some of the different testing characteristics used for mobile applications.

- I. Usability Testing: Usability testing is used for activities that assess UI content and alerts, user operation flows and scenarios, media richness, and gesture interaction [61] [62].
- II. Performance Testing: Performance testing is used for the activities to determine the speed or effectiveness of computer, network, software program or device [63] [61] [62] [65].

- III. Reliability Testing: Reliability Testing relates to testing software's ability to function in given environmental conditions for a particular amount of time [63] [61] [65].
- IV. Security Testing: Security testing includes encryption/decryption techniques to ensure the data communication, checks for multi-user support, and checks within app for the access of files [63] [61] [64] [65].
- V. Memory Testing: 14 Memory testing is used to check how much memory the application is taking. It is also used to check for the memory leakage if the applications are already killed and their active processes are still taking memory [63] [65].
- VI. Energy Testing: Energy testing is used to ensure that the applications do not use more energy than required one. If more energy is taken by single application, then it will reduce the battery life of device [63] [65].
- VII. Interoperability Testing: Interoperability testing involves testing whether a given software program or technology is compatible with others and promotes cross-use functionality [61].
- VIII. Compatibility Testing: Compatibility testing is part of software non-functional tests, is testing conducted on the application to evaluate the application's compatibility with the computing environment [64] [63] [62].

2.6 Factors influencing the choice of Mobile money services.

An individual's choice of a mobile money service system is usually because of certain factors. Discussed below are the factors; Customer's Wealth/Levels of Income, Educational Level, Employment Level, Personal Preferences, Transaction-Specific Factors and Marketing Campaigns.

2.6.1 Customer's Wealth/Income Level

According to Kennickell and Kwast [30], wealth has an important role to play in terms of consumer's decisions on payment choice. Consumer's wealth may influence payment choice and the availability of payment instruments that one can choose. For instance, while wealthy consumers may be able to fund their obligations generally, consumers that experience brief financial shortfalls may not find online bill payment desirable as a payment instrument (Mantel,

2000). In such a situation, the consideration of the risk factor will let some consumers to avoid using pre-authorized transactions.

2.6.2 Customer's Educational Level

The level of sophistication of mobile money applications demands a certain level of literacy amongst users. For example, Kennickell and Kwast [30] have illustrated how education play important role in determining household use of online-money products. Kwast and Kennickell [30] concluded that the US market for such products is still highly specialized, with the demand coming almost entirely from higher income, younger, and more educated households that have accumulated significant financial assets. Educational levels of customers determine whether consumers will adopt online payment or not. Studies have shown that highly educated people patronize online payment products than less-educated people.

2.7 Conceptual and Theoretical Framework

Mobile Money refers to a suite of financial services offered through mobile phones and other handheld mobile devices. These services can include person-to-person transfer of funds, such as domestic and international remittances; person-to-business payments for the purchase of a range of goods and services; and mobile banking, through which customers can access their bank accounts, pay bills, or deposit and withdraw funds [2]

- i. Airtel money allows users to send money to other networks using the short code *778# then selecting the option send to other networks. The recipient receives a unique code which they must present to an airtel agent to withdraw the money [36].
- ii. MTN money allows users to send money to other networks using the short code *303# then selecting the option send to other networks. The recipient receives a unique code called Token ID which they must present to an MTN agent to withdraw the money [41].
- iii. Zamtel Kwacha allows users to send money to other networks using the short code *344# then selecting the option send to other networks. The recipient receives a unique code which they must present to Zamtel Kwacha agent to withdraw the money [39].

2.8 Chapter Summary

This chapter has reviewed the literature on the financial inclusion, Android operating system, user interfaces, interoperability of mobile money services and the aspect of illiteracy in the use of mobile applications. Many factors have been identified by researchers and authors as being responsible for the use of mobile applications for mobile money services. Among these factors are time savings, expenses control, reduced risk of loss and theft, low commissions, user friendly and convenience. The challenges such as security, trust, and infrastructure together with the theoretical and conceptual framework have been reviewed.

3. CHAPTER THREE: METHODOLOGY

3.0 Introduction

This chapter discusses the research methodology that was used in conducting the study. It will be organized under the following sections: System Design, Data Collection techniques and tools, Program development using Android Studio, System integration, System Testing and Report Writing. A research methodology can be described as a way of studying and pondering over a social reality [54]. It describes the systematic way to solve the research problem [8]. Research Methodology should not be mistaken for research methods since there is a striking difference. According to [8], research methods encompass all the techniques used by the researcher in executing research operations including methods of data collection, statistical techniques for analysis as well as the methods used to assess the validity of results obtained. Quantitative and Qualitative approaches are the two main methodologies. Both approaches should not be viewed as opposites instead, they represent different ends on a continuum [71].

3.1 Research Design

Research design is simply the blueprint for conducting the study that maximises control over factors that could interfere with the validity of the findings. Designing a study helps the researcher to plan and implement the study in a way that will be helpful to obtain the intended results, thus increasing the chances of obtaining information that could be associated with the real situation [18]. This study will employ the descriptive quantitative research design. Quantitative research provides a means of explaining phenomenon by collecting numerical data that are analysed using methods that are mathematically based (statistics) [71]. Research is influenced by philosophical worldviews though these worldviews are not explicitly seen in most research works. Underlying paradigms or philosophical assumptions of researchers are necessary and need to be identified in any research work [73]. The underlying epistemology adopted in this study is the positivist pragmatic worldview. The pragmatist approach is flexible and adopts different methods at different stages depending on the research question under consideration and research objectives [70]. Quantitative research provides a means of testing objective theories by examining causal relationship among variables. These variables can be measured typically on instruments so that numbered data can be analysed using statistical procedures [70]. The quantitative research methodology will be appropriate for this study because the types of data generated from this research were predominantly numbers emanating from surveys which were quantitative in nature. Quantitative methods encompass techniques

and designs that produce distinct values or discrete data [74]. Methods that fall into this category include surveys, experiments, case study, grounded theory, action research and design science. Among the various quantitative methods, the Design Science method was adopted due to its appropriateness for the achievement of the research objectives.

The flow chart in figure 3.1 below illustrates how the mobile application works.

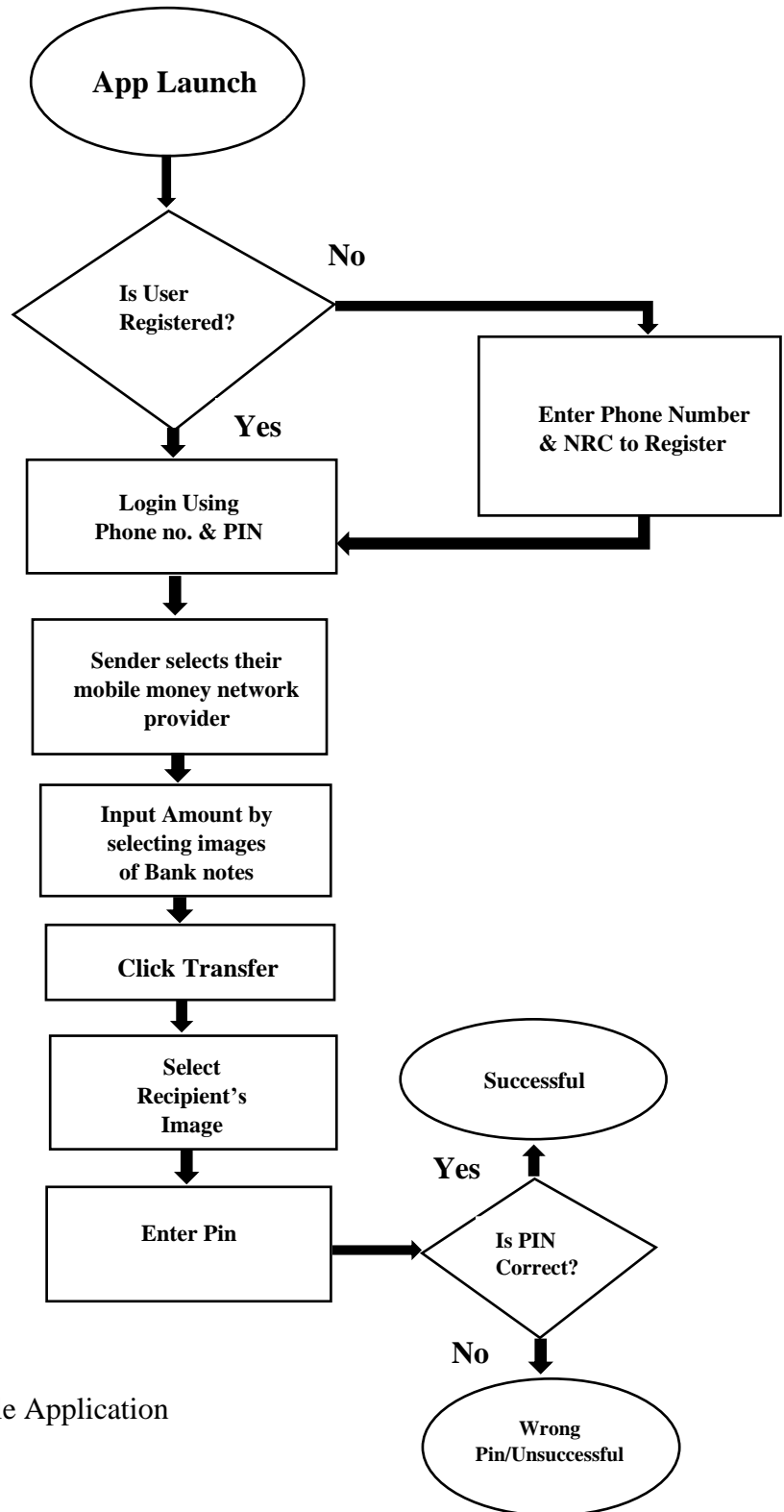


Figure 3.1 Flow Chart of the Mobile Application

Figure 3.1 shows a flow chart of how the mobile application is expected to operate. Upon launching the app, an authentication procedure takes place where the user is asked if they are registered or not, this is done by a prompt which asks for their login credentials and these include their phone number. If the user is not registered, they must register to access the features on the mobile application. After the user has logged into the mobile application, the main menu will be displayed from which the user can select the mobile network they belong to. After selection of their network, the display changes to enable the user to input the amount by selecting the images of money bills. Other options available here is the addition and subtraction of money bills by simply clicking the image of the amount needed to be added or subtracted. When the user is satisfied with the selection of the amount they want to transfer, they select transfer, and the next option allows them to select the recipient's photo from a list of saved recipients on the mobile application. Entering a personal identification number for the authentication process to determine if the transaction is successful or unsuccessful.

According to Kombo and Tromp [23], a research design is used to show how all the major parts of the research project work together to try to address the central research questions [10]. This study will employ descriptive research design. A descriptive study describes the variables around the phenomenon of interest. Therefore, researcher does not have any intention to manipulate the variables or to determine any relationship between the variables around the phenomenon of interest and descriptive research design will also enable the researcher to get the accurate views of the respondents on the topic at hand.

3.2 Mobile Application Development and Tools Used

The development of the mobile application was based on the functional model proposed and the basic features of the system interface was designed. This was designed based on the primary requirements gathered from the user and analysis of secondary data from proprietary reports.

3.2.1 Programming Language and Tools Used

The mobile application was programmed using Kotlin language and the integrated development environment (IDE) tool that was used is Android studio version 4.0. Kotlin was created by JetBrains in 2010, It is a multi-paradigm language, supporting both object-oriented and functional programming paradigms hence it allows developers to combine them, as with most modern languages nowadays. It supports non-nullable types and helps to make applications less prone to null pointer exceptions. It also includes smart casting, higher-order

functions, and extension functions, the language follows the principle of pragmatic evolution, according to three main aspects; (i) to keep the language modern over time, (ii) to keep in constant feedback loop with the users, and (iii) to make updating to new versions comfortable for users.

The growth of Kotlin followed Google's official support announcement in the year 2017. The most important reason for the popularity is due to the full interoperability with Java, as both languages can be used interchangeably, and migration can be gradual. Developers can also take advantage of the Java environment using all its existing libraries and frameworks, while taking advantage of modern language features. Moreover, its adoption by the Android community was reinforced by the Stack Overflow developer survey, which showed Kotlin among the most loved programming languages in 2018 and 2019. We also observe the growth of Stack Overflow questions about Android development with Kotlin [59].

The official integrated development environment (IDE) for Google's Android operating system is known as android studio, built on JetBrains IntelliJ IDEA software and designed specifically for Android Development and is available for download on Windows, macOS and Linux based operating systems or as subscription-based service in 2020 [89].

3.2.1.1 Libraries Used for the mobile application development.

The following are the libraries that were used in the mobile application development.

1. Fresco

This library is used for displaying images in android applications. Fresco's image pipeline will load images from the network, local storage, or local resources. To save data, it has three levels of cache; two in memory and another in internal storage.

Fresco's Drawee shows a placeholder until the image has loaded and then automatically shows the image when it arrives. When the image goes off-screen, it automatically releases its memory.

Fresco uses drawees for display. These offer several useful features:

- Scale the image to a custom focus point, instead of the center.
- Show the image with rounded corners, or a circle.
- Let users tap the placeholder to retry load of the image if the network load failed.
- Show custom backgrounds, overlays, or progress bars on the image [90].

2. Material

Material design is a comprehensive guide for visual, motion, and interaction design across platforms and devices. To use material design in android applications, one has to follow the guidelines defined in the material design specification and use the new components and styles available in the material design support library.

Android provides the following features to help you build material design apps:

- New APIs for custom shadows and animations
- A material design application theme to style UI widgets
- Widgets for complex views such as lists and cards

3. Drawables

These new capabilities for drawables help you implement material design apps:

- Vector drawables are scalable without losing definition and are perfect for single-color in-app icons. Learn more about vector drawables.
- Drawable tinting lets you define bitmaps as an alpha mask and tint them with a colour at runtime. See how to add tint to drawables.
- Colour extraction lets you automatically extract prominent colours from a bitmap image. See how to select colours with the Palette API [91].

```
dependencies {
    implementation fileTree(dir: 'libs', include: ['*.jar'])
    implementation "org.jetbrains.kotlin:kotlin-stdlib-jdk7:$kotlin_version"
    implementation 'androidx.appcompat:appcompat:1.2.0'
    implementation 'androidx.core:core-ktx:1.3.2'
    implementation 'androidx.constraintlayout:constraintlayout:2.0.4'
    implementation 'androidx.lifecycle:lifecycle-extensions:2.2.0'
    implementation 'androidx.lifecycle:lifecycle-viewmodel-ktx:2.3.1'
    implementation 'androidx.legacy:legacy-support-v4:1.0.0'
    implementation 'com.google.android.material:material:1.3.0'
    implementation 'com.android.volley:volley:1.2.0'
    implementation 'com.facebook.fresco:fresco:2.4.0'
    implementation 'com.squareup.okhttp3:okhttp:4.8.1'
    testImplementation 'junit:junit:4.13.2'
    androidTestImplementation 'androidx.test.ext:junit:1.1.2'
    androidTestImplementation 'androidx.test.espresso:espresso-core:3.3.0'
}
```

Figure 3.2 Dependencies

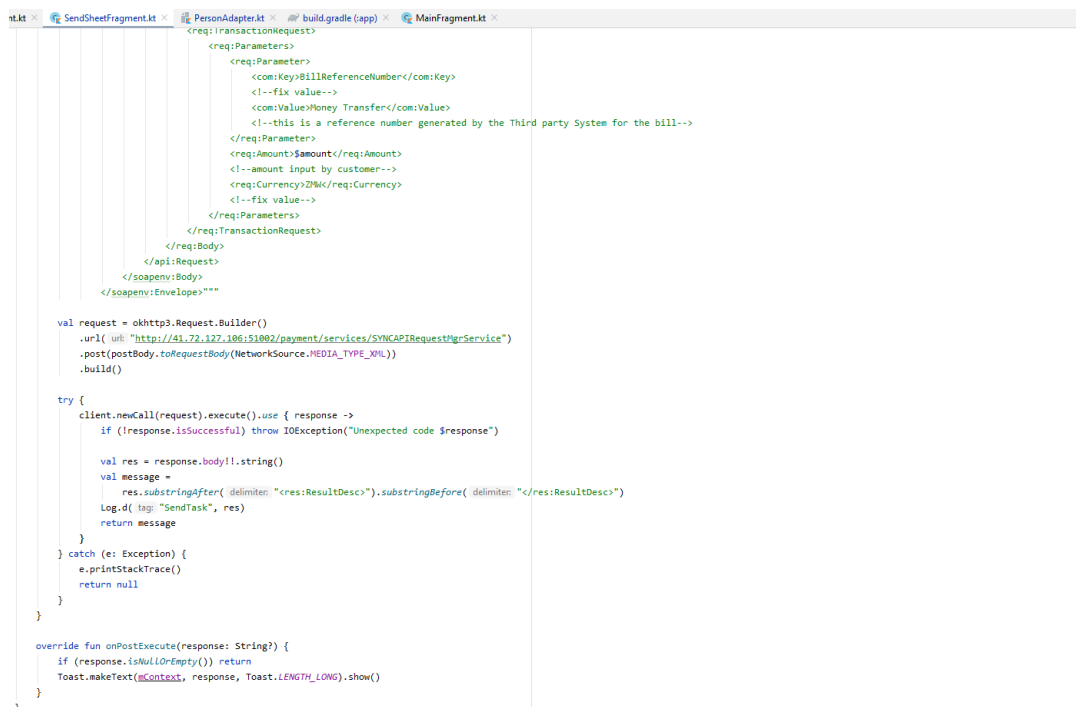
4. Volley and okhttp

Volley is an HTTP library that makes networking for Android apps easier and most importantly, faster. Volley is available on GitHub.

Volley offers the following benefits:

- Automatic scheduling of network requests.
- Multiple concurrent network connections.
- Transparent disk and memory response caching with standard HTTP cache coherence.
- Support for request prioritization.
- Cancellation request API. One can cancel a single request or can set blocks or scopes of requests to cancel.
- Ease of customization, for example, for retry and backoff.
- Debugging and tracing tools.

OkHTTP is an open-source project designed to be an efficient HTTP client. It supports the SPDY protocol which is the basis for HTTP 2.0 and allows multiple HTTP requests to be multiplexed over one socket connection.



```

<!--fix value-->
<com:Key>BillReferenceNumber</com:Key>
<com:Value>Money Transfer</com:Value>
<!-- this is a reference number generated by the Third party System for the bill-->
</req:Parameter>
<req:Amount>$amount</req:Amount>
<!-- amount input by customer-->
<req:Currency>2M</req:Currency>
<!--fix value-->
</req:Parameter>
</req:TransactionRequest>
</req:Body>
</api:Request>
</soapenv:Body>
</soapenv:Envelope>""

val request = okhttp3.Request.Builder()
    .url("http://41.72.127.106:51002/payment/services/SYNCAPIRequestMgrService")
    .post(postBody.toByteArray(NetworkSource.MEDIA_TYPE_XML))
    .build()

try {
    client.newCall(request).execute().use { response ->
        if (!response.isSuccessful) throw IOException("Unexpected code $response")

        val res = response.body!!.string()
        val message =
            res.substringAfter( delimiter: "<res:ResultDesc>").substringBefore( delimiter: "</res:ResultDesc>")
        Log.d( tag: "SendTask", res)
        return message
    }
} catch (e: Exception) {
    e.printStackTrace()
    return null
}

override fun onPostExecute(response: String?) {
    if (response.isNullOrEmpty()) return
    Toast.makeText(mContext, response, Toast.LENGTH_LONG).show()
}

```

Figure 3.3 Okhttp being used for requests

3.2.2 Overview on APIs

The mobile money industry is evolving towards a platform-based approach where other apps and software can easily integrate with the mobile money product via plug-and-play access through Application Programming Interfaces (APIs). By providing easily accessible APIs, providers can create almost endless opportunities to build additional services on top of mobile money as well as opportunities to monetise those services [53].

API is an integer value that recognizes the framework API revision provided by a version of the Android platform. The Android platform offers so many different framework API that applications can easily use to interact with the hidden Android system. The API should be independent of the platform so that every platform could leverage the API calls according to their needs. Since the API development can be used by any application so the code should be as generic as possible. An API being a piece of software that creates a link between applications therefore connects digital payment platforms with telecom networks with regards to mobile money APIs. This benefits the user because they no longer need to manage vast telecom networks and bank accounts. With mobile money, for instance, APIs allow developers to completely ignore how the payment part of the process will work and simply rely on just getting their platform to fit into the innovation. The end-user's experience with mobile money APIs usually involves the two most common APIs: debit APIs and credit APIs, which allow customers to collect and pay out money, respectively. These are the two sides of the payments coin in mobile money transfers. But this activity needs to be managed, which is where account verification APIs enter the process. This API will carry out security checks, such as ensuring that the recipient is linked to an active mobile money account. The mobile money API ecosystem then branches out from here, including a web of APIs designed for very specific use cases. A balance check API is used to ascertain whether a certain balance guideline is being met. For some mobile money platforms, there is a balance limit, which must be checked and approved to execute the transaction. If the current balance is not without the guidelines, the API detects the error and freezes the account. The heavily regulated world of digital finance requires fiduciary oversight of all account holders. For this reason, there are Know Your Customer (KYC) APIs that trace the digital identities of end-users by establishing online records of their name, legal ID, official address and other personal information. In Zambia, the widespread use of mobile money has had the corollary effect of creating an identity database for hundreds of thousands of people that were not only previously unbanked but also unidentified. This realization has thrust the importance of APIs to center stage. The KYC APIs

create a digital record for identity and show that mobile money APIs have use cases that can go far beyond payments, this is not the only mobile money API that is valuable outside of the financial realm. The e-signature API, used to validate transactions, could also one day enable people to vote electronically [52].

To enable interoperability of mobile money services, the concept that was used was to integrate both Zamtel mobile money application programming interface and MTN Zambia mobile money application programming interface. Application Programming Interface (API) enables a third-party application to use an interface through which it can access a common set of tools or services. In banking, this means a bank can offer third party access to its custom services through dedicated APIs. Multiple third parties can then use banking services or also offer the same to its customers. A good number of electronic money service providers in Zambia now also allow developer organisations to use their API platform and build custom APIs. From building an API from scratch, testing it, to going live, banks and mobile money service providers offer all the tools and features to the developers to build powerful and efficient APIs. The following are the Application programming interface (API) that were used for this project;

i) Zamtel API

1. Customer Pay Bill (Async Model) API - Sample Request

```

override fun doInBackground(vararg params: Double?): String? {
    val amount = params[0]
    val sdf = SimpleDateFormat( pattern: "yyyyMMdHHmmss", Locale.getDefault())
    val timestamp = sdf.format(Date())
    val client = OkHttpClient().newBuilder()
        .connectTimeout( timeout: 60, TimeUnit.SECONDS)
        .readTimeout( timeout: 60, TimeUnit.SECONDS)
        .writeTimeout( timeout: 60, TimeUnit.SECONDS)
        .build()
    val postBody =
        """<soapenv:Envelope xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/" xmlns:api="http://cps.huawei.com/synccpsinterface/api_requestmgmt" xmlns:req="http://cps.huawei.com/synccpsinterfa
        <soapenv:header>
        <soapenv:body>
        <api:Request>
        <req:Header>
        <req:Version>1.0</req:Version>
        <!--fix value-->
        <req:CommandID>InitTrans_Customer Pay Org Bill</req:CommandID>
        <!--fix value-->
        <req:OriginatorConversationID>429106433679961234</req:OriginatorConversationID>
        <!--Unique ID generated by THIRD PARTY system-->
        <req:Caller>
        <req:CallerType>2</req:CallerType>
        <!--fix value-->
        <req:ThirdPartyID>C11_Caller</req:ThirdPartyID>
        <!--fix value--><req:Password>e58eeP9Td6q5nAcxvty8Kp5iLiQ#9</req:Password>
        <!--fix value-->
        </req:Caller>
        <req:KeyOwner>1</req:KeyOwner>
        <!--fix value-->
        <req:Timestamp>${timestamp}</req:Timestamp>
        </req:Header>
        <req:Body>
        <req:Initiator>
        <req:IdentifierType>1</req:IdentifierType>
        <!--fix value-->
        <req:Identifier>${Prefs.getZamtel(mContext)}</req:Identifier>
        <!-- Customer's Mobile Number -->
        </req:Initiator>
        <req:ReceiverParty>
        <req:IdentifierType>4</req:IdentifierType>
    """
}

```

Figure 3.4 Zamtel API Soap

The figure 3.5 below shows a work in progress of extensible Markup Language (XML) in android studio. XML is used for drawing the interfaces of an application.

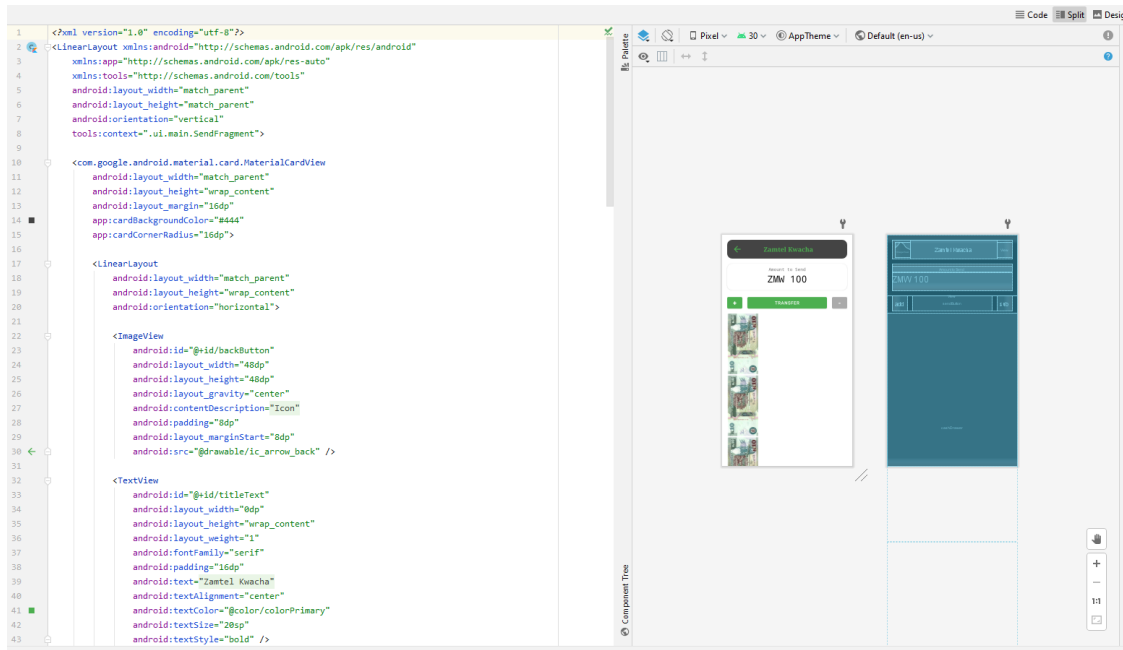


Figure 3.5 XML in Android studio

ii) MTN API

MoMo is the name of MTN mobile money service, it is a financial service that is used for personal, agency, merchant and corporate applications. The MTN Mobile Money API provides services that enable remote and automatic collection of bills fees and taxes. It allows one to automatically deposit funds to multiple users and more [53].

3.2.2.1 API Methods

The MTN mobile money API uses POST, GET, PUT methods. Below is a brief overview of the interaction sequence used in the API and the usage of the methods.

i. POST

The method used for creating a resource in Wallet Platform is known as POST. The request includes a reference id which is used to uniquely identify the specific resource that are created by the POST request. If a POST is using a reference id that is already used, then a duplication error response will be sent to the client e.g. POST /requesttopay.

The POST is an asynchronous method. The Wallet Platform will validate the request to ensure that it is correct according to the API specification and then answer with HTTP 202 Accepted. The created resource will get status PENDING. Once the request has been processed the status

will be updated to SUCCESSFUL or FAILED. The requester may then be notified of the final status through callback [53].

ii. GET

The method used for requesting information about a specific resource is known as GET. The URL in the GET includes the reference of the resource. If a resource was created with POST, then the reference id that was provided in the request is used as the identity of the resource. For example;

POST /requesttopay request is sent with X-Reference-Id = 11377cbe-374c-43f6-a019-4fb70e57b617

GET /requesttopay/11377cbe-374c-43f6-a019-4fb70e57b617 will return the status of the request.

iii. PUT

The PUT method is used by the Open API when sending callbacks. Callback is sent if a callback URL is included in the POST request. The Wallet Platform will only send the callback once. There is no retry on the callback if the Partner system does not respond. If the callback is not received, then the Partner system can use GET to validate the status [52].

3.2.2.2 Use Cases

The following are various ways that the API can be used:

- Request to Pay
- Pre-Approval
- Transfer
- Validate Account Holder
- Get Balance

iv. Request to Pay

This service is used for requesting a payment from a customer (Payer). This can be used by e.g. an online web shop to request a payment for a customer. The customer is requested to approve the transaction on the customer client. Customer (Payer) have selected product(s) in the merchant web shop and decided to check out and selects to pay with Mobile Money.

The provider system collects the account information for the customer e.g. mobile number and calculate the total amount of the products. The provider system sends a request to pay (POST /requesttopay) operation to Wallet Platform. This request includes the amount and customer (Payer) account holder number. Wallet Platform will respond with HTTP 202 Accepted to the provider system Provider shall inform the customer that a payment needs to be approved, by giving information on the merchant web page. For example, the merchant could show information that payment is being processed and that customer needs to approve using the own client, e.g. USSD, mobile app. Wallet Platform will process the request so that the customer can approve the payment. The request to pay will be in PENDING state until the customer have approved/Rejected the payment. The Customer (Payer) will use his/her own client to review the payment. Customer can approve or reject the payment. Wallet platform will transfer the funds if the customer approves the payment. Status of the payment is updated to SUCCESSFUL or FAILED. If a callback URL was provided in the POST /requesttopay then a callback will be sent once the request to pay have reached a final state (SUCCESSFUL, FAILED). Note the callback will only be sent once. There is no retry. GET request can be used for validating the status of the transaction. GET is used if the partner system has not requested a callback by providing a callback URL or if the callback was not received [52].

v. *Pre-Approval*

This method is used to setup an auto debit towards a customer. The Partner can request a pre-approval from the customer. Once the customer has approved then the partner can debit the customer account without authorization from the customer. The Provider sends a POST /preapproval request to Wallet platform. Provider shall inform the customer that pre-approval needs to be approved. Customer (Payer) will use the own client to view the pre-approval request. Customer can approve or reject the request. Callback will be sent if a callback URL was provided in the POST request. The callback is sent when the request has reached a final state (Successful, Failed). The Provider can use the GET request to validate the status of the pre-approval.

vi. *Transfer*

This feature is used for transferring money from the provider account to a customer. The Provider sends a POST /transfer request to the Wallet platform. The Wallet platform will directly respond to indicate that the request is received and will be processed. The Wallet platform will authorize the request to ensure that the transfer is allowed. The funds will be

transferred from the provider account to the Payee account provided in the transfer request. Callback will be sent if a callback URL was provided in the POST request. The callback is sent when the request has reached a final state (SUCCESSFUL, FAILED). The Provider can use the GET request to validate the status of the transfer.

vii. Validate Account Holder

This can be used to do a validation if a customer is active and able to receive funds. The use case will only validate that the customer is available and active. It does not validate that a specific amount can be received. The Partner can send a GET /accountholder request to validate if a customer is active. The Partner provides the ID of that customer as part of the URL and wallet platform will respond with HTTP 200 if the account holder is active.

viii. Get Balance

The Get balance request is used to check the balance on the default account connected to the API User. The partner will send a GET /account/balance request. Wallet platform will respond with the available balance on the API user account [53].

3.2.2.3 Testing

To facilitate testing a set of predefined users and Test accounts are provided. These users and accounts have a predefined test scenario. A developer needs to Sign up and Subscribe to a Product before accessing any of the APIs.

3.2.2.4 The API used for the Mobile money application.

The following is the type of API that was used to develop the mobile application.

i. Request to Pay API

This API allows the mobile application to act as an intermediary between three parties in a transaction, these include;

- The **payee** - the merchant that runs the mobile app service, or other party that requests to be paid.
- The **payer** - the party that is sending the money, authenticates and authorizes payment or transfer of funds as required.

- The *payment method* – this is the medium through which the payer uses to pay the payee.
- The *payment method provider* the company which establishes the ecosystem to support that payment method.

The details of how to fulfil a payment request for a given payment method is an implementation detail of a *payment handler*. Concretely, each payment handler defines:

Steps to check if a payment can be made:

How a payment handler determines whether it, or the user, can potentially "make a payment" is also an implementation detail of a payment handler.

Steps to respond to a payment request:

Steps that return an object or dictionary that a merchant uses to process or validate the transaction. The structure of this object is specific to each payment method [53].

3.2.2.5 Goals and scope

- Enable a payment method provider to bring more secure payment transactions to the web and mobile Applications.
- Standardize (to the extent that it makes sense) the communication flow between a merchant, user agent, and payment method provider.
- Allow the user agent to act as intermediary between a merchant, user, and payment method provider.
- Enable user agents to streamline the user's payment experience by considering user preferences, merchant information, security considerations, and other factors.

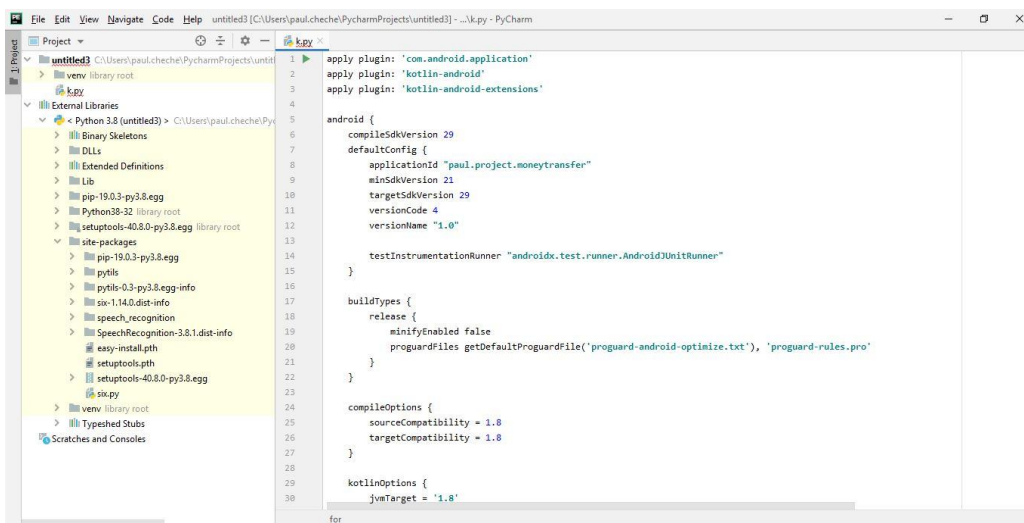


Figure 3.6 Code overview (Applying necessary plugins)

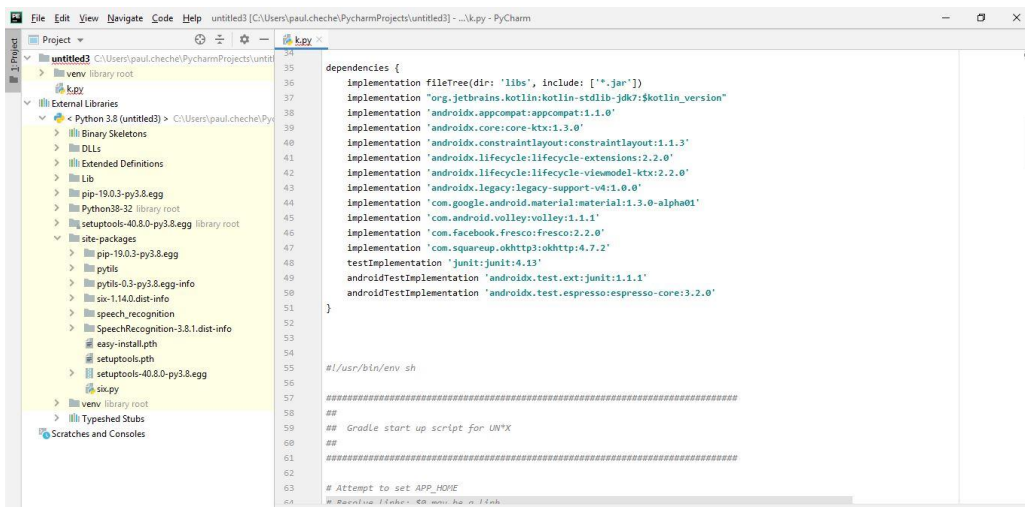


Figure 3.7 Code overview (Implementation)

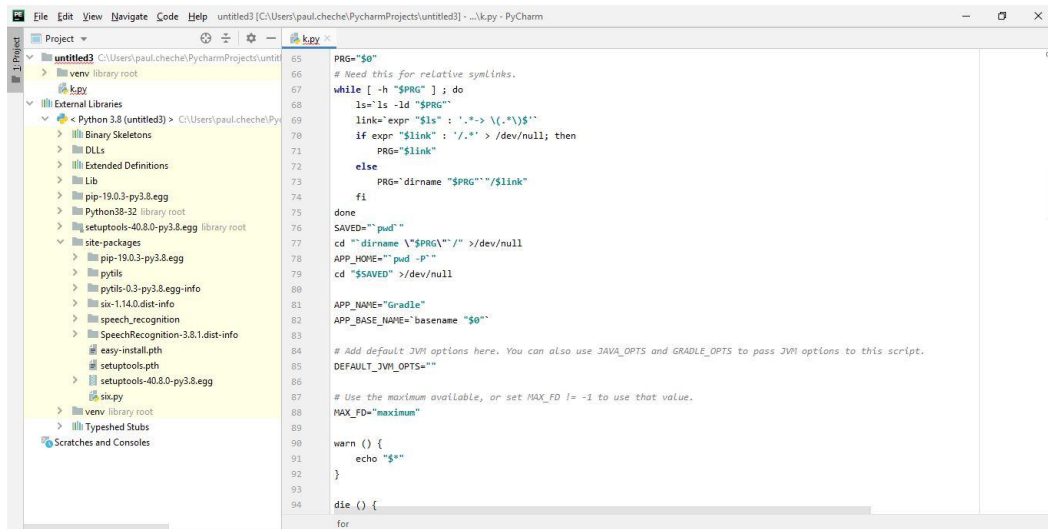


Figure 3.8 Code overview (Symlinks)

```

181 # OS specific support (must be 'true' or 'false').
182 cygwin=false
183 msys=false
184 darwin=false
185 nonstop=false
186 case "$uname" in
187   CYGWIN* )
188     cygwin=true
189     ;;
190   Darwin* )
191     darwin=true
192     ;;
193   MINGW* )
194     msys=true
195     ;;
196   NONSTOP* )
197     nonstop=true
198     ;;
199   esac
200
201 CLASSPATH=$APP_HOME/gradle/wrapper/gradle-wrapper.jar
202
203 # Determine the Java command to use to start the JVM.
204 if [ -n "$JAVA_HOME" ]; then
205   if [ -x "$JAVA_HOME/jre/sh/java" ]; then
206     # IBM's JDK on AIX uses strange locations for the executables
207     JAVACMD="$JAVA_HOME/jre/sh/java"
208   else
209     JAVACMD="$JAVA_HOME/bin/java"
210   fi
211 fi
212
213 for

```

Figure 3.9 Code overview (OS specific support)

```

131   if [ ! -x "$JAVACMD" ]; then
132     die "ERROR: JAVA_HOME is set to an invalid directory: $JAVA_HOME
133     location of your Java installation."
134   fi
135   else
136     JAVACMD="java"
137     which java >/dev/null 2>&1 || die "ERROR: JAVA_HOME is not set and no 'java' command could be found in your PATH.
138
139   Please set the JAVA_HOME variable in your environment to match the
140   location of your Java installation."
141   fi
142 fi
143
144 # Increase the maximum file descriptors if we can.
145 if [ "$cygwin" = "false" -a "$darwin" = "false" -a "$nonstop" = "false" ]; then
146   MAX_FD_LIMIT=ulimit -H -n
147   if [ $? -eq 0 ]; then
148     if [ "$MAX_FD" = "maximum" -o "$MAX_FD" = "max" ]; then
149       MAX_FD="$MAX_FD_LIMIT"
150     fi
151     ulimit -n $MAX_FD
152     if [ $? -ne 0 ]; then
153       warn "Could not set maximum file descriptor limit: $MAX_FD"
154     fi
155   else
156     warn "Could not query maximum file descriptor limit: $MAX_FD_LIMIT"
157   fi
158 fi
159
160 for

```

Figure 3.10 Code overview (file descriptors)

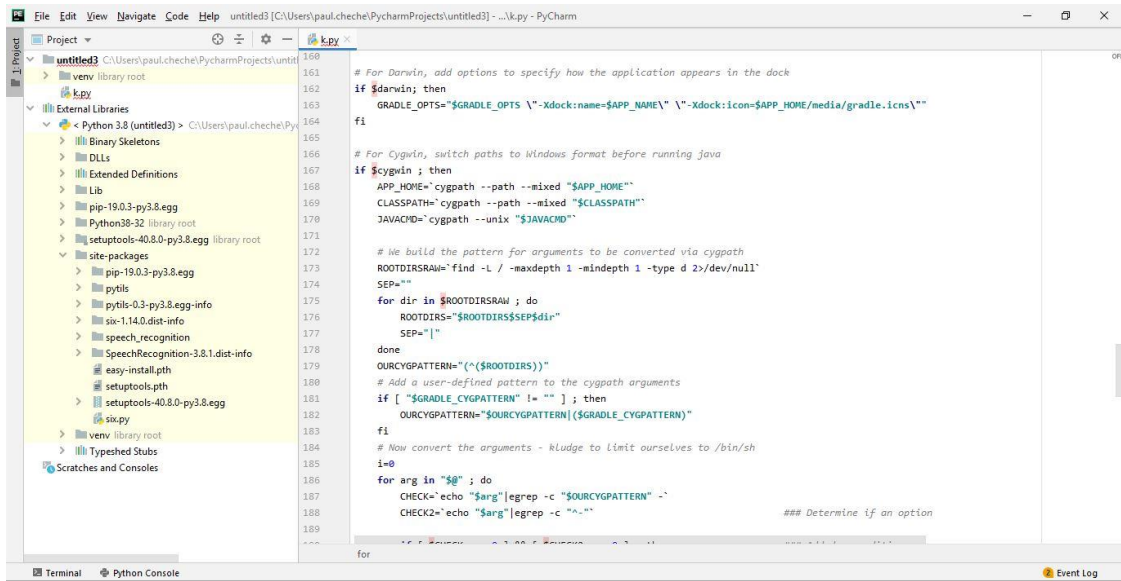


Figure 3.11 Code overview (arguments)

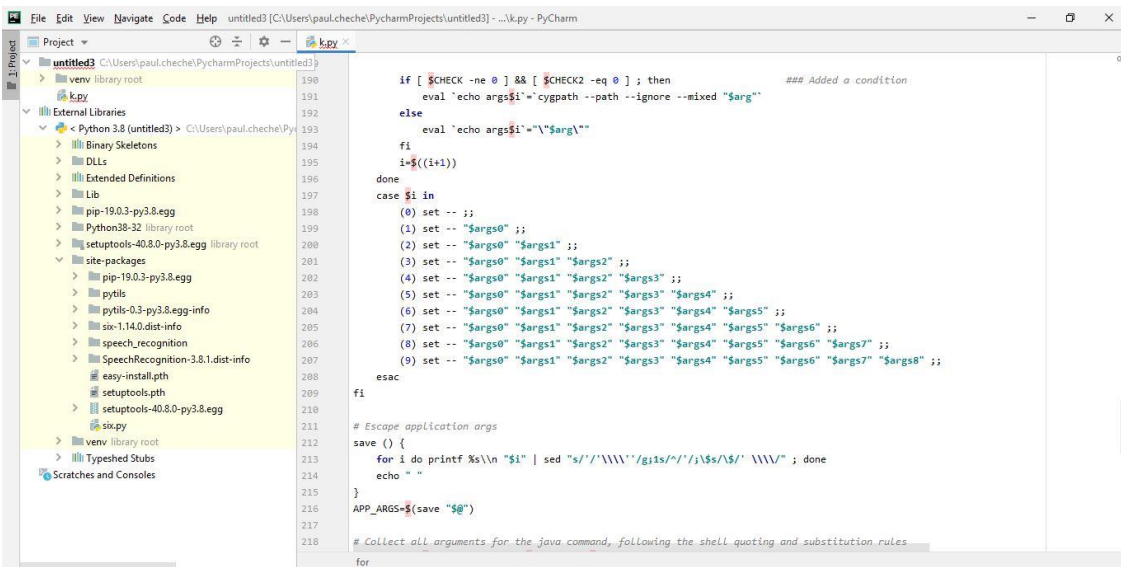


Figure 3.12 Code overview (application arguments)

The figure 3.13 below shows a work in progress overview of the repositories used in the development of the mobile application.

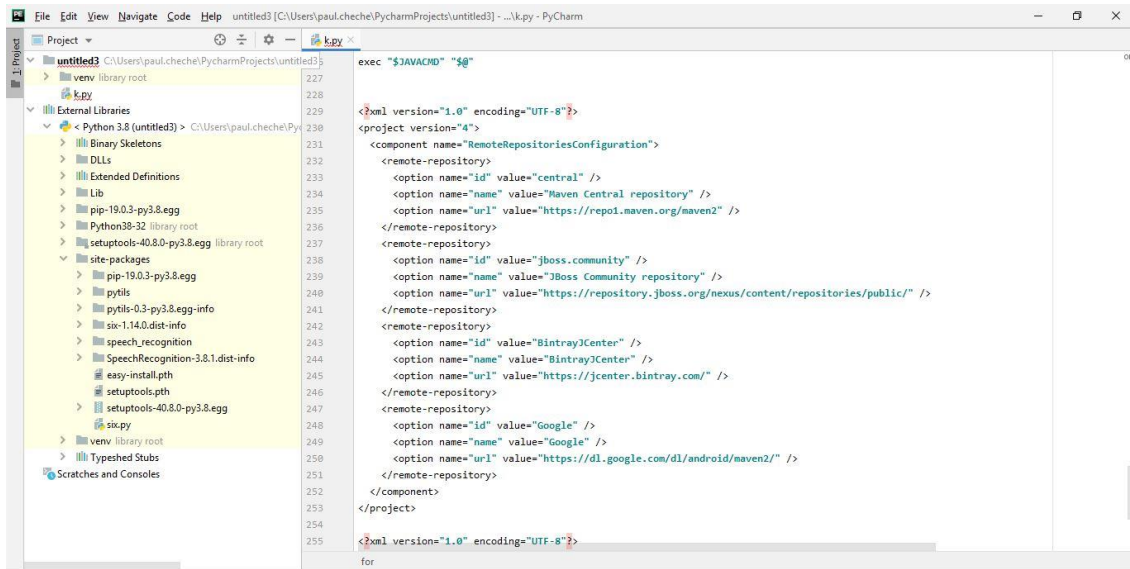


Figure 3.13 Code overview (repositories)

The Flowchart

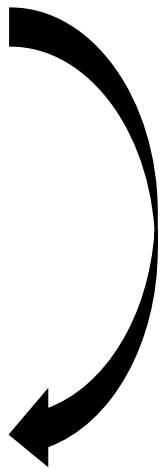
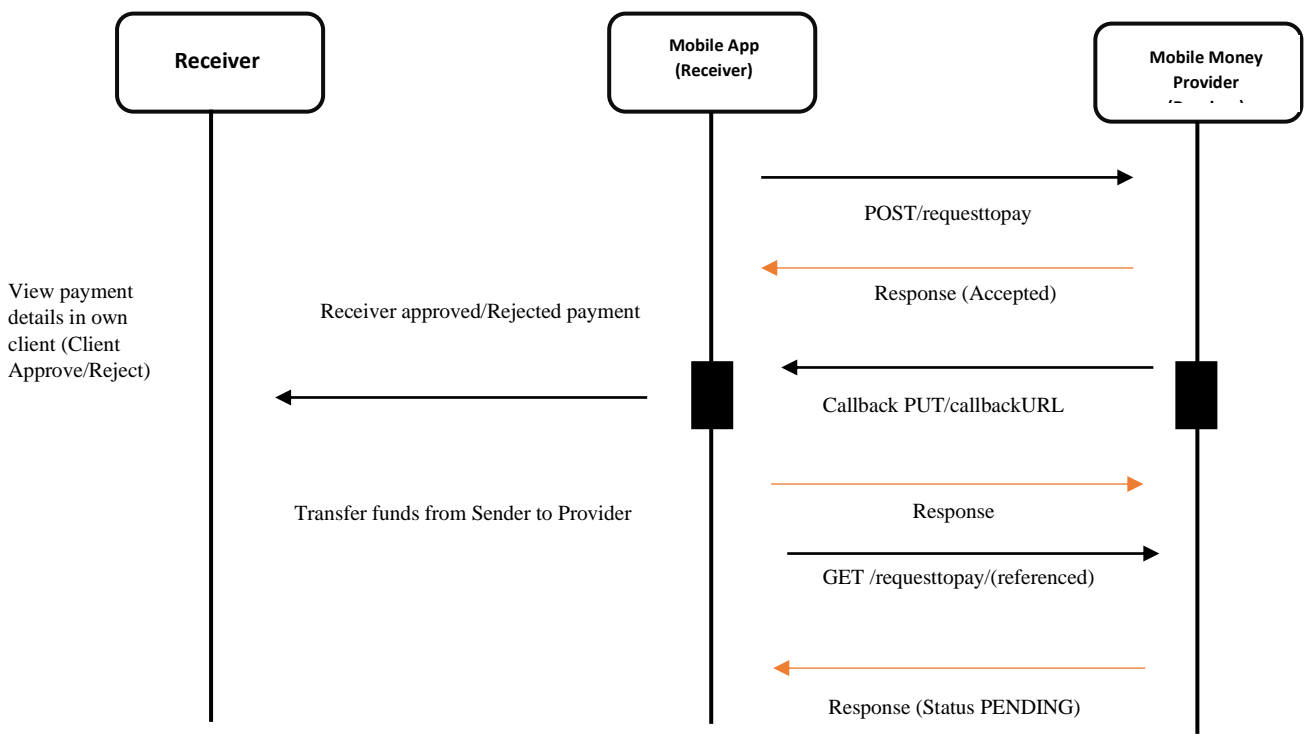
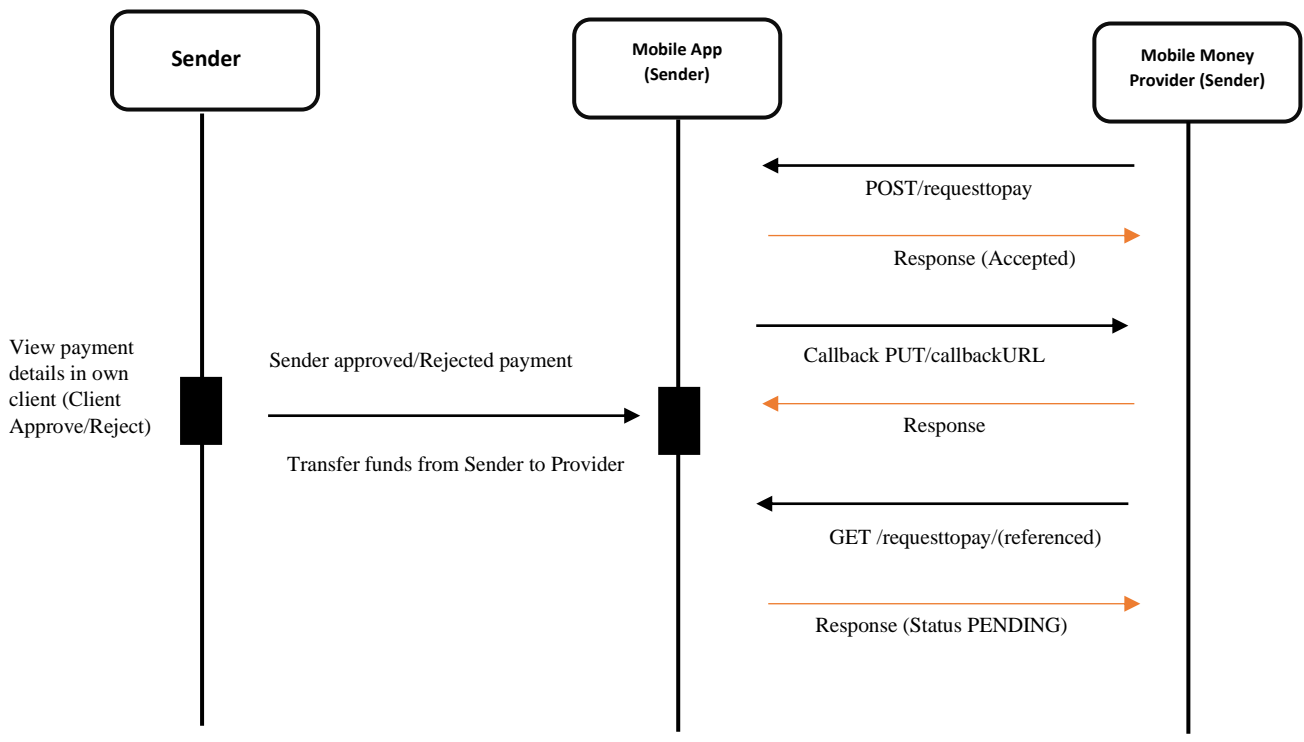


Figure 3.14 Backend Operational Overview of the Mobile Application using Request to pay APIs

3.3 Population Study

Polit and Hungler [19] refer to the population as an aggregate or totality of all the objects, subjects or members that conform to a set of specifications. In this study the population will be Zambian residents of all races, both sex, educational status, socio-economic status living in Lusaka the capital city of Zambia.

3.4 Sampling Techniques

Purposive and Simple random sampling technique was used in the study. Purposive sampling (also known as judgment, selective or subjective sampling) is a sampling technique in which researcher relies on his or her own judgment when choosing members of population to participate in the study. Purposive sampling is a non-probability sampling method, and it occurs when elements selected for the sample are chosen by the judgment of the researcher [77]. One of the factors that was used by the researcher to make judgement was to focus only on the members of the population that fit the criteria and interests of the study, through this sampling method the researcher would obtain a representative sample which would result in saving time as well as concerned with the understanding of the respondents. Simple random sampling method was also used though it can be difficult to conduct structured interviews to large groups of people [76]. The purpose of this study is to develop a mobile application that would enable interoperability of mobile money services in Zambia.

3.5 Data Collection Procedure and Timeline

The data collection method that will be used in this research is the Design Science research methodology which allows for communication of knowledge to both technical and non-technical audience [79]. The Design Science method will fit into the pragmatic research epistemology to be adopted for this study [25]. This means that the Design Science researcher will be considered as a pragmatist. The flexibility of the design science research method, allowing the utilization of diverse methods at certain stages of the research process will afford the inclusion of other relevant methods as and when needed. For Example, the experimental method will be used at the evaluation stage to test the hypothesis that will be emanated from the implementation of the development phase.

3.6 Data Collection Tools

To achieving the study objectives, a survey form was designed and distributed among respondents to be completed by them. This was distributed to young and elderly residents of the capital city of Zambia Lusaka. A total of 38 survey forms were distributed in Lusaka town central business district, Mtendere market, Woodlands shopping complex, Zamtel and MTN Zambia Headquarters. The survey form was distributed to other random residents living in the vicinity and they were asked to fill it up in their free time, the final number of forms collected back with survey completed was thirty-seven (37).

3.7 Ethical Consideration

Ethics that guides the researcher were adhered to ensure that the credibility of the research was promoted at its highest degree. Permission from the University Registrar and the Research ethics committee was obtained. For example, participants were informed in advance before approaching them in answering the questionnaires. The informed consent was given as a form of notice so that the respondents could choose the convenient time that they would like to be offered the questionnaire. Anonymity and confidentiality were also recognized to avoid breach of research ethics. In this regard, identity of the participants would not be revealed to anyone. Furthermore, honesty and integrity in questioning and explaining the purpose of the study would be truthfully exculpated. Due to the type of information that is being collected, the questionnaires were numbered to preserve privacy and confidentiality of the participants. Other ideals are unacceptability of dishonest to retrieve information as well as full and honest report of findings [60]. The information obtained from the participants and secondary sources was strictly confidential and would be used for the research purpose only.

3.8 Chapter Summary

This chapter clearly outlined the methodology to be adopted for this study. The various stages and levels involved in the development of the proposed framework were clearly spelt out in detail. The Study population, sampling procedure, data collection instruments and data collection procedure.

4. CHAPTER FOUR: DATA COLLECTION AND ANALYSIS

4.0 Introduction

This chapter presents the findings and analysis of the study according to the research objectives. The results are presented under respective subheadings organized based on the objectives of the study. The findings relate to the questions that were used in the study.

4.1 Descriptive Statistics Summary

Data was collected from self-administered questionnaires, completed by five mobile money agents (n=4) representing a response rate of 100%, students (n=3) representing 100% response rate, Software Engineers (n=3) representing response rate of 100%, Sales and Shop Representatives (n=13) representing response rate of 100%. Businessmen (n=5) representing a response rate of 100% and Entrepreneur (n=2) representing 100% response rate. A total of 36 questionnaires were usable for this study and met the required inclusion criteria. This represented 90% of the expected population. No respondent refused to participate in the survey exercise as this was voluntarily and the low response to surveys about the interoperability of mobile money services could be a partial explanation for the low response rate in this study. Of the remaining one questionnaire deemed unusable with one participant not completing the questionnaire in that some questions were omitted when answering.

4.1.2 Demographic Characteristics

Personal and social characteristics of respondents have a very significant role to play in expressing and giving the responses about the problem under study [80]. Characteristics such as race, ethnicity, gender, age, education, profession, occupation, income level, and marital status are all typical examples of demographics that are used in surveys. All closed-ended questions were used with the aim to define a characteristic for the respondents. The idea was to gain an understanding of traits or behaviours of the respondents. When compared, survey responses from men and women do vary and may affect the data accordingly. Keeping this in mind, this study has a set of personal characteristics namely, gender, age and professional qualification (education) of the respondents were examined.

4.2 Gender of Respondents

The gender of respondents was considered in the study and it was found that out of all respondents who participated in the study 15 out of 32 respondents representing (46.87%) were male while 17 out of 32 respondents representing (53.1%) were female. The table below show the responses.

What is your gender?				
	Frequency	Percent	Valid Percent	Cumulative Percent
Male	15	46.9	46.9	46.9
Female	17	53.1	53.1	100
Total	32	100.0	100.0	

Table 4.1 Statistics showing Gender of respondents.

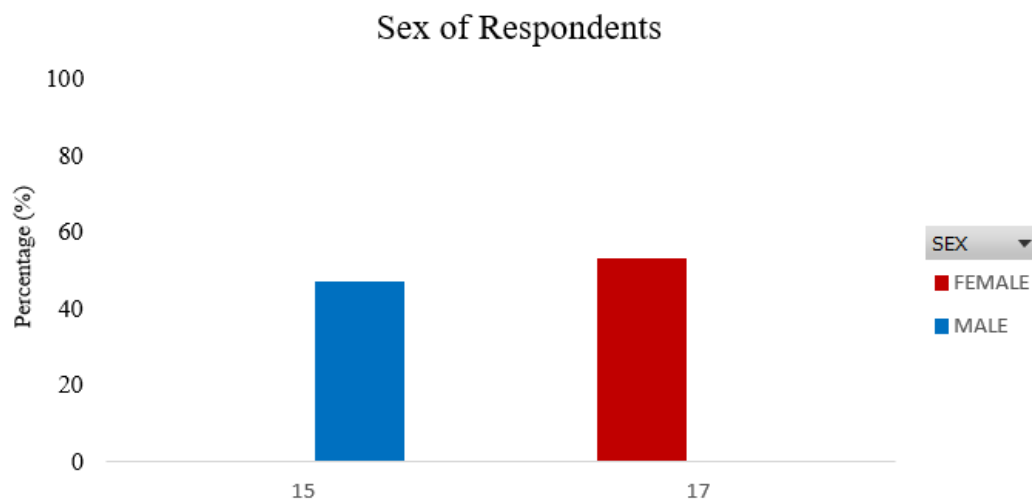


Figure 4.1 Gender of Respondents

The results above show that 32 respondents represented 80% of the distribution participated in the research study. The females are represented by 53.13% while Male respondents are represented by 46.88%.

4.3 Age of Respondents

The age of the respondents who participated in the survey was between 15 years old to 55 years old. The response is illustrated in the pie chart below.

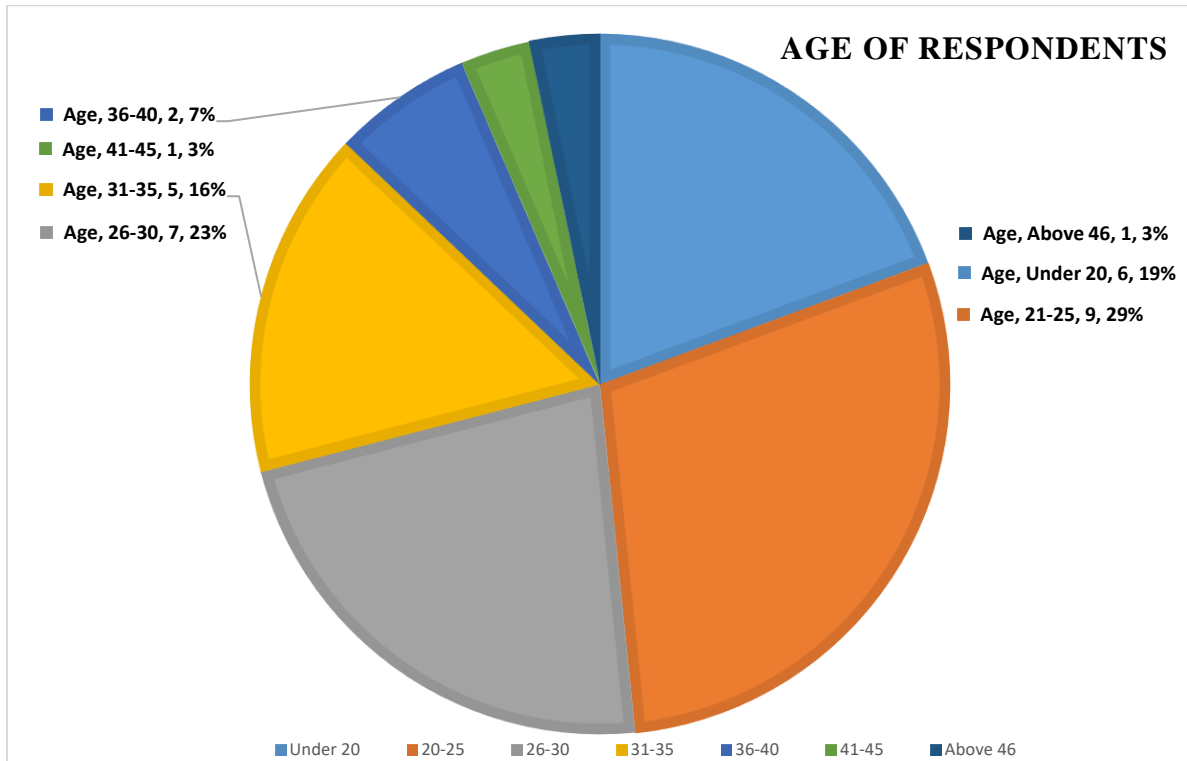


Figure 4.2 Age of Respondents

The pie chart in figure 4.2 above shows the following:

- 30% of the respondents were between the age of 20 and 25.
- 23% of the respondents were between the age of 26 and 30.
- 20% of the respondents were under the age of 20.
- 17% of the respondents were between the age of 31 and 35.
- 7% of the respondents were between the age of 36 and 40.
- 3% of the respondents were between the age of 41 and 45.
- 3% of the respondents were above 46 years old

The table 4.2 below shows more details of the findings.

What is your age?				
	Frequency	Percent	Valid Percent	Cumulative Percent
Below 20	6	18.2	18.2	18.2
21 to 25	11	33.3	33.3	51.5
26 to 30	7	21.2	21.2	72.7
31 to 35	5	15.1	15.1	87.8
36 to 40	2	6.1	6.1	93.9
41 to 45	1	3	3	96.9
46 and Above	1	3	3	100
Total	33	100	100	

Table 4.2 Age of Respondents

4.4 Level of Qualification for Respondents

The qualifications of respondents were considered in the study and it was found that out of all respondents who participated in the study 10 were degree holders, 9 were diploma holders were students and 12 only have grade 12 certificates. It should be noted that the level of education of respondents does not contradict the study as this survey was meant for collection of the general experience of mobile money service users in Zambia. The pie chart below illustrates these findings.

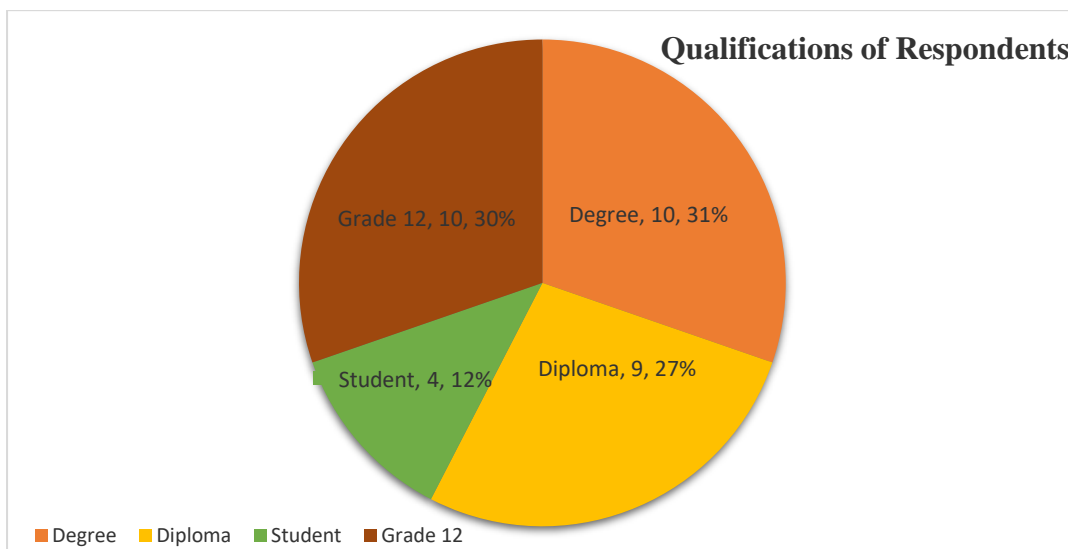


Figure 4.3 Qualifications of Respondents

What is your qualification?				
	Frequency	Percent	Valid Percent	Cumulative Percent
Grade 12 Certificate Holder	10	30	30	30
Student	4	12	12	42
Diploma Holder	9	27	27	69
Degree Holder	10	31	31	100
Total	33	100	100	

Table 4.3 Qualifications of Respondents

4.5 Reliability Analysis

Reliability refers to the fact that the scale should consistently reflect the construct, which it is meant to measure. Reliability is used in situations where two or more observations under the study are equivalent to each other in terms of the construct being measured. The Cronbach's alpha is used to measure reliability. This study used the Cronbach's alpha to assess the internal consistency 35 of the survey [81].

4.6 Smart phone statistics

The following statistics shows the number of respondents who own smart phones and those who do not own smart phones, the bar chart below shows the findings.

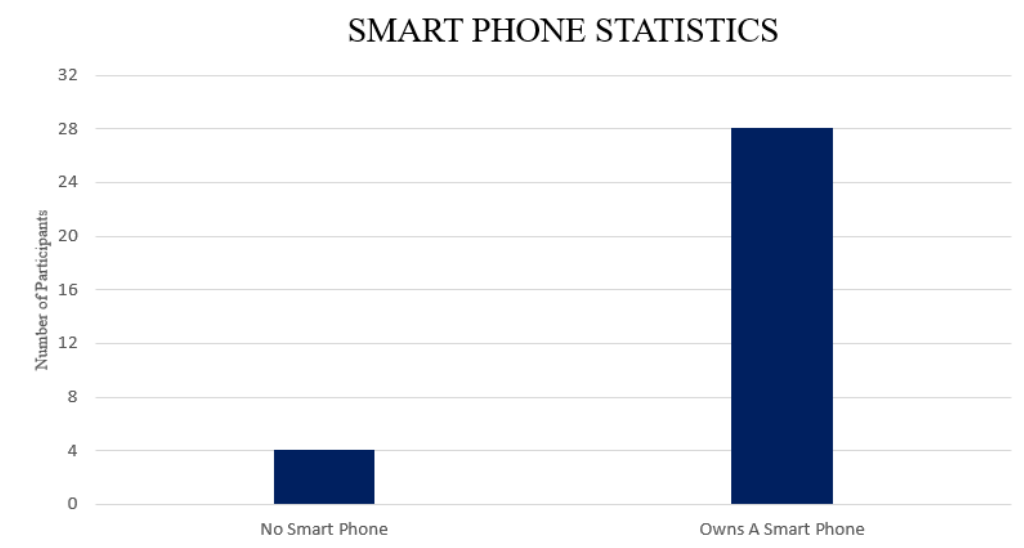


Figure 4.4 Smart phone statistics

The results show that 12.5 respondents do not own smart phones while 87.5 of the respondents own a smart phone.

4.7 Features of Mobile money services used by the respondents.

The following statistics shows the services that respondents use for mobile money.

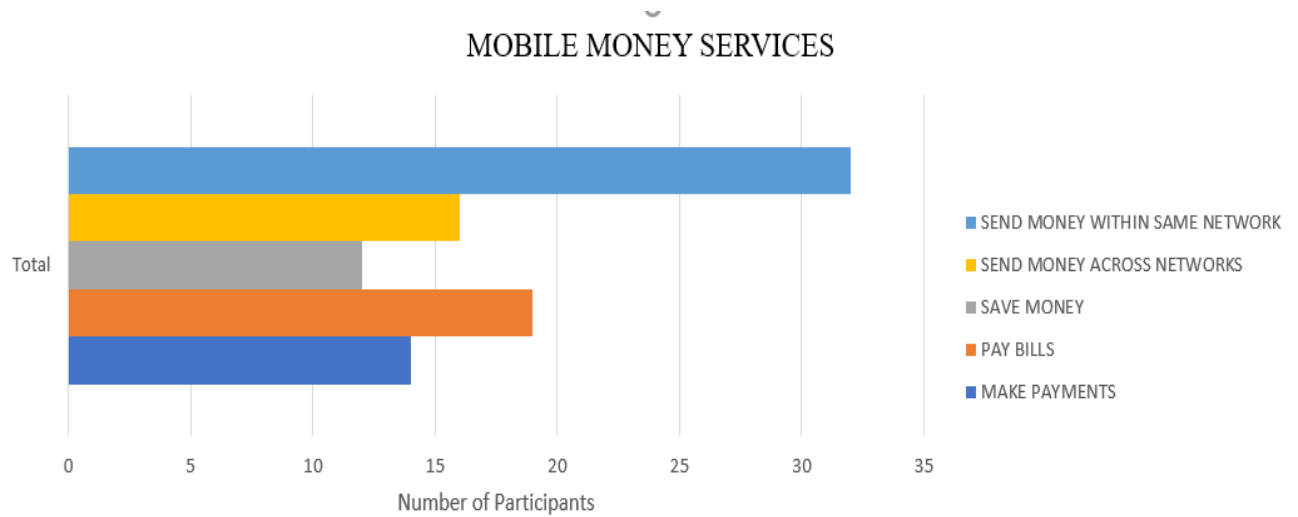


Figure 4.5 Mobile Money Services Statistics

From the figure 4.5 above, we see that the service that is mostly used by the respondents is sending of money within the same mobile money network and this represented 34.4% of the total respondents, Bill payments is used by 20.4% of the total number of respondents, 17.2% of respondents represented those that send money across networks and 15% represented those that make payments using mobile money.

4.7.1 Respondents who have used Inter-Transfer of funds service before

The graph in 4.6 below illustrates the findings.

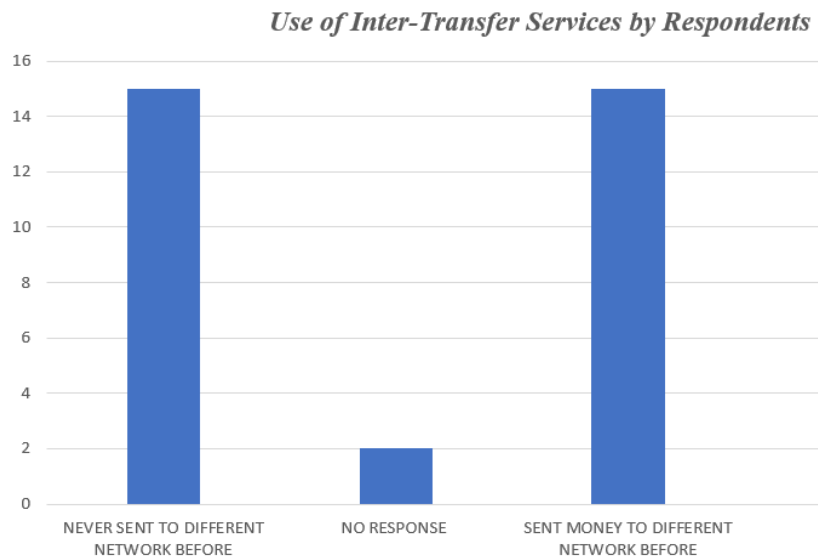


Figure 4.6 Inter-Transfer Services

4.7.2 The effectiveness of interoperability of mobile money services to illiterate users in Zambia.

The researcher used the five-point Likert scale ranging from strongly disagree to strongly agree. An option mid-way for indifferent respondents was provided and the respondents were either not sure or selected to be neutral. The responses were one for strongly agree; one for agree, one for strongly disagree and one for disagree. For example, for the question, “Mobile money services have made sending and receiving money in Zambia easy?” and no respondent strongly disagreed or disagreed to this question. For other questions like “What services do you use mobile money for?” actual solutions were provided. six responses were available, for which the respondents were given a choice to choose as many options as possible. The responses were then profiled to assess the data quality.

4.7.3 Response to how challenging it is to transfer funds from one mobile money to another.

In order to analyse whether respondents have challenges when sending money to other mobile money networks than the one they are registered to, four options were given out of which the respondents were expected to select only one option by ticking or crossing their choice. The options were strongly-agree, disagree, agree and strongly disagree.

The pie chart below illustrates the response to whether respondents found it a challenge to send money from one mobile money network to another using the existing methods.

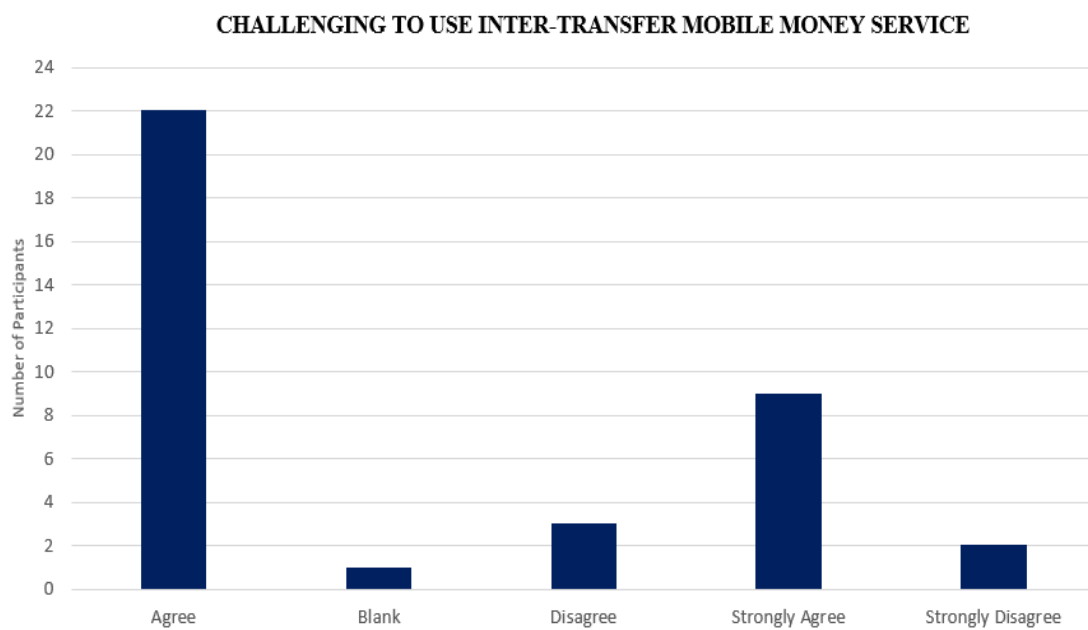


Figure 4.7 Challenges when using inter-transfer services.

The pie chart in figure 4.7 shows that the 60 of the respondents agreed that they face challenges sending money from one mobile money to another, 24 strongly agreed to this question, 8 of the respondents disagreed to this question, 5 strongly disagreed while 3 of the respondents left this question blank.

4.8 Response on whether the mobile money services in Zambia need improvements.

The respondents were given an opportunity to write as many words as they wished on whether the mobile money services in Zambia needed improvement. The following were the responses.

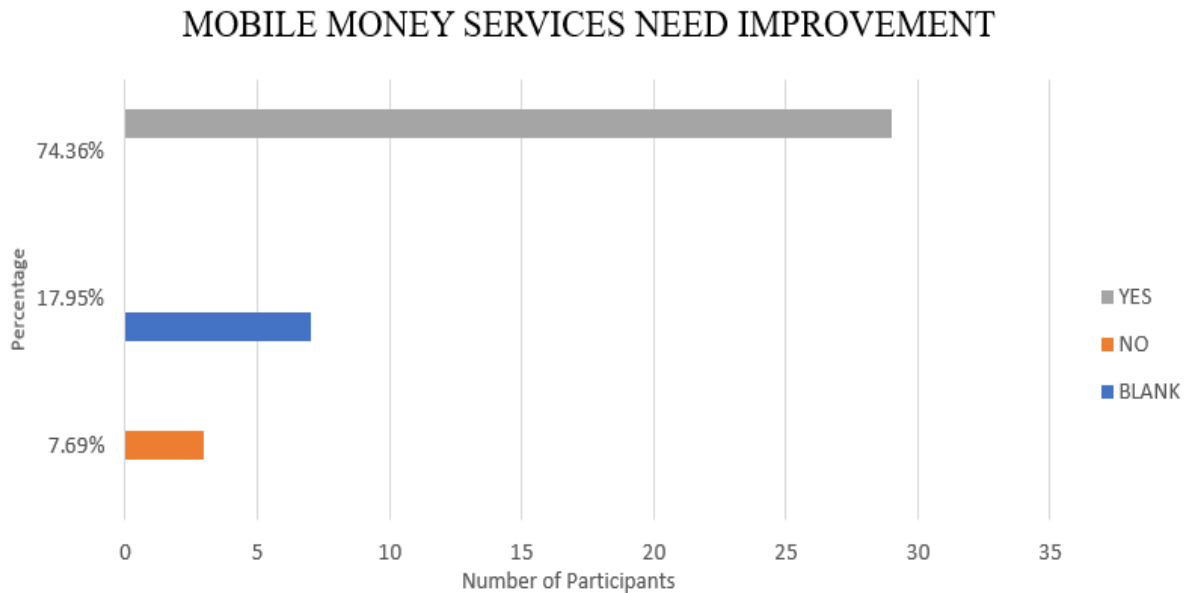


Figure 4.8 Improvement of Mobile money services

As shown in the figure 4.8 above, 29 respondents said mobile money services need improvements in Zambia and this represented 74.36 of the total respondents, one of these respondents said “inter-mobile transfer should be improved and made easier to everyone including those in rural areas of Zambia”. 3 respondents said mobile money services do not need improvements in Zambia and this represented 7.69 of the total respondents, one of these respondents said not really the transfer of funds need to be improved but the security of the mobile money services to avoid fraudulent activities. 7 respondents left this question blank and this represented 17.95 of the total respondents.

4.9 Chapter Summary

This chapter looked at the findings of the study. The effectiveness of interoperability of mobile money services to illiterate users in Zambia depended on whether it was helpful to the user and how necessary the system was in relation other mobile money applications. The chapter further revealed that the application was marred by challenges such as lack of knowledge on how to use smart phones, high internet charges on bundles to connect to the internet for the mobile application to work, etc. The suggested solutions to the challenges by the respondents included teaching the users how to use the mobile application in person and other plans like having tutorials via social media and through adverts on various platforms like radio and television.

5. CHAPTER FIVE: DISCUSSION OF FINDINGS

5.0 Introduction

This chapter will discuss the stated objectives based on the findings of the research presented in chapter four. The focus is on the presentation, findings as well as discussion of data collected from individuals that took part in the evaluation study. It is important to discuss the theoretical viewpoint of the finding so that these might leave useful effects for the stakeholders.

- i. To understand the role that the interoperability of mobile money services plays for all users in Zambia.
- ii. To identify the challenges of illiterate users towards ICT in Zambia.
- iii. To establish an initiative that mobile money services and other financial institutions could put in place to accommodate all types of mobile money users regardless of their educational background.

5.1 The role that the mobile money application plays in aiding users in Zambia.

GSMA sub-Saharan [32] stipulated that USSD remains the dominant channel used for mobile money services. Over 90% of mobile transactions in sub-Saharan African are still processed via USSD but in recent developments, there has been a drastic update in smart phone adoption and mobile internet is on the horizon with an estimation of 280 million new mobile internet subscribers coming online by 2025 in sub-Saharan Africa.

The study revealed that eighty seven percent (87.5%) of the respondents owned smart phones while the rest either had owned one in the past but lost it, know how to use one or does not own any mobile money account. Mobile money services have played a key role in enhancing financial inclusion in Zambia therefore, it is very important that service providers deliver innovative platforms that accommodate all kinds of users. The following are some of the roles that the mobile money application developed will play in aiding users in Zambia.

- i. The mobile application gives users the ability to transfer funds from one service provider to another with ease and the receiver will have their account or wallet credited directly and instantly.

- ii. The mobile application has been integrated to operate between Zamtel Kwacha and MTN Zambia money therefore users can transact between the two mobile money service providers.
- iii. The mobile application has been designed with an interface to accommodate illiterate users because it uses pictography options and less text and digits. This gives the users a better experience and more realistic feeling when transacting.

The findings of this research are consistent with [32] who found that most important facet for the illiterate users is to be able to use an interface where the absence of text and numbers increase their ability to interact and perform activities. The interface relies conclusively on image for interaction elements. The user can confirm through their stack of digitally represented bills and inspect them separately.

The levels of fraud cases relating to mobile money services has been on the rise in recent years therefore security has to be implemented very well on both the user end and the service provider's end to achieve a secure system for transactions. Both the mobile application developer and the mobile service provider have a role in ensuring that the inefficiencies and ineffectiveness of service delivery are properly handled as these can cause risks and disagreements during the payment transactions. From the mobile application end, secret personal identification numbers must be used for a user to be authorized access to an account.

5.2 Challenges of mobile money applications in Zambia

Apart from financial inclusion to large quantities of unbanked communities which mainly comprise of the poor and people living in remote rural area, the ability to support capital accumulation and household savings, the mobile money services are changing money transmission policy and guidelines as well as financial transaction models and rules and regulations of financial transaction environment. According to Christopher and Sébastien [87] central banks have uttered deep apprehension of the risk of mobile money transactions undermining conventional monetary control system, which include financial sector development and price stability [49]. The following are some other challenges being faced by mobile money applications in Zambia.

- i. Smart phone market penetration - The fact that some people do not own smart phones makes the use of mobile money applications limited. They can only use registered mobile money agents to send or receive money. This makes them nonregular users

hence they cannot enjoy the use of various value-added services such as payment of bills and airtime purchase on their own.

- ii. Poor network connectivity and unreliable services - The major factor that hinders large population of customers from using mobile money applications service is network or service failures. Some places especially rural areas have network connectivity problems causing users to have high service drop rates and service hanging, this makes it very difficult to transact.
- iii. Lack of information and understanding among non-users - In many cases, non-users were aware of mobile money applications but had only a very basic understanding of the uses and benefits. When asked to rate their level of understanding, often most of them said that their knowledge of mobile money application was limited.
- iv. Expensive to use due to internet connectivity needs – Some respondents complained on the fact that majority of mobile applications are slow in terms of operation and expensive due to high charges on internet bundles by mobile service providers.

5.3 Proposed initiative to Mobile Money service providers

Initiative that Mobile money service providers could implement is by accommodating illiterate users and handle the challenges of interoperability of mobile money services. There has been a significant increase in the number of people using smart phones in Zambia, this is mainly due to the massive competition amongst mobile smart phone manufacturers. Out of the respondents that took part of the survey, only one was discovered to not owning a smart phone but had further claimed to have had owned one before in their past. According to the survey that was carried out, 74.36% of the respondents suggested that the current mobile money systems need to be improved. There are several ways in which mobile money service providers can improve the service, the most important step is to accommodate all type of users especially the illiterate users.

To improve the levels of ICT illiteracy towards digital money services in Zambia, the government and Non-government organisations should invest in various ways of providing information on the latest technologies and proper guidelines on how to use these technologies and inventions via various platforms. Authentic content for practice should be provided in all provinces and important resources such as internet should be accessible and affordable.

5.4 The Mobile Money Application Outcome

The following are some screenshots of the developed mobile money application.

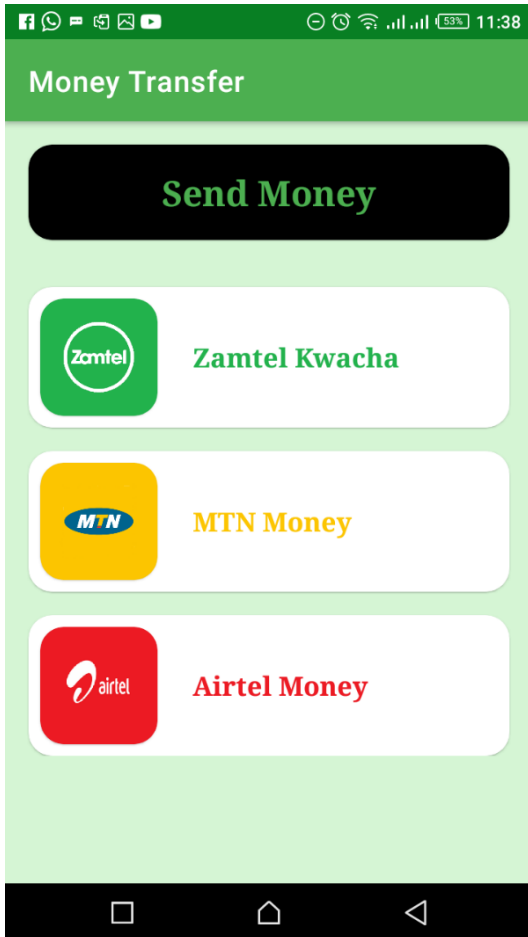


Figure 5.1 a) Home Menu

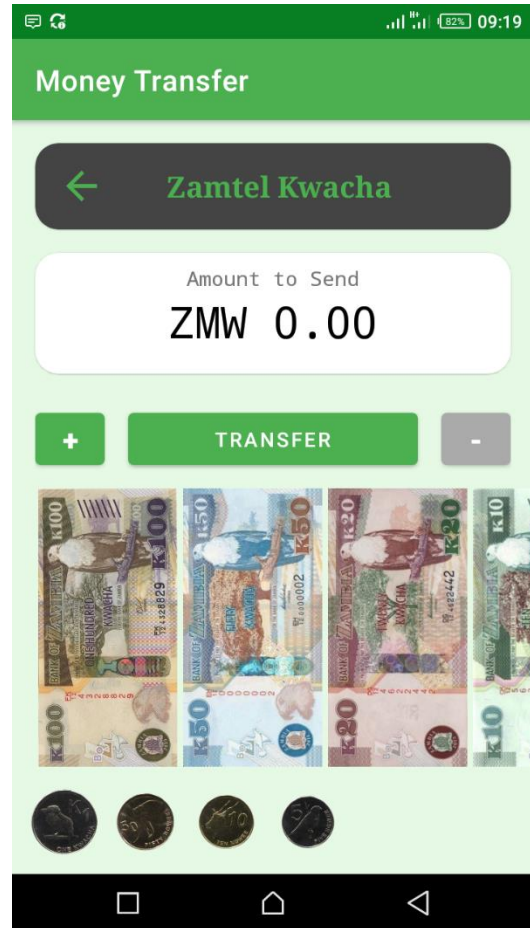


Figure 5.1 b) Transfer Interface Display

The home menu of the mobile application is as shown in figure 5.1 (a) above, the three mobile money network providers are displayed on this menu and a user must select which network that they belong to. Figure 5.1 (b) shows the menu that is displayed after a user selects the network provider that they belong to.

Shown below is the Money transfer menu interface with kwacha bills displayed.

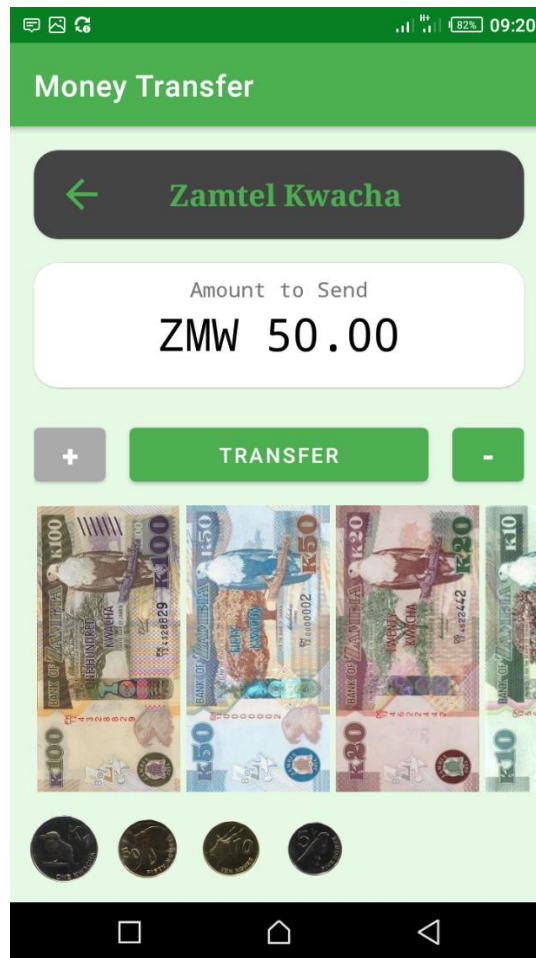


Figure 5.2 Mobile Money application showing selected ZMW50 Bank note

The menu displayed in figure 5.2 above gives the user the freedom to select amount of money they intend to send by clicking the respective bills. To Add or Subtract amounts selected, the plus and minus sign can be used followed by the corresponding bill. Coins are also displayed on the bottom of this menu.

Shown below is the process of transfer and selection of recipient.

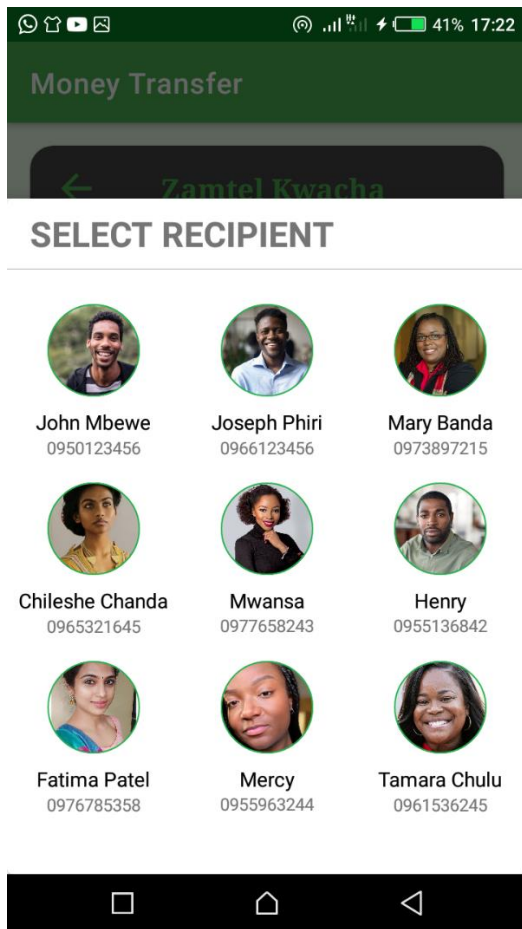


Figure 5.3 (a) Recipient Menu

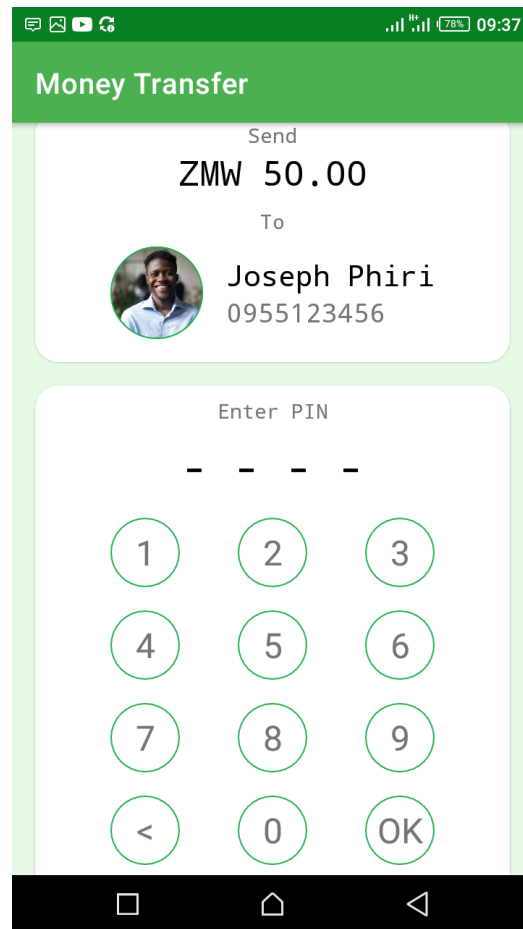


Figure 5.3 (b) Authentication Menu

The recipient menu shown in figure 5.3 (a) above gives the user an option to select whom they wish to send funds to. The recipients are saved in the database under their respective mobile money network provider interlinked with the mobile application. After selection of recipient, the next menu that is displayed is the authentication menu where the user must enter their personal identification number for security purposes as shown in figure 5.3 (b) above.

Shown below is the authentication process on the mobile application.

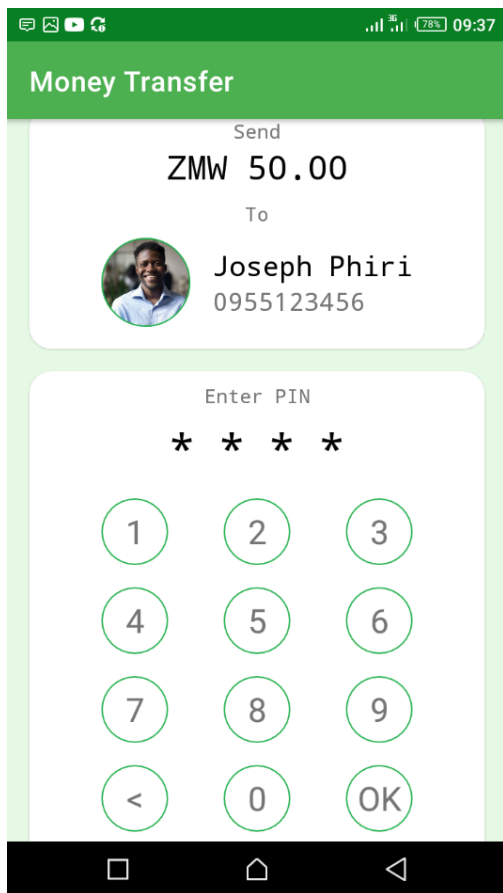


Figure 5.4 (a) Enter PIN for Authentication

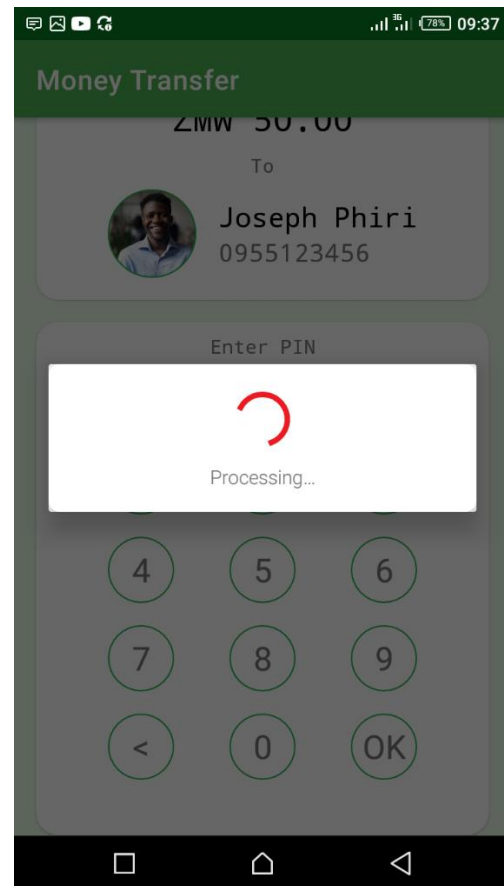


Figure 5.4 (b) Authentication Process

The process of authentication requires the user to enter their personal identification number as shown in figure 5.4 (a) which follows an authentication process shown in figure 5.4 (b) above.

Shown below are the authentication notification types.

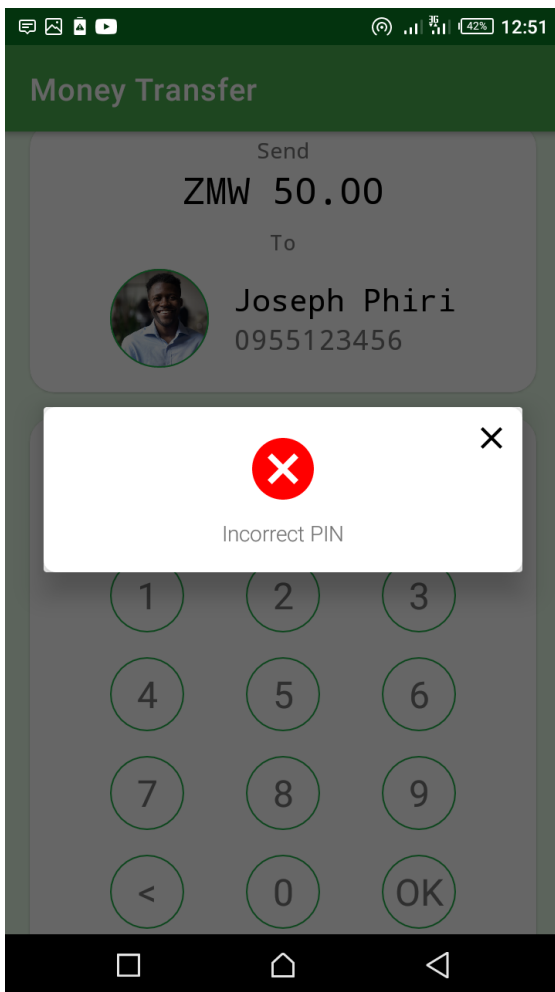


Figure 5.5 (a) Incorrect Pin Notification

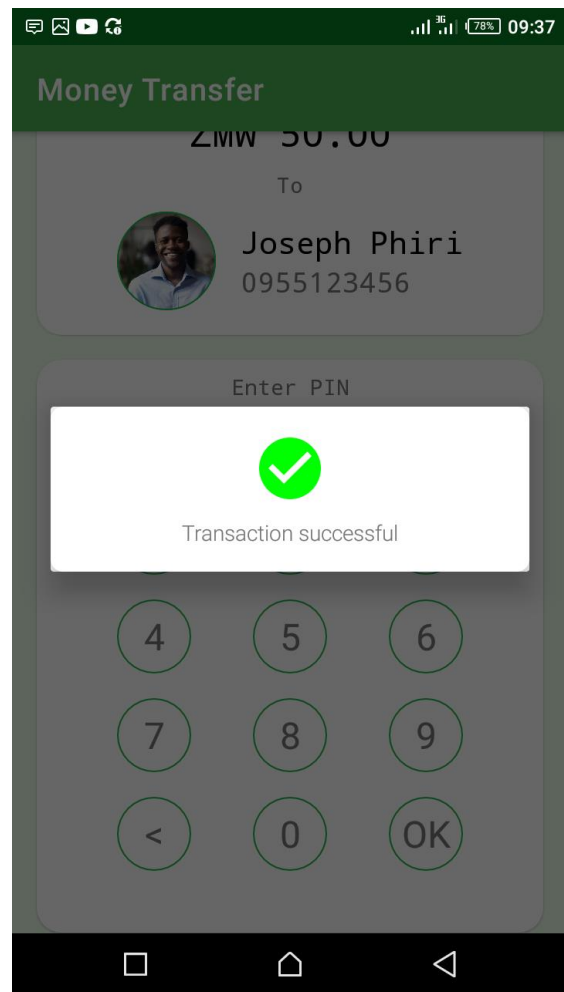


Figure 5.5 (b) Correct Pin Notification

The figure 5.5 (a) above shows the display of an incorrect input of a Pin, this means the transaction is unsuccessful and no funds will be sent to the recipient. If the user enters a correct Pin as shown in figure 5.5 (b) above, the transaction is successful, and funds will be sent to the recipient.

5.4 Chapter Summary

The study found that holding all other factors constant, security, speed, reliability, cost effectiveness and accessibility determine the effectiveness of the interoperability of mobile money services for all kinds of users. For mobile money use to be truly pervasive, there is firstly the need for it to become a universal information utility that is of value to the majority. This in turn requires mobile money solutions to scale up and reach critical mass [88], thus enabling cashless transactions and exchanges to be easily possible. The ubiquity of mobile phone telephony in sometimes the remotest of areas makes it a uniquely suited candidate to address this challenge a challenge compounded by the current lack of interfaces geared towards illiterate users, a sizeable community in some areas of rural Africa (and not only).

In terms of challenges, the main challenges of the use of cashless systems in Zambia is the lack of smart phones in rural areas, internet challenges and high levels of illiteracy towards ICTs amongst the elders and the uneducated.

6. CHAPTER SIX

6.0 Recommendation and Conclusion

This chapter presents the research conclusion and the recommendations. The conclusion is in line with the objectives the research had earlier set out to meet. The recommendations were arrived at having looked at the preceding data and the responders obtained from the respondents.

6.1 Conclusion

Investigation was done on the types of money transforms in Zambia, the findings show that there are various types of money transforms with the main three being those owned by the telecommunications companies in Zambia namely Airtel money, MTN money and Zamtel kwacha. According to the research that was done, the most popular and biggest mobile money service in Zambia is Airtel Money with a market penetration of 48% followed by MTN money with market penetration of 39% and the least among the three is Zamtel with 13%.

The android mobile money application was developed using Kotlin language which is a multi-paradigm language supporting both object-oriented and functional programming paradigms. The integrated development environment (IDE) tool that was used is Android studio.

To achieve interoperability between Zamtel kwacha and MTN Zambia using the findings from the surveys, a mobile application was developed to meet the proposed features needed to satisfy the need for digital inclusion among all type of users in Zambia. The request to pay Application programming interface (APIs) were used and the interface of the mobile application that was developed was intuitive for illiterate users as it encompassed icons and pictography as opposed to number and text-based features currently on the Zambian market which hinders some users to operate efficiently.

6.2 Recommendations

Mobile money services are clearly taking a center stage in the most developing African countries like Zambia. It is therefore top priority for mobile money providers to meet the needs of all potential customers to improve the digital divide in Zambia. There are many innovative ways that mobile money service providers can improve their services but the most significant approach that can be used is making sure that all kinds of users are accommodated in the ever-growing digital world. Options like voice-based systems, image detection and integration of other existing platforms into one platform are some of the alternatives that can be looked at to try and improve the user's experience.

To improve the mobile money application developed in this project, the following are some of the recommendations that can be considered.

1. Voice based system – This feature will make the application suitable for use by the blind. Users can access all features on the mobile application by simply using voice commands and the app will respond accordingly.
2. Image recognition – This can be used as an alternative security feature to prevent unauthorized access to user's accounts by unknown personnel.
3. Integrating more platforms and features onto the mobile application – This will enable more features and platforms to be included onto the mobile application for users to experience a better interoperability platform e.g., talk time, bill payments, point of sale etc.

6.3 Future Works

Future works will involve a continued development of the mobile money application to represent a digital wallet, purchasing and money transfer system. Large scale user evaluation should be performed with the citizens in rural Zambia and inclusion of additional supportive innovations such as voice command and motion-based techniques to accommodate the deaf and blind, respectively. To facilitate the growing number of third-party integrations in the ecosystem, mobile money providers typically do not charge on-boarding fees and generate revenue through transaction fees. In future, offering tiered pricing could further boost growth of the mobile money industry.

References

- [1] Mobile for development, [Online], Available: <https://www.gsma.com/mobilefordevelopment/uncategorizes/unlocking-mobile-money-interopability-and-merchant-payments-across-africa-through-mowali>. [Accessed: February 27, 2020].
- [2] Dolan, J. “Accelerating the Development of Mobile Money Ecosystems”, DC: IFC and the Harvard Kennedy School, Washington (USA). 2009.
- [3] State of the industry 2013, “Mobile financial services for the unbanked”, GSMA, 2013.
- [4] S. Rutherford, “The Poor and their Money: An essay about financial services for the poor”, Institute for development Policy and Management University of Manchester, UK, 1999.
- [5] Aker, Jenny C., and Isaac M. Mbiti, "Mobile Phones and Economic Development in Africa." *Journal of Economic Perspectives*, 24 (3): 207-32, 2010.
- [6] Nzioka, D., Palakurthi, P, *Impact of Mobile Banking on Microfinance Institutions: A Case Study of Small and Micro Enterprise Program (SMEP)*, LAP Lambert Academic Publishing, 2011.
- [7] Patrick M. Mutimushi, “2019 Annual Zicta report”, Zambia Information and Communications technology, 2020.
- [8] Bank of Zambia, finscope survey topline findings, 2020.
- [9] Aman S, Kentaro T, “Text-Free User Interfaces for Illiterate and Semi-Literate Users”, Indrani Medhi, 2005.
- [10] A. Crabtree and T. Rodden, 2002 Ethnography and design? 'International Workshop on 'Interpretive' Approaches to Information Systems and Computing Research', London, 70-74, (2002).
- [11] C. Wasson, Ethnography in the field of design. *Human Organization* 59 (4):377-388 (2000).
- [12] M. Huenerfauth, Developing design recommendations for computer interfaces accessible to illiterate users. Master’s thesis, University College Dublin, (2002).
- [13] Vijay K. Vaishnavi, William L. Kuechler, *Design Science Research in information Systems*. Ais, 2004, pp. 1–45.
- [14] P. Chuhan-Pole and M. Angwafo. Mobile Payments Go Viral:M-PESA in Kenya. In *Yes, Africa Can: Success Stories from a Dynamic Continent*. World Bank Publications, June, 2011.

- [15] J. Kamana. M-PESA: How Kenya Took the Lead in Mobile Money. Available: <http://www.mobiletransaction.org/m-pesakenya-the-lead-in-mobile-money>. [Accessed: October 23, 2019].
- [16] C. Penicaud and A. Katakam. Mobile Financial Services for the Unbanked: State of the Industry, Technical report, GSMA, 2013.
- [17] Bill & Melinda Gates Foundation. Financial Services for the Poor: Strategy Overview. Available: <http://www.gatesfoundation.org/What-We-Do/Global-Development/Financial-Services-for-the-Poor>. [Accessed: February 23, 2020].
- [18] Burns, N. and Grove, S.K, The Practice of Nursing Research, Conduct, Critique, and Utilization. 4th Edition, W.B. Saunders Company, Philadelphia, 2001.
- [19] Polit, D. and Hungler, B.: Nursing Research: Principle and Method, 6th ed.; Philadelphia: Lippincott Company, 1999, P.P. 416-417.
- [20] T. Parikh, K. Ghosh and A. Chavan, Design Considerations for a Financial Management System for Rural, Semi-literate Users. ACM Conference on Computer-Human Interaction, (2003).
- [21] T. Parikh, K. Ghosh and A. Chavan, Design Studies for a Financial Management System for Micro-credit Groups in Rural India. ACM Conference on Universal Usability, (2003).
- [22] T. Parikh, HISAAB: An Experiment in Numerical Interfaces, Media Lab Asia Panel Discussion, Baramati Initiative on ICT and Development, (2002).
- [23] S. Grisedale, M. Graves, A. Grunsteidl: Designing a Graphical UserInterface for HealthcareWorkers in Rural India, ACM CHI, (1997).
- [24] A. Chand, Designing for the Indian rural population: Interaction design challenges. Development by Design Conference, (2002).
- [25] Hevner, A. R., March, S. T., Park, J. and Ram, S. "Design science in information systems research." MIS Quarterly, 2004, 28 (1) 75-105.
- [27] Kendall, J., Maurer, B., Machoka, P., & Veniard, C. An emerging platform: From money transfer system to mobile money ecosystem. innovations, 2011, 6(4), 49-64.
- [28] CGAP, [Online], Available <https://www.cgap.org/news/cgap-finds-technology-alone-cannot-deliver-successful-interoperability>
- [29] "Interoperability", [Online], Available: <https://www.adsc.com/blog/what-is-interoperability-and-why-is-it-important> [Accessed: February 23, 2020].

- [30] Kennickell, Arthur B. “Multiple Imputation in the Survey of Consumer Finances.”, Board of Governors of the Federal Reserve System, mimeo, September, 1998.
- [31] Mantel, Brian, Why Do Consumers Pay Bills Electronically? An Empirical Analysis. *Economic Perspectives*, Quarter 4 Issue, 2000. Available at SSRN: <https://ssrn.com/abstract=248409> or <http://dx.doi.org/10.2139/ssrn.248409>. [Accessed: December 28, 2019].
- [32]. Neil Davidson N, Leishman P, “The case for interoperability: Assessing the value that the interconnection of mobile money services would create for customers and operators”, GSMA, London, 2012.
- [33] Collins, D., Morduch, J., Rutherford, S. and Rutheven, O. *Portfolios of the poor*. Princeton, NJ: Princeton University press, 2009, PP, 1-174.
- [34] Dhakhwa, S., Hall, P., Ghimire, B., Manandhar, P. and Thapa, I. *Human-Computer Interaction*, Part I, HCII 2007, Lecture Notes in Computer Science 4550, pp. 721–730.
- [35] R.Duncome, and R. Boateng. Mobile phones and financial services in developing countries. Working paper, No 37. Centre for development informatics, institute for development policy and management, 2009.
- [36] Airtel, “Airtel Money”, [Online]. Available: www.airtel.co.zm/airtel_money [Accessed: January 20, 2020].
- [37] A. Zelizer. *The social meaning of money: Pin money, pay checks, poor relief, and other currencies*. Princeton University Press. New Jersey, 1997.
- [38] R. Byler. What is Money? Mid-South College Computing Conference, MSCCC, 2004. pp. 200–209 B.
- [39] Zamtel, “Zamtel Kwacha”, [Online]. Available: www.zamtel.zm/personal_kwacha_4_kwacha [Accessed: January 23, 2020].
- [40] Ondiege, P, *Mobile Banking in Africa: Taking the Bank to the People*. Africa Economic Brief, 1 (8), 2010.
- [41] MTN, “MTN Money”, [Online]. Available: www.mtnzambia.com/en/services/mobile-money [Accessed: January 20, 2020].

- [42] Mark A. Foltz, and R. Davis, Query by attention: Visually searchable information maps. International Conference on Information Visualization IV (2001). IEEE Computer Society, (2001).
- [43] Singh R, Roy S, “Financial Inclusion: A Critical Assessment of its Concepts and Measurement”, Asian Journal of Research in Business Economics and Management, 2015.
- [44] Intellectsoft, “Best Mobile IDEs for Android Development”, [Online] Available at: <https://www.intellectsoft.net/blog/5-of-the-best-mobile-ides-for-android/> [Accessed April 1, 2021].
- [45] Artyom Dogtiev, “Android development tools” [Online] Available at: <https://www.businessofapps.com/marketplace/app-development-software/research/android-development-tools/> [Accessed April 1, 2021].
- [46] Alan, “Types of user interfaces”, [Online] Available: <https://alan.app/blog/types-of-user-interface/> [Accessed April 1, 2021].
- [47] Marcus Aaron, “Dare We Define User-Interface Design”, Interactions, 2002.
- [48]. Kleppe, A., Warmer, J., Bast, W.: MDA Explained: The Model Driven Architecture: Practice and Promise. Pearson Education, Inc., Boston (2003).
- [49]. Pleuss, A.: MML: A Language for Modeling Interactive Multimedia Applications. In: ISM 2005: Proceedings of the Seventh IEEE International Symposium on Multimedia, pp. 465– 473. IEEE Computer Society, Washington, DC, USA (2005).
- [50]. Pleuß, A., Vitzthum, A., Hussmann, H.: Integrating heterogeneous tools into model-centric development of interactive applications. In: Engels, G., Opdyke, B., Schmidt, D.C., Weil, F. (eds.) MODELS 2007. LNCS, vol. 4735, pp. 241–255. Springer, Heidelberg (2007).
- [51] Akshay S and Sakshi S, “Android Application Development using Android Studio and PHP Framework”, IMS Engineering College IMS Engineering, 2016.
- [52] Justin Calderon, “Mobile money APIs are transforming Africa: MFS Africa’s founder explains how”, 29 May 2020. [Online] Available: <https://www.reloadly.com/blog/api-mobile-money/>. [Accessed: June 13, 2020].
- [53] Francesco Pasti, “Mobile money API industry report towards seamless integrations”, GSMA, 2019.
- [54] Corbin, J., & Strauss, A, Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory (3rd ed.). Thousand Oaks, CA: Sage, 2008.
- [55] Mobile money in Tanzania use, barriers and opportunities, The Financial Inclusion Tracker Surveys Project, February, [Online] Available: http://www.intermedia.org/wp-content/uploads/FITS_Tanzania_Full_Report_final.pdf Jack, W & Suri. [Accessed December 19, 2020].

- [56] Tanzania mobile money tracker study - Wave 3 Report, [Online] Available: <http://www.audiencescapes.org/sites/default/files/Tanzania%20Mobile%20MoneyQ3.pdf> [Accessed December 13, 2020].
- [57] IFC (International Finance Corporation), “Mobile Money Study 2011, Washington”, [Online] Available: <http://www.ifc.org/ifcext/globalfm.nsf/Content/Mobile+Money+Study+2011>. [Accessed January 12, 2021].
- [58] "Exploring consumer adoption of mobile payments - A qualitative study," Journal of Strategic Information Systems, Vol. 16, pp. 413-432, 2007. 69 Merritt, C 2010.
- [59] Victor O, Leopoldo T, Felipe E, “On the Adoption of Kotlin on Android Development: A Triangulation Study”, Informatics Center Federal University of Pernambuco, 2020.
- [60] Neuman, W. L. Social research methods qualitative and quantitative approach (6th ed.), Upper Saddle River: Pearson, 2006.
- [61] Jerry Gao, Xiaoying Bai, Wei-Tek Tsai, Tadahiro Uehara. "Mobile Application Testing: A Tutorial". Computer (Volume: 47, Issue: 2), 02 January 2014. pp. 46-55.
- [62] Kochhar, P.S; Thung, F.; Nagappan, N.; Zimmermann, T. “Understanding the Test Automation Culture of App Developers” Software Testing, Verification and Validation (ICST), 2015 IEEE 8th International Conference on 13-17 April 2015,pp 1-10.
- [63] Kirubakaran, B. Karthikeyani,V.”Mobile Application Testing – Challenges and Solution Approach through Automation”.Pattern Recognition, Informatics and Mobile Engineering (PRIME), 2013 International Conference on Feb. 2013. pp 79-84.
- [64] Harleen K. Flora, Xiaofeng Wang, Swati V.Chande,” An Investigation into Mobile Application Development Processes: Challenges and Best Practices”in IJMECS Vol.6, No. 6, June 2014.
- [65] Muccini, H. Di Francesco, A, Esposito, P, “Software testing of mobile applications: Challenges and future research directions” Automation of Software Test (AST), 2012 7th International Workshop on 2-3 June 2012,pp 29-35.
- [66] Zhifang Liu,Xiaopeng Gao, Xiang Long. “Adaptive Random Testing of Mobile Application”,Computer Engineering and Technology (ICET), 2010 2nd International Conference on (Volume:2) April 2010,pp V2-297 - V2-301.

- [67] Coimbra Morgado, I. Paiva, A.C.R.; Faria, J.P.”Automated Pattern-Based Testing of Mobile Applications”.Pattern Recognition, Informatics and Mobile Engineering (PRIME), 2014 International Conference on Sept. 2014.pp 294-299.
- [68] Statista, “Mobile operating systems' market share worldwide from January 2012 to January 2021”, [Online] Available: <https://www.statista.com/statistics/272698/global-market-share-held-by-mobile-operating-systems-since-2009/> [Accessed March 31, 2021].
- [69] V. Patel, “Guide to Porting Android Applications to Windows 8” [Online]. Available at: <http://www.developer.com/ws/android/programming/guide-toporting-android-applications-to-windows-8.html> [Accessed March 31, 2021].
- [70] Creswell, J, Research design: Qualitative, quantitative, and mixed methods approaches (3rd ed.). Thousand Oaks, CA: Sage, 2009.
- [71] Isadore Newman, Carolyn R. Benz, Professor Carolyn S Ridenour, Qualitative-quantitative Research Methodology: Exploring the Interactive Continuum, illustrated, SIU Press, 1998.
- [72] Aliaga, M. and Gunderson, B, *Interactive statistics*. Upper Saddle River, N.J.: Pearson Prentice Hall, 2006.
- [73] Slife, B. D., & Williams, R. N, What’s behind the research? Discovering hidden assumptions in the behavioral sciences. Thousand Oaks, CA: Sage Publications, 1995.
- [74] Sjoberg Svein, “Constructivism and Learning”, University of Oslo, Norway, 2007.
- [75] LoBiondo-Wood, Geri, and Judith Haber. *Nursing Research: Methods, Critical Appraisal, and Utilization*. St. Louis: Mosby, 1998.
- [76] Donald K.K., and Delno L. A. T, “Proposal and Thesis Writing, An introduction”, Pauline Publications Africa. Nairobi, Kenya, 2009.
- [77] Geoff Payne and Judy Payne, “Key concepts in social research”, SAGE, London, 2004.
- [78] D.K Kombo and D.L Tromp, “Proposal and thesis writing: An introduction”, Nairobi: Paulines Publications Africa 5, 2008, 814-30.
- [79] Vaishnavi, V., Kuechler, W.: Design Science Research Methods and Patterns: Innovating Information and Communication Technology, New York, Auerbach (2008).

- [80] Gjonca, E., & Calderwood, L. (2004). Socio-demographic characteristics. *Health, Wealth and Lifestyles of the Older Population in England: The 2002 English Longitudinal Study of Ageing*, 15 – 32. [https://doi.org/10.1016/0020-7489\(70\)90025-8](https://doi.org/10.1016/0020-7489(70)90025-8).
- [81] George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference 11.0 update (4th ed.)*, Boston: Allyn & Bacon.
- [82] “Android Studio” Accessed: Aug 12,2020 [Online]. Available: www.developer.android.com/studio/index.html
- [83] Ducrohet, Xavier; Norbye, Tor; Chou, Katherine (May 15, 2013). "Android Studio: An IDE built for Android". *Android Developers Blog*. Google. Retrieved May 16, 2020.
- [84] ^ "Getting Started with Android Studio". *Android Developers*. Google. Retrieved May 14,2020.
- [85] Woldmariam M, Morten G, “A Mobile Money Solution for Illiterate Users”, IEEE international Conference on Mobile Services, 2015
- [86] M. Crawford, *Catching the Sun*, American Society of Mechanical Engineers, Feb. 2013. Accessed on: Nov. 2, 2017. [Online]. Available: <https://www.asme.org/engineering-topics/articles/renewable-energy/catching-the-sun>
- [87] Adam, Christopher S, and Sebastien E. J. Walker, “Mobile Money and Monetary Policy in East African Countries.” University of Oxford. Unpublished, April 2015.
- [88] BYLER, R., What is money? Proceedings of the 2nd annual conference on Mid-south college computing, 2004, New Little Rock, Arkansas April 02 - 03, 2004, Pages: 200 – 209, Mid-South College Computing Conference.
- [89] Ducrohet, Xavier; Norbye, Tor; Chou, Katherine (May 15, 2013). "Android Studio: An IDE built for Android". *Android Developers Blog*. Google. Accessed Aug 10, 2020.
- [90] Fresco, “An image management library” [Online], Available: <https://frescolib.org/> [Accessed January 12, 2021].
- [91] Material, “Material design for android” [Online], Available: <https://developer.android.com/guide/topics/ui/look-and-feel>, Material Design for Android, 2020 [Accessed April 7, 2021].

Appendices

Appendix A: Code

```
apply plugin: 'com.android.application'
apply plugin: 'kotlin-android'
apply plugin: 'kotlin-android-extensions'

android {
    compileSdkVersion 29
    defaultConfig {
        applicationId "paul.project.moneytransfer"
        minSdkVersion 21
        targetSdkVersion 29
        versionCode 4
        versionName "1.0"

        testInstrumentationRunner "androidx.test.runner.AndroidJUnitRunner"
    }

    buildTypes {
        release {
            minifyEnabled false
            proguardFiles getDefaultProguardFile('proguard-android-
optimize.txt'), 'proguard-rules.pro'
        }
    }

    compileOptions {
        sourceCompatibility = 1.8
        targetCompatibility = 1.8
    }

    kotlinOptions {
        jvmTarget = '1.8'
    }
}

dependencies {
    implementation fileTree(dir: 'libs', include: ['*.jar'])
    implementation "org.jetbrains.kotlin:kotlin-stdlib-
jdk7:$kotlin_version"
    implementation 'androidx.appcompat:appcompat:1.1.0'
    implementation 'androidx.core:core-ktx:1.3.0'
    implementation 'androidx.constraintlayout:constraintlayout:1.1.3'
    implementation 'androidx.lifecycle:lifecycle-extensions:2.2.0'
    implementation 'androidx.lifecycle:lifecycle-viewmodel-ktx:2.2.0'
    implementation 'androidx.legacy:legacy-support-v4:1.0.0'
    implementation 'com.google.android.material:material:1.3.0-alpha01'
    implementation 'com.android.volley:volley:1.1.1'
```

```

implementation 'com.facebook.fresco:fresco:2.2.0'
implementation 'com.squareup.okhttp3:okhttp:4.7.2'
testImplementation 'junit:junit:4.13'
androidTestImplementation 'androidx.test.ext:junit:1.1.1'
androidTestImplementation 'androidx.test.espresso:espresso-core:3.2.0'
}

#!/usr/bin/env sh

## Gradle start up script for UN*X
##

# Attempt to set APP_HOME
# Resolve links: $0 may be a link
PRG="$0"
# Need this for relative symlinks.
while [ -h "$PRG" ] ; do
    ls=`ls -ld "$PRG"`
    link=`expr "$ls" : '.*-> \(.*)$'`
    if expr "$link" : '/.*' > /dev/null; then
        PRG="$link"
    else
        PRG=`dirname "$PRG"`"/$link"
    fi
done
SAVED=""`pwd`"
cd "`dirname \"$PRG\"`/" >/dev/null
APP_HOME=""`pwd -P`"
cd "$SAVED" >/dev/null

APP_NAME="Gradle"
APP_BASE_NAME=`basename "$0"`

# Add default JVM options here. You can also use JAVA_OPTS and GRADLE_OPTS
to pass JVM options to this script.
DEFAULT_JVM_OPTS=""

# Use the maximum available, or set MAX_FD != -1 to use that value.
MAX_FD="maximum"
warn () {
    echo "$*"
}
}

die () {
    echo
    echo "$*"
    echo
    exit 1
}

# OS specific support (must be 'true' or 'false').

```

```

cygwin=false
msys=false
darwin=false
nonstop=false
case "`uname`" in
  CYGWIN* )
    cygwin=true
    ;;
  Darwin* )
    darwin=true
    ;;
  MINGW* )
    msys=true
    ;;
  NONSTOP* )
    nonstop=true
    ;;
esac

CLASSPATH=$APP_HOME/gradle/wrapper/gradle-wrapper.jar

# Determine the Java command to use to start the JVM.
if [ -n "$JAVA_HOME" ] ; then
  if [ -x "$JAVA_HOME/jre/sh/java" ] ; then
    # IBM's JDK on AIX uses strange locations for the executables
    JAVACMD="$JAVA_HOME/jre/sh/java"
  else
    JAVACMD="$JAVA_HOME/bin/java"
  fi
  if [ ! -x "$JAVACMD" ] ; then
    die "ERROR: JAVA_HOME is set to an invalid directory: $JAVA_HOME"
  fi
else
  JAVACMD="java"
  which java >/dev/null 2>&1 || die "ERROR: JAVA_HOME is not set and no
'java' command could be found in your PATH."
fi

Please set the JAVA_HOME variable in your environment to match the
location of your Java installation."
fi

# Increase the maximum file descriptors if we can.
if [ "$cygwin" = "false" -a "$darwin" = "false" -a "$nonstop" = "false" ] ;
then
  MAX_FD_LIMIT=`ulimit -H -n`
  if [ $? -eq 0 ] ; then
    if [ "$MAX_FD" = "maximum" -o "$MAX_FD" = "max" ] ; then
      MAX_FD="$MAX_FD_LIMIT"
    fi
  fi
fi

```

```

    fi
    ulimit -n $MAX_FD
    if [ $? -ne 0 ] ; then
        warn "Could not set maximum file descriptor limit: $MAX_FD"
    fi
else
    warn "Could not query maximum file descriptor limit: $MAX_FD_LIMIT"
fi
fi

# For Darwin, add options to specify how the application appears in the
dock
if $darwin; then
    GRADLE_OPTS="$GRADLE_OPTS \"-Xdock:name=$APP_NAME\" \"-
Xdock:icon=$APP_HOME/media/gradle.icns\""
fi

# For Cygwin, switch paths to Windows format before running java
if $cygwin ; then
    APP_HOME=`cygpath --path --mixed "$APP_HOME"`
    CLASSPATH=`cygpath --path --mixed "$CLASSPATH"`
    JAVACMD=`cygpath --unix "$JAVACMD"`

    # We build the pattern for arguments to be converted via cygpath
    ROOTDIRSRAW=`find -L / -maxdepth 1 -mindepth 1 -type d 2>/dev/null`
    SEP=""
    for dir in $ROOTDIRSRAW ; do
        ROOTDIRS="$ROOTDIRS$SEP$dir"
        SEP="|"
    done
    OURCYGPATTERN="(^($ROOTDIRS))"
    # Add a user-defined pattern to the cygpath arguments
    if [ "$GRADLE_CYGPATTERN" != "" ] ; then
        OURCYGPATTERN="$OURCYGPATTERN|($GRADLE_CYGPATTERN)"
    fi
    # Now convert the arguments - kludge to limit ourselves to /bin/sh
    i=0
    for arg in "$@" ; do
        CHECK=`echo "$arg"|egrep -c "$OURCYGPATTERN" -`
        CHECK2=`echo "$arg"|egrep -c "^-"`
### Determine if an option

        if [ $CHECK -ne 0 ] && [ $CHECK2 -eq 0 ] ; then
### Added a condition
            eval `echo args$i`=`cygpath --path --ignore --mixed "$arg"`
        else
            eval `echo args$i`="\"$arg\""
        fi
        i=$((i+1))
    done
    case $i in

```

```

(0) set -- ;;
(1) set -- "$args0" ;;
(2) set -- "$args0" "$args1" ;;
(3) set -- "$args0" "$args1" "$args2" ;;
(4) set -- "$args0" "$args1" "$args2" "$args3" ;;
(5) set -- "$args0" "$args1" "$args2" "$args3" "$args4" ;;
(6) set -- "$args0" "$args1" "$args2" "$args3" "$args4" "$args5" ;;
(7) set -- "$args0" "$args1" "$args2" "$args3" "$args4" "$args5"
"$args6" ;;
(8) set -- "$args0" "$args1" "$args2" "$args3" "$args4" "$args5"
"$args6" "$args7" ;;
(9) set -- "$args0" "$args1" "$args2" "$args3" "$args4" "$args5"
"$args6" "$args7" "$args8" ;;
    esac
fi

# Escape application args
save () {
    for i do printf %s\\n "$i" | sed "s/'/'\\\\\\\\'/g;ls/^/'/;\\$s/\\$/' \\\\\\\/"
; done
    echo " "
}
APP_ARGS=$(save "$@")

# Collect all arguments for the java command, following the shell quoting
and substitution rules
eval set -- $DEFAULT_JVM_OPTS $JAVA_OPTS $GRADLE_OPTS "\-
Dorg.gradle.appname=$APP_BASE_NAME\\" -classpath "\$CLASSPATH\\"
org.gradle.wrapper.GradleWrapperMain "$APP_ARGS"

# by default we should be in the correct project dir, but when run from
Finder on Mac, the cwd is wrong
if [ "$(uname)" = "Darwin" ] && [ "$HOME" = "$PWD" ]; then
    cd "$(dirname "$0")"
fi

exec "$JAVACMD" "$@"

```

```

<?xml version="1.0" encoding="UTF-8"?>
<project version="4">
  <component name="RemoteRepositoriesConfiguration">
    <remote-repository>
      <option name="id" value="central" />
      <option name="name" value="Maven Central repository" />
      <option name="url" value="https://repo1.maven.org/maven2" />
    </remote-repository>
    <remote-repository>
      <option name="id" value="jboss.community" />
      <option name="name" value="JBoss Community repository" />
    </remote-repository>
  </component>
</project>

```

```

        <option name="url"
value="https://repository.jboss.org/nexus/content/repositories/public/" />
    </remote-repository>
    <remote-repository>
        <option name="id" value="BintrayJCenter" />
        <option name="name" value="BintrayJCenter" />
        <option name="url" value="https://jcenter.bintray.com/" />
    </remote-repository>
    <remote-repository>
        <option name="id" value="Google" />
        <option name="name" value="Google" />
        <option name="url" value="https://dl.google.com/dl/android/maven2/"
/>
    </remote-repository>
</component>
</project>

<?xml version="1.0" encoding="UTF-8"?>
<project version="4">
    <component name="RunConfigurationProducerService">
        <option name="ignoredProducers">
            <set>
                <option
value="org.jetbrains.plugins.gradle.execution.test.runner.AllInPackageGradl
eConfigurationProducer" />
                <option
value="org.jetbrains.plugins.gradle.execution.test.runner.TestClassGradleCo
nfigurationProducer" />
                <option
value="org.jetbrains.plugins.gradle.execution.test.runner.TestMethodGradleC
onfigurationProducer" />
            </set>
        </option>
    </component>
</project>

<component name="ProjectCodeStyleConfiguration">
    <code_scheme name="Project" version="173">
        <JetCodeStyleSettings>
            <option name="PACKAGES_TO_USE_STAR_IMPORTS">
                <value>
                    <package name="java.util" alias="false" withSubpackages="false"
/>
                    <package name="kotlinx.android.synthetic" alias="false"
withSubpackages="true" />
                    <package name="io.ktor" alias="false" withSubpackages="true" />
                </value>
            </option>
            <option name="PACKAGES_IMPORT_LAYOUT">
                <value>

```

```

    <package name="" alias="false" withSubpackages="true" />
    <package name="java" alias="false" withSubpackages="true" />
    <package name="javax" alias="false" withSubpackages="true" />
    <package name="kotlin" alias="false" withSubpackages="true" />
    <package name="" alias="true" withSubpackages="true" />
  </value>
</option>
<option name="CODE_STYLE_DEFAULTS" value="KOTLIN_OFFICIAL" />
</JetCodeStyleSettings>
<codeStyleSettings language="XML">
  <indentOptions>
    <option name="CONTINUATION_INDENT_SIZE" value="4" />
  </indentOptions>
  <arrangement>
    <rules>
      <section>
        <rule>
          <match>
            <AND>
              <NAME>xmlns:android</NAME>
              <XML_ATTRIBUTE />
              <XML_NAMESPACE>^$</XML_NAMESPACE>
            </AND>
          </match>
        </rule>
      </section>
      <section>
        <rule>
          <match>
            <AND>
              <NAME>xmlns:.*</NAME>
              <XML_ATTRIBUTE />
              <XML_NAMESPACE>^$</XML_NAMESPACE>
            </AND>
          </match>
          <order>BY_NAME</order>
        </rule>
      </section>
      <section>
        <rule>
          <match>
            <AND>
              <NAME>.*:id</NAME>
              <XML_ATTRIBUTE />
            </AND>
          </match>
        </rule>
      </section>
    </rules>
  </arrangement>
</codeStyleSettings>
<XML_NAMESPACE>http://schemas.android.com/apk/res/android</XML_NAMESPACE>
  </AND>
</match>
</rule>
</section>
<section>

```

```

    <rule>
      <match>
        <AND>
          <NAME>.*:name</NAME>
          <XML_ATTRIBUTE />
        </AND>
      </match>
    </rule>
  </section>
  <section>
    <rule>
      <match>
        <AND>
          <NAME>name</NAME>
          <XML_ATTRIBUTE />
          <XML_NAMESPACE>^$</XML_NAMESPACE>
        </AND>
      </match>
    </rule>
  </section>
  <section>
    <rule>
      <match>
        <AND>
          <NAME>style</NAME>
          <XML_ATTRIBUTE />
          <XML_NAMESPACE>^$</XML_NAMESPACE>
        </AND>
      </match>
    </rule>
  </section>
  <section>
    <rule>
      <match>
        <AND>
          <NAME>.*</NAME>
          <XML_ATTRIBUTE />
          <XML_NAMESPACE>^$</XML_NAMESPACE>
        </AND>
      </match>
      <order>BY_NAME</order>
    </rule>
  </section>
  <section>
    <rule>
      <match>
        <AND>
          <NAME>.*</NAME>
          <XML_ATTRIBUTE />
        </AND>
      </match>
    </rule>
  </section>

```

```

<XML_NAMESPACE>http://schemas.android.com/apk/res/android</XML_NAMESPACE>
    </AND>
  </match>
  <order>ANDROID_ATTRIBUTE_ORDER</order>
</rule>
</section>
<section>
  <rule>
    <match>
      <AND>
        <NAME>.*</NAME>
        <XML_ATTRIBUTE />
        <XML_NAMESPACE>.*</XML_NAMESPACE>
      </AND>
    </match>
    <order>BY_NAME</order>
  </rule>
</section>
</rules>
</arrangement>
</codeStyleSettings>
<codeStyleSettings language="kotlin">
  <option name="CODE_STYLE_DEFAULTS" value="KOTLIN_OFFICIAL" />
</codeStyleSettings>
</code_scheme>
</component>

```

```

{
distributionBase=GRADLE_USER_HOME
distributionPath=wrapper/dists
zipStoreBase=GRADLE_USER_HOME
zipStorePath=wrapper/dists
distributionUrl=https\://services.gradle.org/distributions/gradle-6.5-
all.zip }

```

Appendix B: APIs

Customer Pay Bill (Async Model) API – Actual Response

```
<soapenv:Envelope xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/">
  <soapenv:Body>
    <api:Result xmlns:api="http://cps.huawei.com/synccpsinterface/api_requestmgr"
      xmlns:com="http://cps.huawei.com/synccpsinterface/common"
      xmlns:res="http://cps.huawei.com/synccpsinterface/result">
      <res:Header>
        <res:Version>1.0</res:Version>
        <res:OriginatorConversationID>429106433679961234</res:OriginatorConversationID>
        <res:ConversationID>PRE_AG_20190918_101388eac2dad8d</res:ConversationID>
      </res:Header>
      <res:Body>
        <res:ResultType>0</res:ResultType>
        <res:ResultCode>0</res:ResultCode>
        <res:ResultDesc>Process service request successfully.</res:ResultDesc>
        <res:TransactionResult>
          <res:TransactionID>000000080309</res:TransactionID>
          <res:ResultParameters>
            <res:ResultParameter>
              <com:Key>DebitBalance</com:Key>
              <com:Value>{"list":[{"accountno":"100000000110261029","accounttypename":"Customer
                Dedicated
                Account","amount":"0.00","currency":"ZMW"},{"accountno":"100000000110261037","accountty
                pename":"Customer EMoney
                Account","amount":"7359.60","currency":"ZMW"}],"total":{"amount":"7359.60","currency":"ZM
                W"}}}</com:Value>
            </res:ResultParameter>
            <res:ResultParameter>
              <com:Key>CreditBalance</com:Key>
              <com:Value/>
            </res:ResultParameter>
          </res:ResultParameters>
        </res:TransactionResult>
      </res:Body>
    </api:Result>
  </soapenv:Body>
</soapenv:Envelope>
```

```

        </res:ResultParameter>
    </res:ResultParameters>
</res:TransactionResult>
<res:ReferenceData>
    <res:Referenceltem>
        <com:Key>BillReferenceNumber</com:Key>
        <com:Value>5961231560242127</com:Value>
    </res:Referenceltem>
</res:ReferenceData>
</res:Body>
</api:Result>
</soapenv:Body>
</soapenv:Envelope>

```

MTN Request to pay API

```

import java.net.URI;
import org.apache.http.HttpEntity;
import org.apache.http.HttpResponse;
import org.apache.http.client.HttpClient;
import org.apache.http.client.methods.HttpGet;
import org.apache.http.client.utils.URIBuilder;
import org.apache.http.impl.client.HttpClients;
import org.apache.http.util.EntityUtils;

public class JavaSample
{
    public static void main(String[] args)
    {
        HttpClient httpclient = HttpClients.createDefault();

        try
        {

```

```
URIBuilder builder = new URIBuilder("https://sandbox.momodeveloper.m  
tn.com/disbursement/v1_0/requesttopay/{referenceId}/deliverynotification");
```

```
URI uri = builder.build();  
HttpPost request = new HttpPost(uri);  
request.setHeader("notificationMessage", "");  
request.setHeader("Language", "");  
request.setHeader("Authorization", "");  
request.setHeader("X-Target-Environment", "");  
request.setHeader("Content-Type", "application/json");  
request.setHeader("Ocp-Apim-Subscription-Key", "{subscription key}")
```

```
// Request body
```

```
StringEntity reqEntity = new StringEntity("{body}");  
request.setEntity(reqEntity);
```

```
HttpResponse response = httpClient.execute(request);  
HttpEntity entity = response.getEntity();
```

```
if (entity != null)
```

```
{  
    System.out.println(EntityUtils.toString(entity));  
}
```

```
}
```

```
catch (Exception e)
```

```
{  
    System.out.println(e.getMessage());  
}
```

6.5.2 Field Descriptions

OriginatorConversationID:- OriginatorConversationID should be unique for each request and is generated from your end

CallerType:- Is a fixed value, i.e. 2

ThirdPartyID:- API thirdparty Id defined on the Mobile Money System and shared with the integrating third parties

Password:- Password for the API thirdpartyID connection, provided by Zamtel Mobile Money

ResultURL:- ResultURL is the url from your side, which is used to receive result parameters following the submission of the request

KeyOwner:- Fixed Value

Timestamp:- timestamp , format yyyyymmddhhmmss

IdentifierType:- is a fixed value i.e. 1 This identifies where it is a customer, customer as initiator , like send money , customer withdraw, customer pay bill , pay merchant etc.

Identifier:- Variable, Customer's Mobile Number

SecurityCredential:- SecurityCredential is the encrypted PIN customer entered , should be encrypted from your side . Padding type is PKCS5PADDING and Mode is EBC. You can test 1234 and see if encrypted PIN is kMhIAmNE4h8= or not

ReceiverParty IdentifierType:- Fixed Value i.e. 4

ReceiverParty Identifier>:- Organisation Short Code being credited and this is created and provided for your usage by Zamtel Mobile Money

BillReferenceNumber:- value which indicates the reference number for paying a bill

Amount – User/customer inputted amount

Currency:- Fixed value for Currency code

Test Bed URLs

Async Mode(With ResultURL)

<http://172.18.2.132:35001/payment/services/APIRequestMgrService/>

Sync Mode (Without ResultURL)

<http://172.18.2.132:35001/payment/services/SYNCAPIRequestMgrService/>

Appendix C: Timelines

Activities	Timelines											
	December, 2019	January, 2020	February, 2020	March, 2020	April, 2020	May, 2019	June-July, 2020	Aug-September 2020	October 2020	Nov-December 2020	January 2021	March 2021
Contact with supervisors												
Research Topic Selection/Approval												
Proposal development												
Proposal Presentation / Ethical Clearance												
Field Work (Data Collection)												
Mobile App Development												
Compilation of reports												
Seminar Presentation												
Submission												
Final Presentation												

Table 6.1 Timeline

Appendix D: Budget

The budget for this project is as shown in table 6.2 below;

Item	Quantity	Unit Price (ZMK)	Sub Total (ZMK)
1) Rims of paper	2	50	100
2) Bond Paper	10	30	300
3) Pens	5	1	5
4) Pencils	5	0.5	5
5) Rubber	3	1	3
6) Notebooks	2	10	20
7) Flush disk	1	65	65
8) Sim Cards	3	5	15
9) Transportation costs		600	600
10) Ethical Clearance	1	1000	1000
11) Printing of the thesis	3	360	360
12) Binding of the thesis	3	750	750
13) Google Playstore Subscription	1	530	530
14) Internet Bundles		800	800
15) Talktime		250	250
16) Overhead		500	500
TOTAL			5,303

Table 6.2 Budget

Appendix E: Questionnaires

INTEROPERABILITY OF MOBILE MONEY SERVICES FOR ILLITERATE USERS

Instructions: Answer by using a Tick (✓) or Cross (x)

A-1 Do you have a mobile money account?

Yes

No

A-2 How many mobile money accounts do you have?

1

2

3

A-3 What mobile money service provider do you use?

Airtel

MTN

Zamtel

A-4 What services do you use mobile money for?

Send Money within same network

Send Money to another network

Save Money

Pay Bills

Make payments

Other

A-5 Do you ever send money to a different mobile money network than the one you are registered to? If Yes, state how you go about it.....

A-6 Mobile money services have made sending and receiving money in Zambia easy.

Strongly				Strongly
Agree	Agree	Disagree	Disagree	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

A-7 Will this innovation make the transfer of money from one network to another easier?

Yes

No

A-8 Users find it challenging to transfer money to other mobile money networks than the one they are registered to (Inter-Mobile money transfer).

Strongly				Strongly
Agree	Agree	Disagree	Disagree	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Evaluation Study

INTEROPERABILITY OF MOBILE MONEY SERVICES FOR ILLITERATE USERS

Instructions: Answer by using a Tick (✓) or Cross (x)

B-1 Have you tested (used) the Mobile Application?

Yes

No

B-2 Is it easy to use?

Strongly Agree	Agree	Disagree	Strongly Disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

B-3 Can someone illiterate find it easy to use?

Strongly Agree	Agree	Disagree	Strongly Disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

B-4 Would this application be accepted by the public?

Strongly Agree	Agree	Disagree	Strongly Disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

B-5 Would you recommend this Mobile Application to others?

- [] Yes
- [] No



THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
OFFICE OF THE DEAN

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Fax: (+260) 211 293 792 | 290 962 | Email: dean-eng@unza.zm | info-eng@unza.zm | Website: www.unza.zm

28th April, 2020

CHAIRPERSON
NASREC/HSSREC
University of Zambia
P.O. Box 32379
LUSAKA

Dear Sir,

RE: APPROVAL OF RESEARCH PROPOSAL

Reference is made to the above captioned matter.

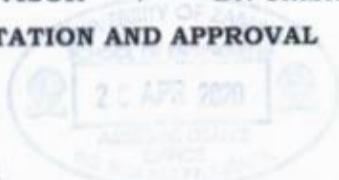
I write to confirm that Research Proposal for the candidate mentioned below was approved as follows;

NAME : Paul Cheche
COMPUTER NO. : 2018254278
PROPOSAL TITLE : To Develop a Mobile Application that will Enable Interoperability of Mobile Money Services for Illiterate Users in Zambia.

PRINCIPAL SUPERVISOR : Dr. Charles S. Lubobya

DATE OF PRESENTATION AND APPROVAL : 12th December, 2019

Dr. Charles Kahanji
ASSISTANT DEAN (PG), SCHOOL OF ENGINEERING



Interoperability of Mobile Money Services for Illiterate Users in Zambia

¹Paul Chiluba Cheche, ²Charles S Lubobya

¹Department Electrical Department, School of Engineering

University of Zambia, Box 32379, Lusaka.

ABSTRACT- This paper presents the design and development of a mobile money solution that targets illiterate people, applying user-centered requirements gathered in a Zambian context. Existing mobile money platforms have text-based interfaces and target literate people. Illiterate people, without the assistance of literate individuals, cannot use such platforms. Emphasis is given to how illiterate users deal with hard cash in their everyday life and how such practices can be mapped into financial technology design. Given the ubiquity of mobile telephony the solution in this paper is based on the widely available, relatively inexpensive and open source Android mobile platforms.

Results of the proposed system show that illiterate individuals can now count money bills, while providing the facility to accept and make payments. In doing so, the mobile application provides an example of how a pervasive technology can empower a hitherto often neglected user category of illiterate users in Zambia.

KEYWORDS – *Android, API, illiterate, Interoperability, Mobile money.*

INTRODUCTION

The lack of access to basic financial services is a contributing factor to poverty throughout the world [1]. Many people live without access to basic banking services such as saving and electronic payments, simply because they live hours or days away from the nearest bank. Lack of these services makes it very difficult for the poor to send, receive funds and to save for future or prepare for unforeseen circumstances. Providing banking through mobile phone networks providers offers the promise of dramatically improving the lives of the world's poor. The M-Pesa system in Kenya [2] pioneered the mobile money service model, in which agents act as intermediaries for withdrawals, deposits, and registrations. Interaction of mobile money services by both agents and users is via USSD (Unstructured Supplementary Service Data) and SMS (Short Message Service) or mobile application, enabling users to send money, pay bills, buy airtime and check account balances. Mobile money systems are offering an alternative banking infrastructure in unserved and underserved areas where traditional banking is impractical.

Mobile money services are available to both mobile and non-mobile users. Statistics show that a high percentage of Zambia's populations are "unbanked" meaning they conduct their transactions outside the banking sector with no access to financial services due to various reasons. The use of mobile money services has enabled safe and secure money transfers without the use of a bank account. According to the 2019 annual Zambia information and communication technology (Zicta) report [3], the value of mobile money transactions more than doubled from ZMW 22.2 billion recorded at the end of 2018 to ZMW 49.6 billion at the end of 2019 reflecting an increase of 123.4 percent.

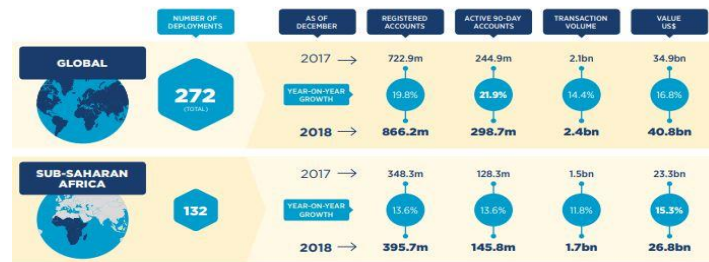


Figure 6.1 Growth of Mobile Money Services [4]

RELATED WORKS

The evolution of banking paved way to using mobile phones to replace bank services that were carried out in the bank. Reaching the unbanked populations through mobile money transfers has led to a widespread of poor populations carrying out financial tasks despite difficulties related to using technology, poor infrastructure, illiteracy and inaccessibility to receive banking services.

A. Mobile Money Transfers in Africa

The actualization of mobile money in Africa and Asia is a significant progress to improving lives of people in the developing world. Despite the challenge of illiteracy in the rural African areas, mobile phones are more accessible and easier to use [5], therefore promoting the rapid spread of financial aptitude among users in the rural areas.

The ubiquity of technology in Africa is limited due to poverty and other factors limiting the effective use of technology. However, use of mobile money is not only evident among the poor populations in Kenya and South Africa but also in Tanzania, Zambia, Uganda, Zimbabwe, Nigeria, Democratic Republic of Congo (DRC) and many other more. The following are some of the other mobile money services in Africa [6];

M-Pesa: - M-Pesa is a mobile phone-based money transfer, financing and microfinancing service, launched in 2007 by Vodafone for Safaricom and Vodacom, the largest mobile network operators in Kenya and Tanzania.

MTN mobile money: - To mean Mobile Telephone Network is a service provider with its head office in South Africa. It operates in 21 countries across the Middle East and Africa.

CelPay: - This is a mobile banking company operating in Zambia, Zimbabwe and Tanzania.

Msenté: - This is a mobile money transfer service like M-pesa operating in Uganda.

Orange Money: Orange Money is the mobile money service of Orange S.A., available in most of the group's affiliates in Africa.

Existing Systems Across Africa

Orange Group and MTN Group, two of Africa's largest mobile operators and mobile money providers launched a joint venture called Mowali, to enable interoperable payments across the African continent. With over 338 million registered accounts, mobile money is the most widely held type of digital financial service account in Sub-Saharan Africa. The ambition of Mowali is to build on this success, helping Africans to gain access to best-in-class digital financial services through the convenience of their phone.

Existing Systems in Zambia

Mobile Money refers to a suite of financial services offered through mobile phones and other handheld mobile devices. These services can include: (1) person-to-person transfer of funds, such as domestic and international remittances; (2) person-to-business payments for the purchase of a range

of goods and services; and (3) mobile banking, through which customers can access their bank accounts, pay bills, or deposit and withdraw funds [7]-[9].

Airtel money allows users to send money to other networks using the short code *778# then selecting the option send to other networks. The recipient receives a unique code which they must present to an airtel agent in order to withdraw the money [7]

MTN money allows users to send money to other networks using the short code *303# then selecting the option send to other networks. The recipient receives a unique code called Token ID which they must present to an MTN agent in order to withdraw the money [8]

Zamtel Kwacha allows users to send money to other networks using the short code *344# then selecting the option send to other networks. The recipient receives a unique code which they must present to Zamtel Kwacha agent in order to withdraw the money [9].

GSMA sub-Saharan [4] stipulated that USSD remains the dominant channel used for mobile money services. Over 90% of mobile transactions in sub-Saharan Africa are still processed via USSD but in recent developments, there has been a drastic update in smart phone adoption and mobile internet is on the horizon with an estimation of 280 million new mobile internet subscribers coming online by 2025 in sub-Saharan

INTEROPERABILITY OF MOBILE MONEY SERVICES

Interoperability refers to the basic ability of computerised systems to connect and communicate with one another readily, even if they were developed by widely different manufacturers in different industries. Being able to exchange information between applications, databases, and other computer systems is crucial for the modern economy [10] FSD Zambia has been supporting the Bank of Zambia (BOZ) to implement interoperability [10] since 2016. This support has seen the formation of the Payment Association of Zambia (PAYZ) aimed at bringing together all MMOs. Zambia Electronic Clearing House Limited (ZECHL), the interoperability Project Manager will deal with non-bank participants in phase II and PAYZ will work at self-regulation within its membership similar to the Banker's Association of Zambia (BAZ). From the developments laid out above, it is clear that interoperability to ensure secure interconnectivity is in its advanced stage towards implementation of the NFS. Seeing that the first phase is almost completed, careful attention should be given to supporting non-bank participants in achieving connectivity into the NFS.

In countries like Tanzania, Kenya and Uganda, the wave of interoperability began with agents becoming interconnected, meaning a customer could transact at any other operators' agent without restriction. It is yet to be seen how mobile money interoperability will be rolled out and how quickly benefits will be seen but the prospects of having this interoperability happen is an exciting phenomenon for FSD Zambia in its quest to support increase in financial inclusion; and more so for mobile money users who will now have an opportunity to transact across different providers and wherever there is a mobile money agent. With this in place, we can expect Zambia to be well on its way towards a new wave of increasing financial inclusion through mobile money. Further, as the National Financial Inclusion Strategy (NFIS) targets an overall increase in financial inclusion from 59% to 80% by 2022, this can be achieved by government migrating key payment streams (notably government-to-person (G2P) and person-to-government (G2P) onto such mobile platforms in order to increase usage and demand. This is one step towards making this a reality.

Interoperability gives mobile money users the ability to send money directly from their wallet to the receiver's wallet in real-time thereby cutting out intermediary steps. This entails that a user can send money across mobile money networks seamlessly, making it very convenient and cost-effective. On the other hand, interoperability gives service providers the opportunity to increase digital transaction volumes, improve the sustainability of their mobile money services and to contribute towards an open digital ecosystem which promotes financial inclusion.

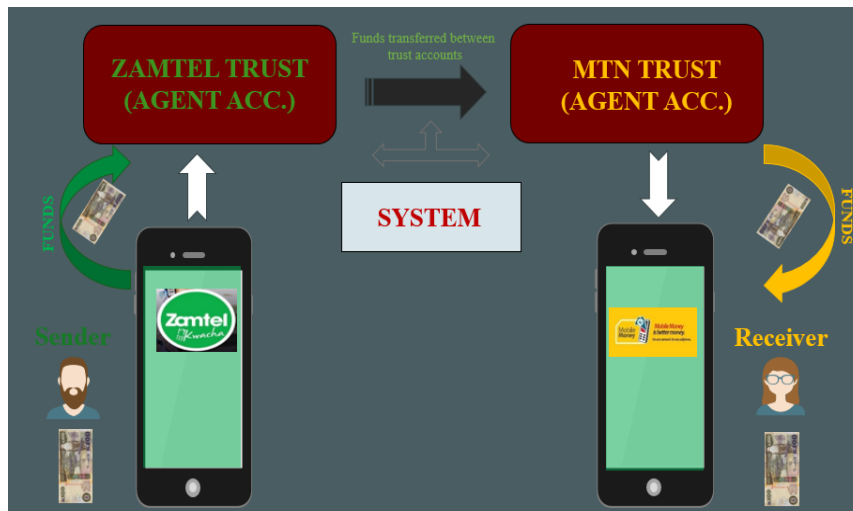


Figure 2: Conceptual Framework

A. Challenges of Mobile Money Applications in Zambia

Apart from financial inclusion to large quantities of unbanked communities comprising the poor and people living in remote rural areas and supporting capital accumulation and household savings, the mobile money services are changing money transmission policy and guidelines, financial transaction models and templates and rules and regulations of financial transaction environment. According to Christopher and Sébastien [11] central banks have uttered deep apprehension of the risk of mobile money transactions undermining conventional monetary control system, which are included financial sector development and price stability[11] The following are some other challenges being faced by mobile money applications in Zambia;

Smart phone market penetration - The fact that some people do not own a smart phone makes the use of mobile money applications limited. They can only use friends' and relatives' phones to send or receive money. This makes them nonregular users and they also can't use any value-added services such as purchase of utility bills and airtime.

Poor network connectivity and unreliable services - The major factor that hindered large population of customers from using mobile money applications service was network or service failures. Some areas especially rural areas have network connectivity problems causing users to have several service drops rates or service hanging.

Lack of information and understanding among non-users - In many cases, non-users were aware of mobile money applications but had only a very basic understanding of the uses and benefits. When asked to rate their level of understanding, often most of them said that their knowledge of mobile money application was limited to the names of the providers.

Expensive to use due to internet connectivity needs - Most of the users were complaining of mobile applications being slow and expensive due to high charges on internet bundles by mobile service providers.

METHODOLOGY

Development of the mobile application based on the functional model proposed and the basic features of the system interface was designed. This was designed based on the primary requirements gathered from the user and analysis of secondary data from proprietary reports.

Kotlin Programming Language

The mobile application was programmed using Kotlin language and the integrated development environment (IDE) tool that was used is Android studio version 4.0. Kotlin was created by JetBrains in 2010 to improve the programming experience for the JVM [2]. It is a multi-paradigm language, supporting both object-oriented and functional programming paradigms, i.e., it allows developers to combine them, as with most modern languages

nowadays [1]. Its support for non-nullable types might make applications less prone to null pointer exceptions. It also includes smart casting, higher-order functions, and extension functions [12], [13]. The documentation [39] also states that the language follows the principle of pragmatic evolution, according to three main aspects; to keep the language modern over time; (ii) to keep in constant feedback loop with the users, and (iii) to make updating to new versions comfortable for users.

Kotlin adoption rapidly increased after its v1.0 release in 2016 and there was an increase on Stack Overflow3 questions containing the kotlin tag, as well as on the number of GitHub4 repositories using Kotlin. This growth also follows Google’s official Kotlin support announcement in 2017. A potential reason for such popularity is the full interoperability with Java, as both languages can be used interchangeably, and migration can be gradual. Developers can also take advantage of the Java environment using all its existing libraries and frameworks [6], [13], while taking advantage of modern language features [14]. Moreover, its adoption by the Android community [15], [16] was reinforced by the Stack Overflow developer survey, which showed Kotlin among the most loved programming languages in 2018 and 2019 [9], [17]. We also observe the growth of Stack Overflow questions about Android development with Kotlin.

Android Studio

The official integrated development environment (IDE) for Google’s Android operating system is known as android studio, built on JetBrains Intelli IDEA software and designed specifically for Android Development and is available for download on Windows, macOS and Linux based operating systems or as subscription based service in 2020 [18].

Software Development Algorithm

Figure 2 shows an algorithm demonstrating the operation of the developed application:

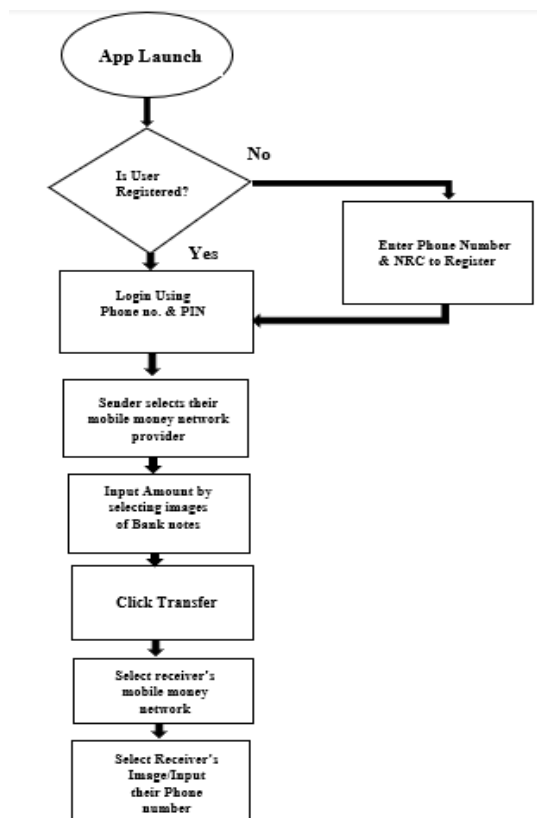


Figure 3: Flow Chart of the Mobile Application

When the app is launched it will ask the user if he/she is registered or not. If not, the user will be asked to register by entering his/her phone number of NRC. If the user is already registered, he will be asked to enter his PIN number or phone number. Next the sender will then select his mobile money network provider; three options are given Zamtel, MTN and Airtel. Immediately after, the sender will then be asked to input the amount by selecting the image of bank notes. Finally, he will select the receivers' mobile money network and image and phone number.

The following are some of the roles that the mobile money application developed plays in aiding users. Firstly, the mobile application gives users the ability to transfer funds from one service provider to another with ease and the receiver will have their account or wallet credited directly and instantly. Secondly, The mobile application has been integrated to operate between Zamtel Kwacha and MTN Zambia money therefore users can transact between the two mobile money service providers and thirdly, The mobile application has been designed with an interface to accommodate illiterate users because it uses pictography options and less text and digits. This gives the users a better experience and more realistic feeling when transacting.

RESULTS AND DISCUSSION

Figure 2 shows the screenshots of the home page of the mobile application that was developed for interoperability of mobile money services. The menu displays the three mobile money service providers in Zambia; Airtel Money, MTN Money and Zamtel Kwacha. For a user to have access to this home menu, they need to login using their phone number and their personal identification number (PIN).

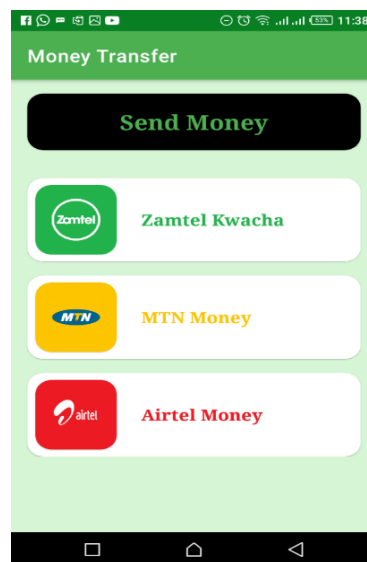


Figure 2 Mobile Application Home Page

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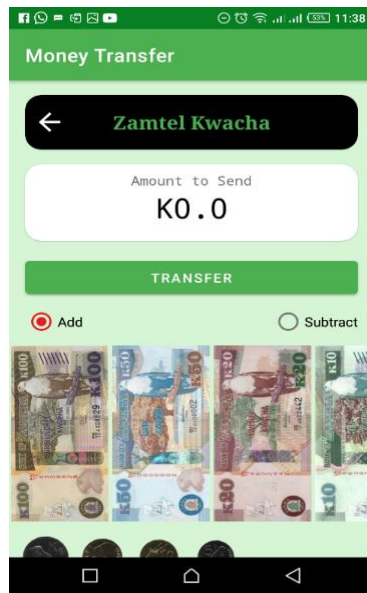


Figure 3 Mobile Application Main Menu

After a user logs into the mobile application, they have an option to choose what type of transfer service they want either intra-network transfer or inter-network transfer and this is done by simply selecting the logo of the service provider the user wants to transfer funds to. After this selection is done, the mobile application displays the interface shown in figure 3 above.

The figure shows money in pictorial format and displays all Zambian kwacha bank notes including coins, the user can select the amount they intend to send by clicking the bank note of their choice. To subtract or remove an amount from the selected displayed figure, the user simply clicks the subtraction option and clicks the amount they intend to remove or subtract.

Coins are also incorporated in the mobile application and can also be added or subtracted in a similar manner as bank noted.

The findings of this research are consistent with [4] who found that most important facet for the illiterate users is to be able to use an interface where the absence of text and numbers increase their ability to interact and perform activities. The interface relies conclusively on image for interaction elements. The user can confirm through their stack of digitally represented bills and inspect them separately.

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CONCLUSION

Results, of the proposed application, show that illiterate individuals can now count money bills, while providing the facility to accept and make payments. In doing so, the mobile application provides an example of how a pervasive technology can empower a hitherto often neglected user category of illiterate users in Zambia

The android mobile money application was developed using Kotlin language which is a multi-paradigm language supporting both object-oriented and functional programming paradigms. The integrated development environment (IDE) tool that was used is Android studio.

To achieve interoperability between Zamtel kwacha and MTN Zambia using the findings from the surveys, a mobile application was developed to meet the proposed features needed to satisfy the need for digital inclusion among all type of users in Zambia. The request to pay Application programming interface (APIs) were used and the interface of the mobile application that was developed was intuitive for illiterate users as it encompassed icons and pictography as opposed to number and text-based features currently on the Zambian market which hinders some users to operate efficiently.

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References

- [1] Bill & Melinda Gates Foundation. Financial Services for the Poor: Strategy Overview. Available:<http://www.gatesfoundation.org/What-We-Do/Global-Development/Financial-Services-for-the-Poor>. [Accessed: February 23, 2020].
- [2] P. Chuhan-Pole and M. Angwafo. Mobile Payments Go Viral:M-PESA in Kenya. In *Yes, Africa Can: Success Stories from a Dynamic Continent*. World Bank Publications, June, 2011.
- [3] Patrick M. Mutimushi, “2019 Annual Zicta report”, Zambia Information and Communications technology, 2020.
- [3] State of the industry 2013, “Mobile financial services for the unbanked”, GSMA, 2013.
- [4] Mobile for development, [Online], Available: <https://www.gsma.com/mobilefordevelopment/uncategorizes/unlocking-mobile-money-interoperability-and-merchant-payments-across-africa-through-mowali>. [Accessed: February 27, 2020].
- [5] Aker, Jenny C., and Isaac M. Mbiti, "Mobile Phones and Economic Development in Africa." *Journal of Economic Perspectives*, 24 (3): 207-32, 2010.
- [6] J. Kamana. M-PESA: How Kenya Took the Lead in Mobile Money. Available: <http://www.mobiletransaction.org/m-pesakenya-the-lead-in-mobile-money>. [Accessed: October 23, 2019].
- [7]Airtel, “Airtel Money”, [Online]. Available: www.airtel.co.zm/airtel_money [Accessed: January 20, 2020].
- [8] MTN, “MTN Money”, [Online]. Available: www.mtnzambia.com/en/services/mobile-money [Accessed: January 20, 2020].
- [9] Zamtel, “Zamtel Kwacha”, [Online]. Available: www.zamtel.zm/personal_kwacha_4_kwacha [Accessed: January 23, 2020].
- [10] “Interoperability”, [Online], Available: <https://www.adsc.com/blog/what-is-interoperability-and-why-is-it-important> [Accessed: February 23, 2020].
- [11] Adam, Christopher S, and Sebastien E. J. Walker, “Mobile Money and Monetary Policy in East African Countries.” University of Oxford. Unpublished, April 2015.
- [12] C. Penicaud and A. Katakam. Mobile Financial Services for the Unbanked: State of the Industry, Technical report, GSMA, 2013.
- [13] Burns, N. and Grove, S.K, The Practice of Nursing Research, Conduct, Critique, and Utilization. 4th Edition, W.B. Saunders Company, Philadelphia, 2001.
- [14] R. Byler. What is Money? Mid-South College Computing Conference, MSCCC, 2004. pp. 200–209 B.

[15] Polit, D. and Hungler, B.: Nursing Research: Principle and Method, 6th ed.; Philadelphia: Lippincott Company, 1999, P.P. 416-417.

[16] LoBiondo-Wood, Geri, and Judith Haber. *Nursing Research: Methods, Critical Appraisal, and Utilization*. St. Louis: Mosby, 1998.

[17] Corbin, J., & Strauss, A, Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory (3rd ed.). Thousand Oaks, CA: Sage, 2008.

[18] *Ducrohet, Xavier; Norbye, Tor; Chou, Katherine (May 15, 2013). "Android Studio: An IDE built for Android". Android Developers Blog.*



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