



Strathmore
UNIVERSITY

Strathmore University
SU+ @ Strathmore
University Library

Electronic Theses and Dissertations

2016

A mobile solution for savings by the youth in Kenya

Mbuthia, B. N.

*Faculty of Information Technology (FIT)
Strathmore University*

Follow this and additional works at: <https://su-plus.strathmore.edu/handle/11071/2474>

Recommended Citation

Mbuthia, B. N. (2016). *A mobile solution for savings by the youth in Kenya* (Thesis). Strathmore University.
Retrieved from <http://su-plus.strathmore.edu/handle/11071/4897>

This Thesis - Open Access is brought to you for free and open access by DSpace @ Strathmore University. It has been accepted for inclusion in Electronic Theses and Dissertations by an authorized administrator of DSpace @ Strathmore University. For more information, please contact librarian@strathmore.edu

A Mobile Solution for Savings by the Youth in Kenya

Mbuthia Benson Njuguna

**Submitted in partial fulfilment of the requirements for the Degree of
Master of Science in Mobile Telecommunications and Innovation
(MSc. MTI) at Strathmore University**

Faculty of Information Technology

Strathmore University

Nairobi, Kenya

June, 2016

This Dissertation is available for Library use on the understanding that it is copyright material and that no quotation from the dissertation may be published without proper acknowledgement.

Declaration

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, this dissertation contains no material previously published or written by another person except where due reference is made in the dissertation itself.

©No part of this dissertation may be reproduced without permission from the author and Strathmore University.

Mbuthia Benson Njuguna

.....
.....

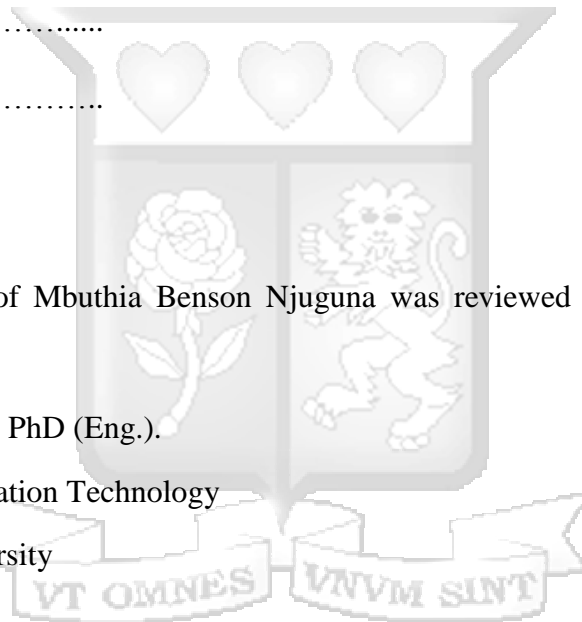
Approval

The dissertation of Mbuthia Benson Njuguna was reviewed and approved by the following:

Humphrey Njogu, PhD (Eng.).

Faculty of Information Technology

Strathmore University



Dr Joseph Orero

Dean, Faculty of Information Technology

Strathmore University

Prof. Ruth Kiraka

Dean, School of Graduate Studies

Strathmore University

Abstract

Kenya as a country has a poor financial savings culture as compared to its East African neighbours. Kenya is consumption driven and a majority of the people especially the youth aged 18 to 25 years lack control in their spending. The youth are not frequent savers yet their potential for saving is high as exhibited by their high expenditures on airtime. The existing saving systems in Kenya have failed to take advantage of the evident financial power of the youth, by failing to design products that entice them to frequently save. These existing systems are not individually tailored to address the saving needs of the youth in terms of convenience, appeal and familiarity.

Based on the aforementioned challenges, this dissertation proposes a mobile based solution tailored for the youth to encourage frequent savings. The solution leverages on the high airtime expenditures by the youth, to bring about a savings model. The solution comprises of a mobile application that can automatically deduct airtime from the youth's airtime account as well as deduct airtime from their parents' or sponsors' airtime accounts and transfer the deductions as savings for the youth in an airtime savings account. The youth can later withdraw the airtime savings in form of either airtime or money after a maturity period. The solution is based on Evolutionary Prototyping software methodology.

The proposed system recorded impressive results in terms of functionality. Over 90 % of the respondents established that the accuracy, responsiveness, scalability, robustness and usability of the application range from moderate to extremely high. It is important to note that if the system is widely adopted in the country, the economic status of the youth as well as the country will be elevated.

Keywords

Savings

Youth

Airtime

Convenience

Appeal

Familiarity



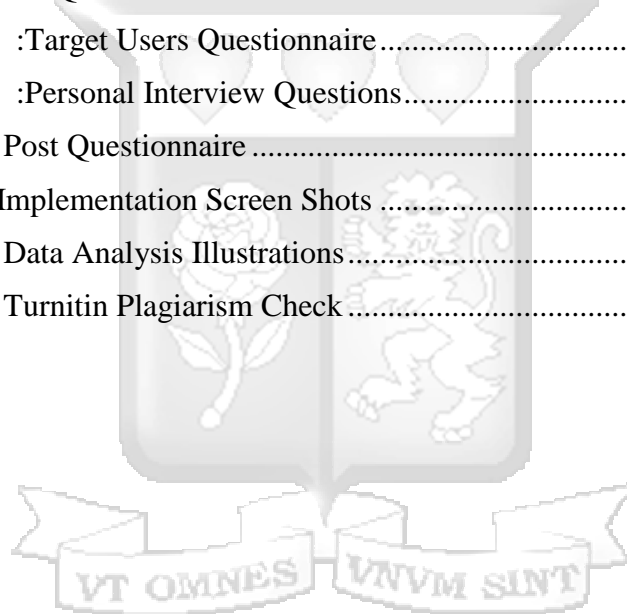
Table of Contents

Declaration	ii
Abstract	iii
Keywords	iv
Table of Contents	v
List of Figures	ix
List of Tables	xi
List of Equations	xii
List of Abbreviations	xiii
Definition of Terms.....	xiv
Acknowledgements.....	xvi
Dedication	xvii
Chapter 1: Introduction.....	1
1.1 Background of the Study.....	1
1.2 Problem Statement	2
1.3 Research Objectives	3
1.4 Research Questions	3
1.5 Justification of the Research	3
1.6 Scope of the Research	4
1.7 Limitations of the Research.....	4
1.8 Conclusions.....	4
Chapter 2: Literature Review.....	5
2.1 Introduction.....	5
2.2 Saving in Kenya	5
2.3 Existing Savings Systems in Kenya	6
2.3.1 Formal Financial Services.....	8
2.3.2 Semi-Formal Financial Services	9
2.3.3 Informal Financial Services	11
2.4 Mobile Based Saving Solutions	11
2.4.1 Mobile Penetration.....	12
2.4.2 Mobile Based Saving Solutions	13
2.5 Airtime Use in Mobile Services	16
2.5.1 Airtime as a Currency	17
2.6 Conclusions	18
Chapter 3: Research Methodology	20

3.1	Introduction	20
3.2	Evolutionary Prototyping Methodology.....	20
3.2.1	Requirement Gathering	21
3.2.2	Analysis, Prototype Development, and Client Evaluations	25
3.2.3	Design	26
3.2.4	Coding/Implementation	26
3.2.5	Integration, Testing and Maintenance.....	27
3.2.6	Ethical Measures	27
Chapter 4: Analysis, Prototype Development, and Client Evaluations		28
4.1	Introduction	28
4.2	Data Analysis	28
4.2.1	Degree of Response	28
4.2.2	Demographic.....	28
4.2.3	Responses on Current System.....	29
4.2.4	Data Analysis Conclusions	32
4.3	Prototype Development and Client Evaluations	33
Chapter 5: System Design		34
5.1	Introduction	34
5.2	System Requirements.....	34
5.2.1	Functional Requirements	34
5.2.2	Non-Functional Requirements	35
5.2.3	Technical Requirements.....	36
5.3	System Architecture	36
5.4	Architectural Components.....	37
5.4.1	A Client Based Mobile Module	37
5.4.2	Mobile Network Operator (MNO).....	38
5.4.3	A Server Based Mobile Module	38
5.4.4	Secondary Airtime Repository Center	38
5.4.5	Web Application Server.....	38
5.5	Architectural Processes	39
5.5.1	Process 1, 2, 3 and 4.....	39
5.5.2	Process 5, 6, 7 and 8.....	39
5.5.3	Process 9, 10, 11, 12,13,14,15,16,17,18 and 19.....	39

5.6	Stakeholders of the System	40
5.6.1	The Target Users	40
5.6.2	The Sponsors.....	40
5.7	Data and Process Modelling.....	41
5.7.1	Data Flow Diagram	41
5.7.2	Use Cases Modelling	43
5.7.3	Sequence Diagram	48
5.7.4	Design Class Diagrams	49
5.7.5	Entity Relationship Diagrams(ER Diagram)	50
5.8	Database Design	51
5.8.1	Database Security.....	51
5.9	User Interface Design.....	51
5.9.1	Mobile Client Application User Login and User Registration Page Designs	51
5.9.2	Mobile Client Application Home Page Design.....	53
5.9.3	Mobile Client Application Deposit, Boost and Withdraw Page Designs.....	53
5.9.4	Mobile Client Application Direct Deposit and Direct Boost Page Designs	55
5.9.5	Web Administration Portal Design.....	55
Chapter 6:	Coding, Integration and Testing	57
6.1	Introduction	57
6.2	Implementation Environment.....	57
6.2.1	Client Mobile Application Prototype.....	57
6.2.2	Server Mobile Application Prototype	57
6.2.3	The Web Portal	57
6.2.4	The Database.....	57
6.3	Implementation Details	58
6.3.1	The Client Mobile Application	58
6.3.2	The Server Mobile Application.....	63
6.3.3	The Web Server Application	63
6.4	System Testing	63
6.4.1	Developer Testing.....	63
6.4.2	User Testing	66
6.5	Summary	68
Chapter 7:	Discussion of Findings.....	69

7.1	Introduction	69
7.2	Explanation of Findings	69
7.3	Discussions.....	69
7.4	The Merits of the Developed Solution over the Existing Saving Solutions.....	70
7.5	Conclusions	71
Chapter 8: Conclusions and Recommendations		72
8.1	Conclusions	72
8.2	Recommendations	72
8.3	Suggestions for Future Work	73
Chapter 9: References.....		74
Appendix A : Pre Questionnaire.....		80
Appendix A.1 :Target Users Questionnaire.....		80
Appendix A.2 :Personal Interview Questions.....		84
Appendix B : Post Questionnaire		84
Appendix C :Implementation Screen Shots		89
Appendix D : Data Analysis Illustrations.....		92
Appendix E : Turnitin Plagiarism Check.....		95



List of Figures

Figure 2.1: Frequency of Savings by the Youth in a Savings Account	6
Figure 2.2 : Financial Services Distribution	7
Figure 2.3 : Saving Services Distribution	7
Figure 2.4: Access to Financial Services	8
Figure 2.5: Top Mobile and Tablet Operating System Platforms in Kenya	12
Figure 2.6: Confidence Level in the Use of Technology for Savings Collection	15
Figure 2.7: Action by Youth on Receiving a Text Message	16
Figure 2.8: Level of Influence of the Text Message on Saving.....	16
Figure 3.1: Evolutionary Prototyping Phases	21
Figure 4.1: Age Distribution of Respondents	29
Figure 4.2: The Frequency of Income Savings among the Youth	29
Figure 4.3: The Use of Existing Saving Methods.....	30
Figure 4.4: The Level of Satisfaction by Users in the Existing Saving Methods	30
Figure 4.5: Daily Airtime Expenditures.....	31
Figure 4.6: Daily Deductions by MVAS	31
Figure 4.7: Leveraging On Airtime Expenditure to Promote Savings.....	31
Figure 5.1 : The Mobile Solution Architecture.....	37
Figure 5.2: Context Diagram	41
Figure 5.3: DFD Level 0	42
Figure 5.4: DFD Level 1	43
Figure 5.5: Saving Using Airtime Mobile Solution Use Case.....	44
Figure 5.6 :The Mobile Solution Sequence Diagram	48
Figure 5.7: The Mobile Solution Design Class Diagram.....	49
Figure 5.8: The Mobile Solution Entity Relationship (ER) Diagram	50
Figure 5.10: Mobile Client Application Login Design	52
Figure 5.11: Mobile Client Application User Registration Design	52
Figure 5.12: Mobile Client Application Home Page Design.....	53
Figure 5.13: Mobile Client Application Deposit, Boost, Withdraw Page Designs	54
Figure 5.14: Mobile Client Application Direct Deposit and Direct Boost Page Designs.....	55
Figure 5.15: Admin Login Page Design	56
Figure 5.16: Administrator Dashboard Design	56
Figure 6.1: Login and Registration	58
Figure 6.2 :Home Page	59
Figure 6.3: Deposit Setting	59
Figure 6.4: Boost Setting Page.....	60
Figure 6.5: Withdraw Page	61
Figure 6.6: Direct Deposit Page.....	61

Figure 6.7:Direct Boost Page	62
Figure 6.8: Installing the Application	66
Figure B. 1: Usability.....	87
Figure B. 2: Responsiveness	87
Figure B. 3: Robustness	88
Figure B. 4: Accuracy	88
Figure B. 5: Scalability	88
Figure C. 1: Administrator Login	89
Figure C. 2: Savers' Report	89
Figure C. 3:Sponsors' Report	90
Figure C. 4: Report on Deposits	90
Figure C. 5: Report on Boosts.....	91
Figure C. 6 : Report on Withdrawals	91
Figure C. 7: Report on Totals	91
Figure D. 1 : Education Level of Target Users	92
Figure D. 2: The Dominating MNO and Majority Subscribers among the Target Users	92
Figure D. 3: The Dominating Mobile OS among Target Users.....	93
Figure D. 4 :The Common Type of Application Installed by Target Users	93
Figure D. 5: Sources of Income for Target Users	93
Figure D. 6 : Barrier to Savings among the Target Users.....	94
Figure D. 7 : Acceptable Airtime Deduction Amounts by Target Users	94
Figure D. 8: Acceptable Savings Maturity Periods by Target Users	94
Figure E 1: Turnitin Report Screenshot	95

List of Tables

Table 2.1: Reasons for Not Saving	5
Table 2.2: Classification of Saving Systems in Kenya	8
Table 2.3: Youth Share of Wallet	17
Table 5.1: Deposit Use Case	45
Table 5.2: Boost Use Case	45
Table 5.3: Transfer Use Case	46
Table 5.4: Withdraw Use Case	46
Table 5.5: Update Use case	47
Table 6.1: Installation and Compatibility Testing	64
Table 6.2: Login and Registration Testing	64
Table 6.3: Automatic Deposit and Direct Deposit Testing	65
Table 6.4: Automatic Boost and Direct Boost Testing	65
Table 6.5: Airtime and Money Withdrawal Testing	66



List of Equations

Equation 3.1: Random Sampling Formulae for Small Populations	23
Equation 3.2: Substituted Equation to Get Sample Population	23



List of Abbreviations

API	-	Application Program Interface
CBA	-	Commercial Bank of Africa
CBK	-	Central Bank of Kenya
CSS	-	Cascading Style Sheet
FSD	-	Financial Sector Deepening Surveys
GSM	-	Global System for Mobile Communications
HTTP	-	Hypertext Transfer Protocol
ID	-	Identity Card
JSON	-	Java Object Notation
KBS	-	Kenya Bureau of Statistics
KRA	-	Kenya Revenue Authority
MFI s	-	Microfinance Institutions
MIT	-	Massachusetts Institute of Technology
MNO s	-	Mobile Network Operators
MoEST	-	Ministry of Education, Science and Technology
MVAS	-	Mobile Value Added Services
NHIF	-	National Hospital Insurance Fund
NSSF	-	National Social Security Fund
OS	-	Operating System
PHP	-	Hypertext Pre-processor
PIN	-	Personal Identity Number
RBA	-	Retirement Benefits Authority
SACCO s	-	Savings and Credit Cooperative Organizations
SDK	-	Software Development Kit
SIM card	-	Subscriber Identity Module card
SMS	-	Short Message Service

Definition of Terms

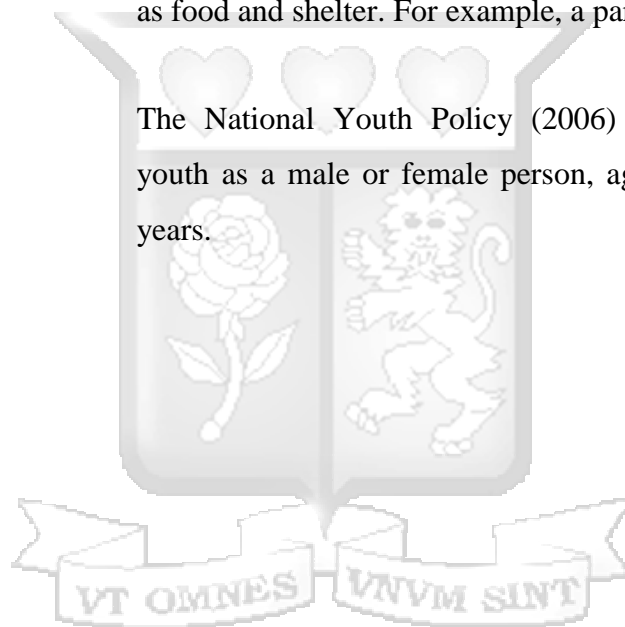
Airtime	A unit of measure used for purchasing voice, data and SMS services from a mobile network operator.
Bug	A manifestation of an error in a software
Formal(prudential) financial services	These are the financial services offered through regulated service providers ,who are supervised by independent statutory agencies like CBK and RBA
Formal(non-prudential)	These are financial services offered through service providers that are subject to non-prudential oversight by government departments that have focused legislations or statutory agencies such as Post Bank, NHIF and NSSF.
Formal(registered)	These financial services are offered through providers that are legally registered and/or operate through direct government interventions.
GSM Based	It is a cell phone network technology that uses SIM cards to allow communication between the cell phones.
Mobile based solution	An integrated system incorporating client mobile applications, server application and database servers that a user directly and indirectly interacts with to get a service. All the components work together to offer the best services possible to the user

Mobile Value Added Services The services offered by a Mobile Network Operator beyond the standard voice calls, which usually come at an extra cost. They may be offered by Third party content providers connected to the MNOs.

Saving The act of putting some income usually extra income aside for accumulation and preservation to use in a future date.

Sponsor A Person who caters for another person's core bills such as food and shelter. For example, a parent or a guardian.

Youth The National Youth Policy (2006) of Kenya defines youth as a male or female person, aged between 15-30 years.



Acknowledgements

I would like to acknowledge @iLabAfrica, Safaricom Academy and Strathmore University for the scholarship opportunity to undertake the master in their program and the technological skills, knowledge and networks I attained. I acknowledge my dissertation supervisor Dr. Humphrey Njogu, who throughout the dissertation period offered guidance and support. I would also wish to acknowledge the Bemavic Creatives team and the Unspoken family for their friendship, prayers and words of encouragement that kept me going. Finally, I acknowledge Henry Mbutia, Catherine Wangari and Alex Githu who ensured I was as comfortable as possible and well equipped with all the necessary resources required in completing this dissertation.



Dedication

I dedicate this dissertation to God, my family and my spiritual parents for the strong foundation and support system that saw me through the Master's degree. I also dedicate it to all my classmates for their insurmountable contribution and friendship throughout the study period. Finally, I wish to dedicate it to the Safaricom Academy Lecturers that impacted me with not only technological knowledge but also a progressive mind-set.



Chapter 1: Introduction

1.1 Background of the Study

According to Ramiirez (2014) , mobile technology in the finance sector of Africa has been used to offer financial services and financial education. Ramiirez reveals two common mobile-based technologies, which are used in Africa to encourage the youth to save regularly in a savings account. These are text message based systems that are used to reinforce financial education concepts and remote savings systems that facilitate the collection of savings via smartphones. In Kenya, the use of mobile devices has been on the rise with an ownership rate of 82 % , where 60 % of that are the youth (Gicheru, 2014). According to Mupaso (2014), the smartphones penetration in Kenya is at 67 % as compared to the other phones. Kimani (2015) notes that Kenya has a huge market domain of budget smartphones most of which run on the Android platform which dominates at 54.28 % of all the smartphones used in Kenya. Kimani explains that the Kenyan population does not use these smart phones for the conventional calling services only, but they have advanced to use the smart phone applications for others added services.

Currently, Kenya is in debt because of a poor income savings culture (Waruinge, 2013). According to a report dubbed Kenya Financial Diaries (2014), most Kenyan households spend as they earn where they match their income to immediate expenditures. According to a report by Retirement Benefit Authority (2009) , the demographic group that is highly affected by this poor income savings culture is the youth aged between 18 to 24 years, who form over 50 % of the non-savers in Kenya. According to a YouthSave Research Brief No. 12-16 (2012) the youth continue in this non-saving culture due to the deficiencies of existing methods of savings that are not tailor made to suit their needs. As Tanaya Kilara (2014) notes, the existing saving methods do not offer the convenience the youth seek to save more frequently, they do not apply strategies to appeal to the youth nor do they take advantage of the avenues the youth are familiar with to encourage savings.

The proposed solution takes advantage of the smartphone dominance among the youth in Kenya to implement a savings solution. The solution incorporates a mobile application which offers convenience by allowing the youth to save at the comfort of their phones. It also uses airtime as the unit for savings, which according to Tyler (2014) , is a good way to facilitate access to a larger client base since it is also a payment mechanism which many consumers are already familiar with. The solution is also endowed with an automatic saving strategy that moves to edge out the procrastination problem exhibited by a majority of the youth when it comes to taking action to save. The solution is also designed to easily fit into the normal mobile phone routine of airtime deductions commonly applied in the billings of mobile value added services that the youth commonly use. The solution creates an appeal to encourage more youth to adopt the solution whereby it provides for parents or sponsors to also be able to share their airtime with the youth. When a culture of savings is adopted in a country, it can uplift the country out of poverty by lowering the dependency and more individuals would be able to invest. This is the effect that uplifted the economies that were once equal to Kenya's economy like Malaysia, Singapore, South Korea, Taiwan and Hong Kong (Mbai & Chatterjee, 2015) and as such, frequent savings should be encouraged in Kenya.

1.2 Problem Statement

The youth in Kenya are yet to fully adopt the culture of frequent saving as reported by FSD Kenya (2015). The report indicates that 52 % of the non-savers in Kenya are the youth aged between 18 to 24 years, yet according to Herbling (2012) and Youth Dynamix (2012) the youth are big consumers of airtime. According to the World Bank report (2014) , one in every five Kenyan mobile users foregoes some other expenditure in order to top up their phones.

According to Fengler (2013) the existing saving systems have failed to encourage the youth to participate in frequent saving due to their limitations in familiarity the youth seek, convenience and appeal .Based on the aforementioned deficiencies in the income saving scene of the youth, this dissertation proposes a mobile based solution that enhances more frequent savings among the youth by incorporating working modalities that would suit them.

The solution offers convenience, familiarity factor to what they are used to and appeal to enhance frequent savings.

1.3 Research Objectives

This research is based on the following research objectives.

- i. To determine how frequent the youth save
- ii. To review the existing saving methods available for the youth in Kenya
- iii. To develop a mobile based system that uses airtime for savings
- iv. To validate the mobile based solution by testing with the intended users

1.4 Research Questions

This research is based on the following research questions.

- i. How frequent do the youth save?
- ii. What are the existing saving methods available for the youth in Kenya?
- iii. How can a mobile system be modelled to use airtime as a saving unit?
- iv. How can the mobile based solution be validated by testing with the intended users?

1.5 Justification of the Research

A poor savings culture leads to consequential problems of dwindling economies and uncertain financial freedoms for the future generations of countries. According to Hardie (2014), flourishing of investments which eradicates poverty is underwritten by savings. A country with youth that are saving is assured of a progressive future economy (Pienaar, 2013). This research was conducted so that the researcher could understand the frequency of income savings among the youth in Kenya and the contributions of the existing saving methods to this frequency. To identify the problems in this sector, the researcher collected data that assisted in the formulation of a solution tailor made to address the identified problem.

This dissertation identified a problem of infrequent income savings among the youth, despite the presence of some saving methods. This led to the design and development of a mobile based interventionary solution that could encourage frequent income saving that is better than the existing solutions.

1.6 Scope of the Research

This study offers a prototype solution and not a complete solution, introduced to a sample population that fall in the age bracket of between 18 to 25 years. The sample population is the youth that reside in Kenya, they are pre-paid subscribers to Safaricom mobile network operator, they are ICT literate and they use Android smart phones on a day to day basis. The research focuses on the airtime expenditures of these youth and how such expenditures are leveraged to yield savings over a period of time.

1.7 Limitations of the Research

The data this research relied on was data from a small sample located in Nairobi, yet the data is used to represent the entire population in Kenya that faces the problem under study. Therefore, this means the data may not provide the full picture of the problem in Kenya. On the other hand, the mobile based solution is limited by the scope under which it will function, in that: It would only work for the pre-paid mobile subscribers, it would only work for the Safaricom subscribers, it would require a user to have a basic Android phone to enjoy the service and it would only work if the users had enough airtime balance in their account. Finally, the research is limited in terms of responses since it would only be dependent on respondents who are willing to participate in the requirements elicitation phase.

1.8 Conclusions

Kenyan youth are actually inclined to saving but the frequency of saving is low. The Kenyan youth are especially seen not to be in the habit of frequently saving yet they are seen to spend highly on airtime that is frequently deducted to pay for other services they frequently use such as MVAS. Currently in Kenya there are several solutions that encourage savings but the saving culture still suffers. After identifying the inadequacies of the existing savings solutions, this research moves to propose a mobile solution that bridges the gaps of the existing systems and foster more frequent savings among the Kenyan youth by offering the convenience, appeal and familiarity the youth seek.

Chapter 2: Literature Review

2.1 Introduction

This chapter will look at the current saving scene in Kenya as discussed by various researchers, and build on that to review existing saving methods among them being the mobile based solutions applied in this current saving scene. The chapter will finally review airtime use in mobile services, where airtime expenditures can be seen as an avenue from which to tap savings.

2.2 Saving in Kenya

According to a report by Zollman and Collins (2012) , Kenyans are actually inclined to saving. The report revealed that people in Kenya save on average 30 % of all their income. The report further asserted that a savings tradition has been there in Kenya, where people who wish to be successful have saved in prospects of investments and wealth. Another report by Austrian and Ngurukie (2009), revealed that if a savings product was easily accessible and confidential, the youth girls would certainly use them.

According an FSD report (2015), 52 % of Kenyans use at least one saving product. Additionally, the report revealed that the uptake of the saving products among urban populations is high, at 60 % while rural population usage is at 49 %. In that report, the financial service that led in usage was M-Pesa and commercial banks. According to Ravi and Tyler (2012) several factors have inhibited savings in Kenya, among them being, the lack of enough money, the high cost of the saving schemes, the requisition of Identity documents to register and the requisition of a referees in order to be allowed to save. The Table 2.1 below reviews the percentage of people affected by these factors.

Table 2.1: Reasons for Not Saving (Ravi & Tyle, 2012).

Barriers	% of people affected
Lots of money needed	13.2
Too expensive	3.3
ID and referee needed	2.7
Nowhere to save	2.8

According to a study by Ramiirez (2014) on the saving habits of the youth in Africa, the youth acknowledge that having a savings account has had a positive impact in their lives yet at the same time these youth themselves are not satisfied with the frequency at which they use the savings accounts for savings. The study revealed that 93 % save at most once a month as shown in Figure 2.1 below. Data from the Global Financial Inclusion Database of the World Bank (2014) also reinforced this where it revealed that 86 % of youth between ages of 15 to 24 years, with formal accounts mostly make utmost one deposit per month.

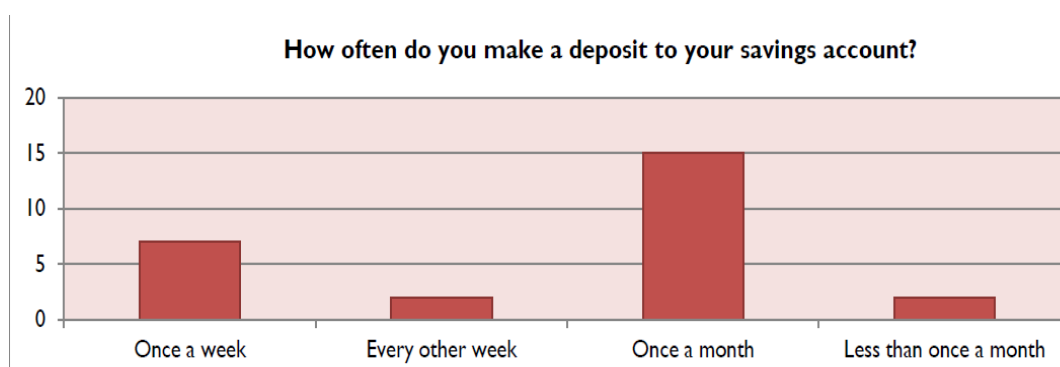


Figure 2.1: Frequency of Savings by the Youth in a Savings Account (Ramiirez, 2014)

The study by Ramiirez (2014) further revealed that half of the youth make savings deposits on their own whereas one-third of them, their deposits are made by their parents. Most of the parents also reported giving money to their children to be saved into the youth accounts.

2.3 Existing Savings Systems in Kenya

The FSD report (2016) defines the savings scene in Kenya as including both the traditional and the non-traditional players, who are:

- i. Commercial Banks
- ii. Deposit Taking Microfinance Institutions (MFIs)
- iii. Savings and Credit Cooperative Organizations (SACCOs)
- iv. Non Traditional Savings Providers (Insurance & Asset Management Savings Providers)
- v. Mobile Financial services
- vi. Informal saving mechanisms

The FSD report reveals that the dominating service compared to the others is the mobile financial services with 15.1 %. This distribution of dominance is as illustrated on Figure 2.2 below. This dominance of mobile financial service is also translated to its dominance in income savings at 43.3 % as shown on Figure 2.3 below.

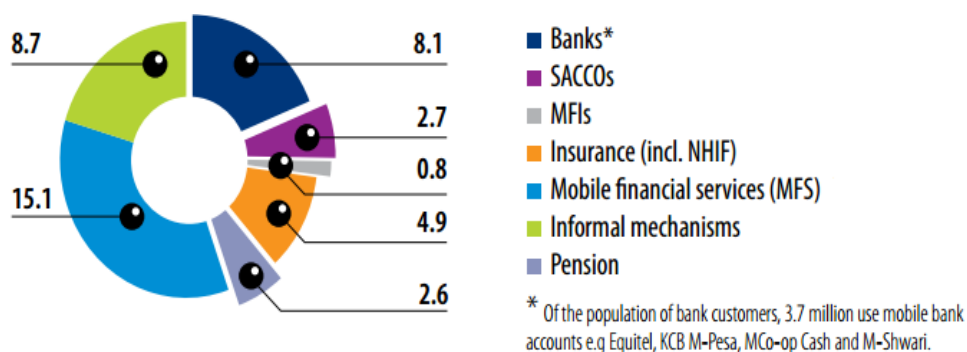


Figure 2.2 : Financial Services Distribution (FSD Kenya, 2016)

	2006	2009	2013	2016
Formal				
Bank ¹	12.4	12.4	9.8	24.0
Postbank	5.6	2.5	2.3	1.5
SACCO	12.8	8.9	10.6	12.6
MFB/ MFI	1.5	3.2	3.1	3.3
MFS	-	-	27.0	43.3
Informal				
ASCA	5.4	7.8	5.9	15.2
ROSCA	29.3	31.7	21.4	33.8
Excluded				
Family or friends	16.6	11.6	19.2	15.4
Secret place	27.9	55.7	31.7	35.8

16.8% have savings in mobile bank accounts

Figure 2.3 : Saving Services Distribution (FSD Kenya, 2016)

The report explains that the saving systems currently available in Kenya can be broadly classified into formal, semi-formal and Informal as described on Table 2.2 below:

Table 2.2: Classification of Saving Systems in Kenya (FSD Kenya, 2016)

Access Strand	Type of Institution
Formal	Banks ,Insurance Companies, Building Societies, Post-Bank
Semi-Formal	Savings and Credit Cooperative Organizations (SACCOs), Microfinance Institutions (MFIs), Government Institutions, Mobile Money services
Informal	Rotating Savings and Credit Associations (ROSCAs), Accumulating Savings and Credit Associates (ASCAs), Groups of friends, Money lenders ,Employers, Hire purchase
Excluded	Savings kept in secret places.

2.3.1 Formal Financial Services

According to FSD report (2016) , there has been an increase in the use of the formal financial services from 26.7 % in 2006 to 73.3 % in 2016 as illustrated on Figure 2.4 below.

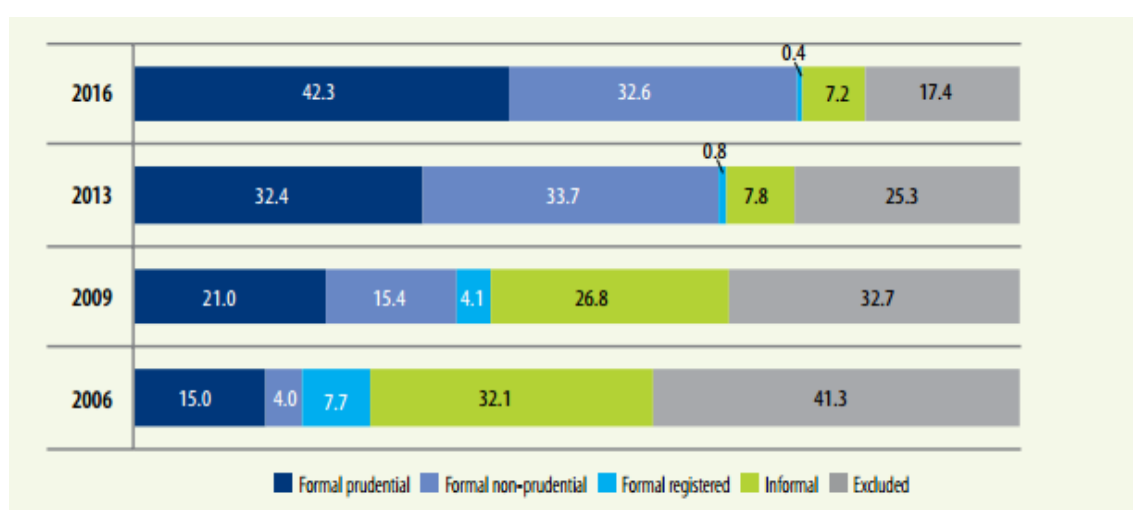


Figure 2.4: Access to Financial Services (FSD Kenya, 2016)

According to Johnson, Lee, Osei-Akoto (2012) , formal financial inclusion can lead to important youth development effects. According to a United Nations Capital Development Fund report (2012) , if some of the youth that save informally were given a convenient saving opportunity in the formal banking services, they would participate. However, such opportunities are less. The report continued to state that the development of financial products that would be particularly appealing to the youth such as a regular custodial savings account that allowed some control to the youth, would lead to participation of the youth who had never participated in the formal sector.

According to Tanaya Kilara (2014), a barrier for the youth to save using the formal banking, is one where the financial institutions steer clear of youth. Such institutions do not view the youth as customers because it is a challenge to serve them, at the same time maintain good profits. This is because marketing to youth is expensive, and they generally operate in very small monetary amounts. The other factor is that the parents are their most significant influencers. As a substitute, financial institutions lean on the more lucrative adult population (Tanaya Kilara, 2014).

2.3.1.1 Commercial Banks

According to FSD Kenya report (2016) , commercial banks are regulated by the Central Bank of Kenya under the Banking Act, which outlines; licensing of institutions, prohibited business activities, deposit protection and information and reporting requirements. The report notes that commercial banks have had a rapidly growing role in the Kenyan savings landscape. The growth of savings accounts in commercial banks has increased from 12.4% in 2006 to 24% in 2016.

2.3.2 Semi-Formal Financial Services

In the FinAccess report (2016), non-bank for-profit institutions have gained ground in Kenya where Insurance companies also offer unique savings vehicles. While the products they offer are not technically regulated as savings accounts, such companies offer ways for lower income earners in Kenya to save and invest. Their savings plans allow account holders to invest money in mutual funds such as Treasury bills, commercial papers and other interest earning assets.

Traditionally such services required Ksh.7million to Ksh.15 million, but such institutions have been able to reduce this barrier to up to Ksh.5000. Their clients do not have the flexibility to withdraw cash as they would in a liquid savings account, but they have the opportunity to see greater returns on their investments than with commercial bank accounts. Ravi and Tyler (2012) describe the problem with these providers is the use of agency model, where agents sell the product and this makes it difficult for sales.

2.3.2.1 Savings and Credit Cooperative Societies

According to Ravi & Tyler (2012) ,by December 2010, there were 3,280 savings and credit cooperatives that were active across Kenya. In October 2011, Kenya's entire SACCO industry had mobilized Ksh.230 billion, equal to 31 % of national savings. According to FSD report (2016) the emergence of mobile financial services has led to a decline in use of the SACCOs from 12.8% in 2006 to 12.6% in 2016.

2.3.2.2 Microfinance Institutions (MFI)

According to Ravi & Tyler (2012) , MFIs are less widespread than commercial banks yet they play an important role in Kenya's savings sector. By September 2011, these MFIs held 1.52 million deposit accounts and close to Ksh. 10 billion in deposits. Recently, these institutions have had a decline in use whereby they only have 3.3% as of 2016 January (FSD Kenya, 2016).

2.3.2.3 Mobile Network Operators (MNOs)

Ravi & Tyler (2012) describe the MNOs as having established themselves in Kenya's financial scene. These MNOs have come up with mobile money accounts that are able to reach a vast market to offer financial services. There are five MNOs offering mobile money services in Kenya. They include: Safaricom, Airtel, Orange, Essar and Equitel. As financial institutions struggle to maintain and grow their market, the MNOs are now focused on reaching the low income populations. They have increased their small balance savings accounts and introduced integrations with actual bank accounts. Customers can now send money from their mobile money accounts to actual bank accounts. Kenya is considered as a pioneer in this technology, for financial inclusion.

Ravi and Tyler further discuss that 65 % of M-Pesa users save compared to 31 % of non-users thus M-Pesa promotes savings and it is considered the most important savings tool of this generation. According to (2016), they are dominant service with 43.3 % over the other financial saving services.

2.3.3 Informal Financial Services

In Kenya, the use of informal services which are the Rotating Savings and Credit Associations (ROSCAs) and Accumulated Savings and Credit Associations (ASCAs) is at 33.8% and 15.2 % respectively (FSD Kenya, 2016). According to Christina (2012) , ROSCAs function by taking monthly deposits from each member of a group and then giving the whole monthly sum to one member of the group. The recipient of the monthly sum is based on a predetermined rotation, ensuring each participant will eventually receive a pay-out. ASCAs on the other hand function by taking regular contributions from each member. Instead of rotating pay-outs, the ASCA group fund is used to offer loans to group members or trusted third parties that pay back with interest. After a certain period of time, the group funds plus the interest are paid back to the original members.

According to FinMark Trust's FinScope (2012), by 2009 there were approximately 37 million people participating in some sort of informal savings group in East Africa. The gain such individuals get by participating in savings groups includes both tangible economic benefits and intangible social benefits. According to Christina (2012), 70 % of people in emerging markets do not have a formal bank account. Despite exclusion from the formal banking, these people in emerging markets like Kenya have figured out their own ways to save money in informal savings group. Christina defines an informal savings group as a social organization formed to help community members save money for specific purposes either at individual or community level.

2.4 Mobile Based Saving Solutions

There have been a number of mobile based saving solutions available in Kenya and other African Countries. This section will review the mobile penetration in Kenya and the mobile based saving solutions in Kenya and Africa.

2.4.1 Mobile Penetration

According to Huawei (2014) the ownership of mobile phones by Kenyans is at 82 %. Statistics by Human IPO (2014) on the other hand reveal that the smartphone penetration in Kenya is at 67 % over all the phones. The statistics reveal that this is a 40 % difference from the general Africa's continent smartphone penetration that lied at 12 % to 18 % by January 2014. Kimani (2015) explains that Kenya has a huge market domain of budget smartphones most of which run on the Android platform. He continues to reiterate, the statistics from StatCounter that reveal that Google's Android platform is the market leader in the smart phone scene of Kenya by running on 54.28 % of all the smartphones used in Kenya. This is as illustrated on the Figure 2.5 below.

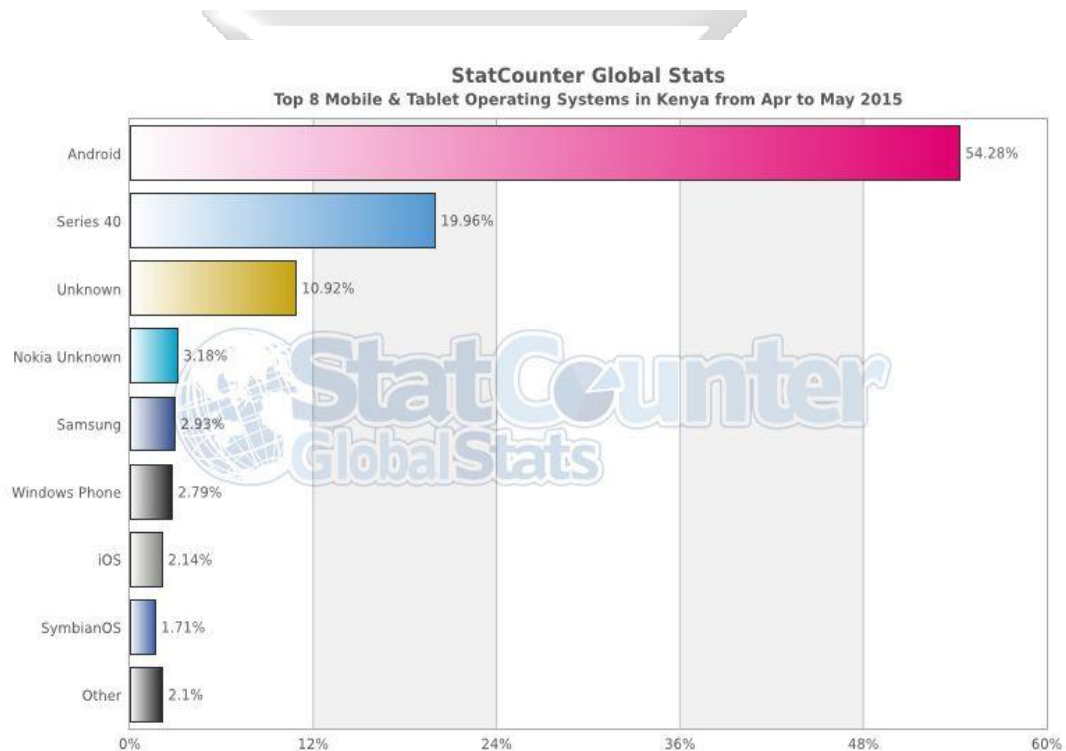


Figure 2.5: Top Mobile and Tablet Operating System Platforms in Kenya (Kimani, 2015)

2.4.2 Mobile Based Saving Solutions

This sub-section describes the various saving solutions in Kenya that rely on the mobile platform.

2.4.2.1 M-Kesho

A research by Demombynes (2012) revealed that M-Kesho was a failed initiative of Safaricom's M-Pesa and Equity bank. M-Pesa is an SMS based mobile money transfer system that allows individuals to deposit, send, and withdraw money using their cell phone (William & Tavneet, 2010). M-Kesho account was fully integrated into the M-Pesa's user interface and allowed users to deposit and withdraw from their M-Pesa account and Equity bank accounts through M-Pesa transfers. It aimed to benefit Kenyan's by convenience in depositing and withdrawing. The backside was that only Equity bank customers got the convenience. However, it did not have minimum balance nor ledger fees and the money had an annual interest, thus users could use it as a savings system (Sleepless Kenya, 2010). Demombynes (2012) revealed that the actual use of M-Kesho was very low six months after its launch. Demombynes further asserts that just 0.6 % of Kenyan adults saved with M-Kesho, and these savers were concentrated at the high end of the wealth distribution. Demombynes explains that the low rate of M-Kesho adoption was influenced by bureaucracy between the providers.

The failure of M-Kesho was also blamed on the strategic failure by the two involved companies to structure a sound revenue sharing model since the one they used was expensive to its target customer due to double transaction fees. The account offered M-Pesa users a linkage to more sophisticated financial services including:

- i. Access to tiered interest rates.
- ii. Linkages with credit and insurance facilities.
- iii. No minimum balances, account opening fees or ledger fees.
- iv. Ability to view account balance and a shortened financial statement over the mobile phone.

2.4.2.2 M-Shwari

M-shwari is a system developed under a partnership between Commercial Bank of Africa (CBA) and Safaricom Inc. M-shwari is somewhat a copy of M-Kesho but they differ in terms of bureaucratic requirements. This solution makes CBA totally dependent on M-Pesa and its agents as opposed to M-Kesho that was able to establish its own agents. M-shwari is a separate interest earning non-transactional savings account and an overdraft facility with interest rates for emergencies.

It is highly integrated with M-Pesa, whereby one can check balances on either accounts, transfer money electronically between either accounts and request a month long loan from the M-Pesa menu, all using the same PIN. M-Shwari has three benefits for customers when it comes to saving as opposed to a bare M-Pesa account (Tuwakenya, 2012).

- i. Customers can use M-Shwari to effectively store twice the amount M-Pesa can't hold without having to access other bank accounts.
- ii. Customers can use M-Shwari as a piggy bank, building separate pocket to save against particular objectives they might have.
- iii. Customers can earn some interest (2-5 % annual rate) which is more than what other banks offer.
- iv. They do not have transactional charges to and fro M-Pesa account

The delimiting factor about M-shwari is that it has no provision of automatic deductions like the commercial banks that have the option of a standing order. On the other hand, M-shwari saving is a reserve of the middle level to upper level income earners who have money in M-Pesa and want to save the extra money in M-shwari. The M-shwari loans have high interest rates of 7.5 % per month, which is 90 % per year and equivalent to 139 % interest rate on a reducing balance. Finally one, cannot access the mobile cash via an ATM like the conventional banking systems (Tuwakenya, 2012).

2.4.2.3 Remote Saving Smartphone Systems

The remote savings system involves SACCO staff visiting homes, schools and businesses with their collection enabled smartphones and portable mini-printers. It has been used in Mali years. The SACCO staffs go into the field and remotely collect savings from account holders and print receipts to confirm deposits and record the transaction. The smartphone automatically transfers the information on the transaction to the SACCO's systems and upon returning to the branch, the staffs reconcile the money received along with the receipts they printed. This system offers convenience in savings and saves time and cost to a customer for travel to the branches.

The direct connection to financial institutions management information system and provision of instant receipts reassures the customers who would otherwise had been concerned about their deposits not reaching their accounts either because of theft or loss. The youth and parents in Mali have had high confidence in the technology being utilized as depicted in Figure 2.6 below, with only a few with reservations due to fear of mistakes that may arise in the system (Ramiirez, 2014).

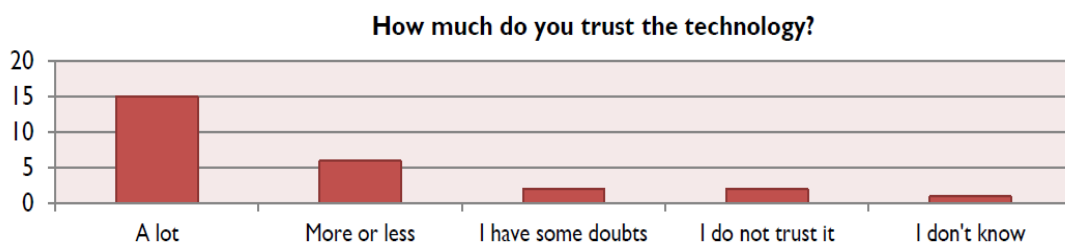


Figure 2.6: Confidence Level in the Use of Technology for Savings Collection (Ramiirez, 2014)

2.4.2.4 Text Message Based Saving Systems

Text messages based saving system reinforces key financial education concepts and act as reminders that nudge the youth to remember to save more frequently. According to Ramiirez (2014) a majority of the youth read the message as depicted on Figure 2.7 below, while an average number of them who have read feel motivated to save and decide to save as shown on Figure 2.8 below.

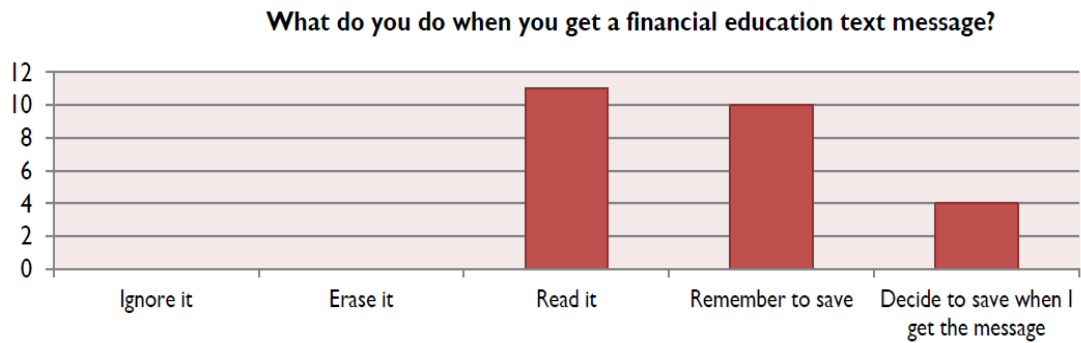


Figure 2.7: Action by Youth on Receiving a Text Message (Ramiirez, 2014)

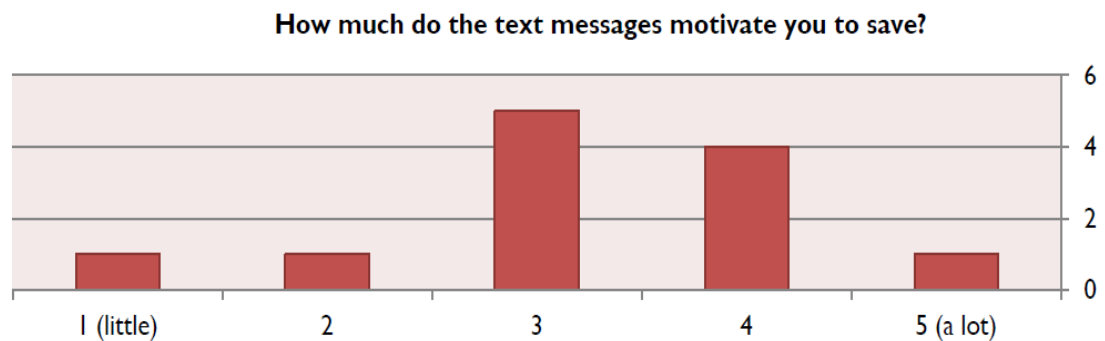


Figure 2.8: Level of Influence of the Text Message on Saving (Ramiirez, 2014)

2.5 Airtime Use in Mobile Services

According to the World Bank (2014), people in the low income bracket of Kenya, are forgoing other important expenses in order to purchase prepaid mobile airtime. In their report, the World Bank stated that one in every five Kenyan mobile users foregoes some other expenditure in order to top up their phones. Findings by Youth Dynamix (2012) show that young Kenyans aged between 16 and 24 are constantly on their cell phones (texting and surfing the Internet), sending an average of 250 messages daily. The study established that young people spend roughly Ksh.900 monthly on their mobile phones (mostly on data services and sending of short messages). When asked to prioritize their needs, savings and investments ranked lower compared to expenditure on airtime as outlined on Table 2.3 below.

Table 2.3: Youth Share of Wallet (Capital Campus in Campus Social, 2012)

Airtime	79%
Clothes	78%
Shoes	57%
Transport	57%
Hair care	52%
Accessories	49%
Food	43%
Savings/Investments	41%
Buying CDS/DVDs	39%
Outings (Food & drinks)	38%

2.5.1 Airtime as a Currency

Currently in Africa, pre-paid mobile airtime minutes have been used as currency that can be transferred between phones, exchanged for cash with dealers, or bartered for goods and services. According to Chris Chan (2013) of Tranglo, a Malaysian firm that facilitates airtime remittances to mobile phones states that in Cote d'Ivoire, Egypt, Ghana and Uganda, pre-paid minutes can be swapped for cash or spent in shops in exchange of products. Hannes Van Rensburg (2013) Visa's boss for sub-Saharan Africa, states that in Nigeria, airtime is commonly used as money since regulators in Nigeria have made it difficult for banks to offer the newer forms of mobile money. Another example is in Zimbabwe where Oswell Binha (2013), president of the Zimbabwe National Chamber of Commerce states that American banknotes have largely replaced the inflated Zimbabwean dollar and the American coins are scarce, thus prompting almost everybody in Zimbabwe to transfer airtime in place of coins. He continues to state that Zimbabwean retailers that offer airtime in place of sweets for change have a competitive advantage.

In Kenya, airtime is also being used as currency. Unlike mobile money, airtime's value does not rely directly on a government's ability to hold down inflation (e.g. by showing restraint printing money). In Kenya, opening a mobile money account typically requires registration using one's national ID.

Contrary, airtime can often be purchased and sent immediately and anonymously thus easily adopted by people. According to estimates by Berg Insight (2015), the value of international airtime transfers had doubled from 350 million US dollars in 2011 to 700 million US dollars in 2012. That was attributed to the fact that many telecom firms in Africa and elsewhere transfer minutes nationwide free of charge. Therefore, airtime can be especially useful for saving and investing. One demerit of using airtime as a currency is that criminals, terrorists or extremist groups could use airtime to move money covertly. According to Financial Action Task Force (2013), an intergovernmental body, some people buy top up cards in one country and sell the airtime in another. The Task Force has studied over 50 instances of suspicious dealings in airtime.

2.6 Conclusions

The literature reviewed reveals lack of a frequent saving culture among the youth of Kenya. In a month, it can be deduced that a majority of the youth do not save more than once. This state is present despite the presence of several savings systems that encourage the youth to be frequent income savers.

By virtue of all the above mentioned existing saving systems, the proposed mobile solution will be uniquely designed to close the gaps in each and adopt some of the good features present in the existing systems. The mobile solution will work to automatically slice a portion of pre-paid airtime in frequent intervals from a subscriber's Android device and set it aside in an airtime repository account, according to the subscriber specifications. Some of the features that elevate the proposed mobile solution over the existing formal saving solutions are: Its mobility aspect that makes saving easily accessible to the youth at the comfort of their mobile phones, the convenience it offers, the appeal and familiarity.

The practice of saving will be easily accessible in remote areas where people travel for distances to the next available bank. The proposed solution will also have the advantage low maintenance costs as opposed to formal banking institutions. It will have less registration requirements such as one to be a registered Safaricom pre-paid subscriber and not require the conventional account opening documentations such as, PIN certificates from KRA, Passport size photos and National ID copies.

The remote saving aspect of the proposed system will enable the youth with limited economic opportunities; less mobility and less independence now make routine savings. The convenience of the remote savings aspect will be a critical factor in enhancing more frequent income saving by the youth, especially taking into account the small amounts they might be able to deposit and that they might not bother depositing at a branch. Other features that elevate the proposed mobile solution over the existing mobile based solutions are that: Lack of money in the mobile money account will not be an issue. Unlike the existing mobile money accounts, the solution will not be a reserve of the high end income earners. It will also serve the low income earners who rarely have money in their mobile money accounts but often buy airtime.

In the existing mobile based interest earning savings account, the user is expected to manually transfer money from one account to another for savings. This process rarely gets to happen due to the poor saving discipline and spending culture in Kenya. For that, the proposed solution offers automatic transfers set in advance by the subscribers to avoid the trap of spending and saving procrastination.

Among the unique features of the proposed solution that outstands from the rest is the use of airtime as the saving unit. Use of airtime will provide the targeted youth who are already highly indulged in paying for mobile value added services using airtime, a familiar feel to the deduction thus less resistance to the deductions for savings. The use of airtime is also ideal since pre-paid airtime purchases are at an all-time high among the youth and as such this can be leveraged to elevate savings in proportionality to the expenditure.

Chapter 3: Research Methodology

3.1 Introduction

This chapter describes the methodology that was employed to enable the proposed solution answer the research questions that are outlined below:

- i. How frequent do the youth save?
- ii. What are the existing saving methods available for the youth in Kenya?
- iii. How can a mobile system be modelled to use airtime as a saving unit?
- iv. How can the mobile based solution be validated by testing with the intended users?

3.2 Evolutionary Prototyping Methodology

The software methodology adopted was Evolutionary Prototyping Model. In this model the system was developed in increments that were readily modifiable according to user feedback (Construx Software Builders, 2002). This prototyping model was ideal for requirements determination since there was no existing system from which requirements could be drawn and therefore, it helped to demonstrate the feasibility of the solution in advance.

The prototype methodology applies an agile framework so as to allow for immediate release and follow up of the most important features in small incremental releases (Waters, 2007). The prototype process model used for the proposed system is as illustrated on the Figure 3.1 below.

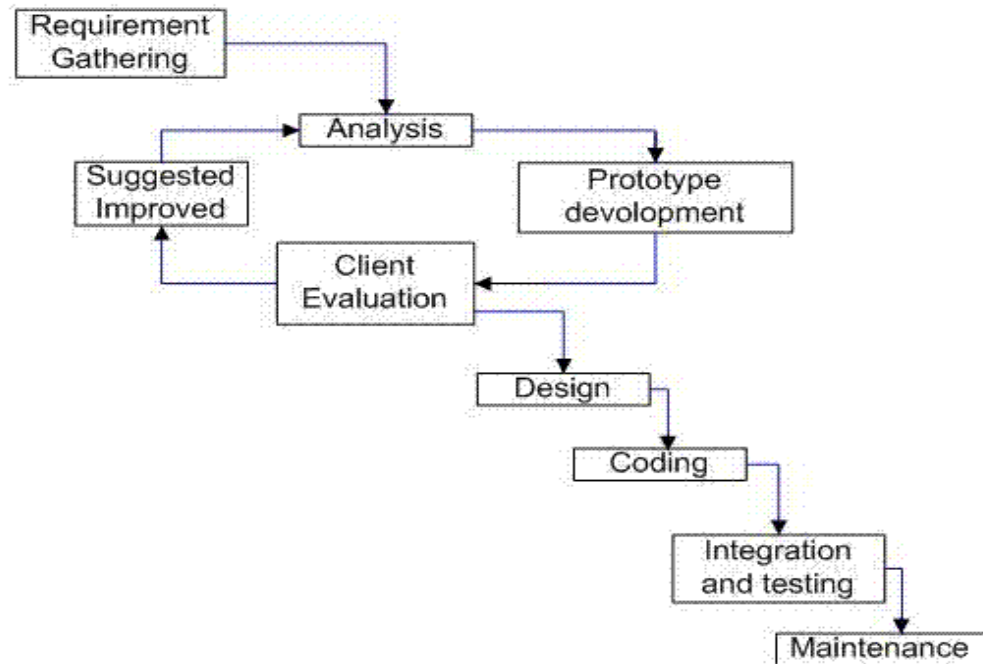


Figure 3.1: Evolutionary Prototyping Phases (Sami, 2012)

3.2.1 Requirement Gathering

The Evolutionary prototyping methodology includes requirements gathering that involves identifying: a location, the target population, the sample, the data collection procedure and the data collection instruments. The first step in requirement gathering was to identify the sample population and key stake holders that would be involved in the system. This was followed by data collection in an identified research location through basic personal interviews, questionnaires and observations from a sample of the target population.

3.2.1.1 Location of the Study

The study was conducted at Strathmore University in Nairobi- Kenya where the University offered an ideal sample population for the targeted College level students. The population at Strathmore University offers the major characteristics of the target users of the proposed solution, which are: they are technologically literate, there are youth that fall within the age group of 18 to 24 years, they are youth who are users of mobile value added services and a majority of them rely on a sponsor for their bills.

The location was ideal for the researcher since he is a current student at Strathmore University thus access to the other students who form part of the target population was easy and cost effective.

3.2.1.2 Target Population

The target population that was used was the Undergraduate and Diploma students from Strathmore University- Nairobi Kenya, who total to 4197 students by 2015 (Strathmore University, 2015). This is the selected target because the research problem affects the youth aged 18 to 25 years, most of who are at the University and College level.

The researcher also focused on University and College students as the target since according to Waswa (2011), these are people with essential IT skills and therefore they will have the ability to use the proposed ICT based mobile solution. According to the recent national population census (2009) and records of the Ministry of Education, Science and Technology (2012) Sessional Paper Number 14 , there are approximately 0.5 million young people that aged 18 to 23 are attending either University or College education. Out of the all the universities and colleges in Kenya, a single University was picked to offer a cluster population. The researcher also used purposive sampling to select 5 sponsors who cater for the bills of any of the target population individuals.

3.2.1.3 Sampling

Random sampling was used where the researcher distributed online questionnaires to the students via their class Whatapp groups and email groups as well as printed questionnaires that were handed to them in their classes. The researcher used this method so as to get an unbiased representation where each student would get an equal chance to participate in the pre-questionnaires stage of the requirements gathering. Stratified sampling was later used to classify the respondents to obtain a stratum of the respondents that had the ability and provisions to use the interventionary mobile solution. The use of Stratified sampling was influenced by need to only focus on the respondents that would enable the prototype solution to evolve into a final product, by their continuous evaluations of the system.

To get the sample size from the small Strathmore University cluster population, the researcher used the normal approximation to the hypergeometric distribution as shown on Equation 3.1 below. This gave a total of 188 students as the required sample size for this research as shown on the substituted Equation 3.2 below.

$$n = \frac{N z^2 pq}{(E^2 (N - 1) + z^2 pq)}$$

n = the required sample size

N = the population size

p and q = the population proportions. (default is 0.5)

z = the value that specifies the level of confidence one wants in their confidence interval when they analyse their data. Typical levels of confidence for surveys are 95%, in which case z is set to 1.96.

E = sets the accuracy of the sample proportions. Such as to get the proportion of individuals are in favour of some policy, with an accuracy of plus or minus 7%, then E is set to 0.07.

Equation 3.1: Random Sampling Formulae for Small Populations (Morris, 2016)

To get the sample size from a target population of 4197 youth, the following calculations were made.

$$\frac{4197 * (1.96)^2 * 0.5 * 0.5}{(0.07^2 (4197 - 1) + (1.96)^2 * 0.5 * 0.5)} = 188$$

Equation 3.2: Substituted Equation to Get Sample Population

All the 5 sponsor respondents interviewed via telephone conversations. This purposive selection of all the 5 sponsor respondents was cost effective yet vital for better illumination in understanding the sampled student population.

3.2.1.4 Data Collection Techniques, Procedures and Instruments

This study utilized three data collection techniques namely: Personal Interviews, Questionnaires and Observation techniques. The personal interviews were based on a set predetermined open ended questions asked to some of the parents or sponsors of the sampled population via phone calls, where the responses were recorded. The Questionnaires were both online based questionnaires on Google forms and printed questionnaires .The online questionnaires were distributed via emails and Whatsapp online chat application while the printed ones were issued in the classrooms by the researcher. The responses from online questionnaires were automatically recorded on a Google spread sheet that is optimized for analysis with Google analytics while the responses from the printed questionnaires were manually updated to the online Google form tool that ensures the responses are also captured in the same Google sheet. The Observation technique was used to visually compare the changes in the collected data using charts, before and after the implementation of the interventionary prototype mobile solution.

The data collection procedure was conducted in three stages. The first stage involved a review of data from previous research works. This stage helped in defining the state of affairs in which the research problem exist .The second stage involved data collection from the sampled population who are regarded as the target in the research. This helped in requirements specifications, quick design and implementation of a prototype that would be used for further evaluation of the solution. The third stage involved data collection from the selected sample users that used and evaluated the prototype to suggest improvements. This stage helped to determine whether the proposed solution addressed the identified research problem and whether it met expected performance standards. This stage allowed for further modifications to yield a better prototype product. These data collection instruments employed in the three stages of the data collection procedures are as outline below.

i. Personal Interviews

The researcher conducted telephone call meetings with some of the Sponsors of the youth in the sample population. The personal interview questions were open ended as defined on Appendix B.

ii. Questionnaires

The research employed pre-questionnaires that were supplied to the sample respondents for requirement analysis, so that a prototype could be designed and developed. The research also used post questionnaires for functional tests on the developed prototype. The questionnaires were distributed manually to the students in their classrooms, via emails and via Whatsapp chat application. These questionnaires had scaled choices that could be analysed to provide quantitative evaluation data as shown on Appendix A below.

iii. Observation

All the data collected through questionnaires was recorded on a statistical spread sheet that could produce visible graphs and charts from the quantitative data. Through observation of the charts and graphs, the existing state of affairs could be deducted.

3.2.2 Analysis, Prototype Development, and Client Evaluations

Analysis phase involved the analysis of the data collected via the pre-questionnaires quantitatively via Google analytics online tools to prove the need of the solution statistically. Quantitative research was ideal in this case since it sought to establish relationships between measured variables which could clearly demonstrate any change effects before and after the research problem was solved. Quantitative approach was used since it enabled the researcher to be detached from the study and to produce outputs that could be regarded bias free.

This study also required qualitative evidence, to offer descriptive information on the current saving systems in use by the youth and their existing saving culture. The Qualitative approach generated descriptive information rather than numerical values. It added the human touch to the understanding of patterns. It helped the researcher to understand the underlying reasons of why the current hypothesis is as is. The coding analysis of common trends in the data provided insights into the problem that lead to definition of a good hypothesis for the quantitative research

The Analysis produced a list of functional, non-functional and technical requirements for the system. This was followed by a quick design and development of a prototype that allowed collection of further data from the sampled users.

The sampled users were provided with the prototype and a post-questionnaire that captured the data from their evaluations of the prototype. The data was analysed via Google Analytics from which improved system requirements were produced for the final product for this dissertation.

3.2.2.1 Validation of Data

Validity is concerned with the extent that a method in research investigates what it is intended to investigate. This research achieved validity by use of mixed method approach where Qualitative data from secondary data sources helped in the development quantitative data collection questionnaires. Both data from qualitative and quantitative methods led to better requirements specifications for the prototype development and iterations to a final prototype that addresses the research problem adequately.

3.2.2.2 Reliability

The reliability of the solution can be supported by the consistent use and increase in system users even after the research evaluations are over. Reliability of this study can also be proved whereby the system appealed to new youth users that were never involved in the research as a sample. This depicts the research findings were more accurate representations of the entire population.

3.2.3 Design

The design involved coming up with Data flow diagrams, Use case designs, Sequence diagrams, Design Class diagrams, Entity Relationship Diagrams and User Interface designs. This is where details of the working modalities and architectural designs of the system were produced.

3.2.4 Coding/Implementation

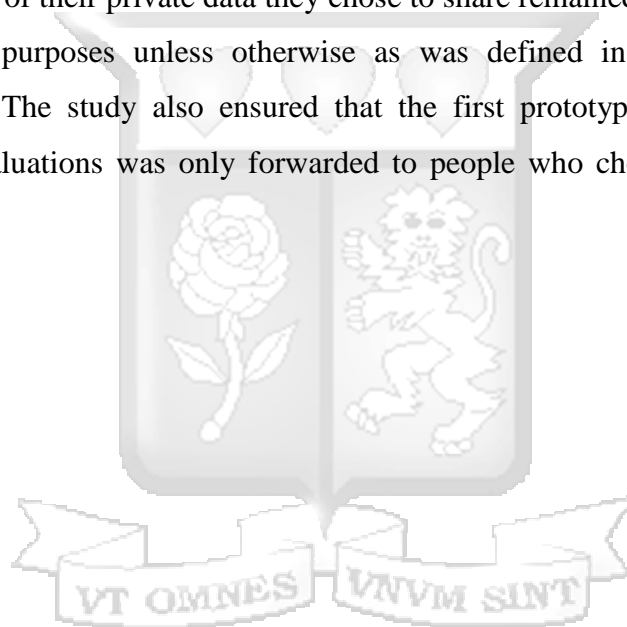
In this phase, the designs were converted to a final working prototype that addressed all the system requirements suggested by the users. Implementation code and visible user interfaces were produced for each deliverable of the design phase.

3.2.5 Integration, Testing and Maintenance

This phase involved integration of the various modules of the system, integration of the architectural components and testing each of these components to meet the set objectives, the acceptable responsiveness levels, the acceptable usability levels, the acceptable accuracy levels, the acceptable scalability levels and the acceptable robustness levels as expected from the system. Maintenance involved ensuring each component and module of the system is always up and running with their performance benchmarked to the desired levels.

3.2.6 Ethical Measures

The study ensured that all the respondents acted at will and they were not coerced. Any of their private data they chose to share remained private and only used for analysis purposes unless otherwise as was defined in agreements with the respondents. The study also ensured that the first prototype version that needed plenty of evaluations was only forwarded to people who choose participate in the test.



Chapter 4: Analysis, Prototype Development, and Client Evaluations

4.1 Introduction

This chapter looks at the analysis of the collected data, the prototypes developed, the clients' evaluations on the prototypes and the conclusions made from the data. The analysed data led to; establishment of the final system requirements, design and structuring of a solution that could address the identified problem.

4.2 Data Analysis

The data collected for this study was analysed so that system requirements could be established. The data was collected from a target sample of 188 respondents using the pre questionnaire shown on Appendix A and post questionnaires as shown on Appendix B below. The questionnaires were formulated on Google forms and the results recorded automatically on Google sheets. This could then be easily analysed using Google analytics that is in built on the Google sheets. The data also collected from the 5 sponsors of the target respondents was also analysed using qualitative coding technique to identify qualitative patterns.

4.2.1 Degree of Response

Out of the 188 sampled users who received pre questionnaires, the study acquired 166 responses that form 88.3% response rate. 30% of these respondents formed the sample stratum that facilitated in later evaluations of the prototypes that led to development of the final solution. The study also acquired responses from all the 5 Sponsors who participated in the personal interviews. The transactional data of these respondents as stored in the database was observed to offer more data on the viability of the solution. Having surpassed an overall response rate of 50 % from all the intended sample respondents, the research can confidently use the responses as representative of the entire population.

4.2.2 Demographic

From all the responses of the sampled target users, 70.7 % were between the ages of 18 to 25 years, 22% were 25 years and 7.3% were below 18 years of age as shown in Figure 4.1 below.

Out of all the sampled respondents, it is only 2.4% whose level of satisfaction with the current saving methods was above 50% satisfaction, as shown on Figure 4.4 below. From the observations of sampled users that agreed take part in the evaluations of the prototype, more than 60% of them were from the age group of 18 to 25 years.

What is your age?

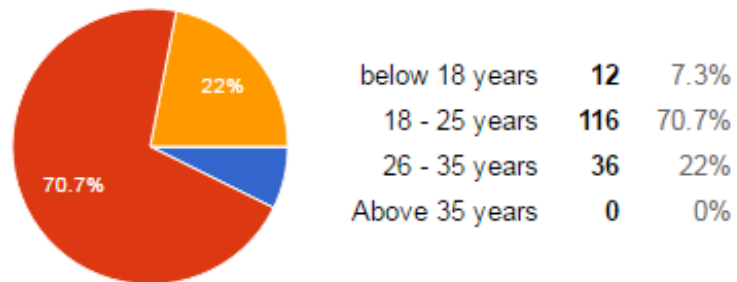


Figure 4.1: Age Distribution of Respondents

4.2.3 Responses on Current System

After issuance of the pre questionnaires to the sample respondents the following responses were established.

4.2.3.1 The Frequency of Saving Among the Youth

How often do you save from your income?

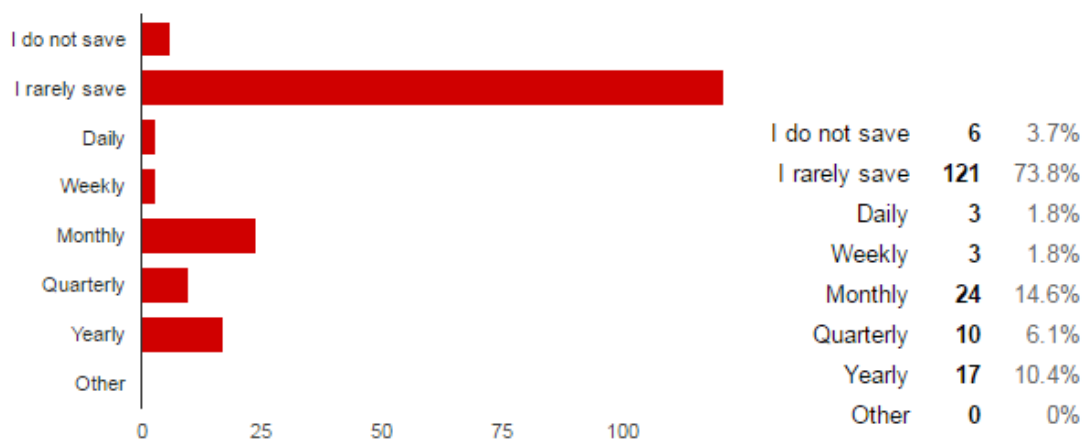


Figure 4.2: The Frequency of Income Savings among the Youth

Figure 4.2 above revealed that the youth do not often save. This has supported the hypothesis that a majority of the youth do not frequently save where 73.8 % of the respondent admitted to rarely saving.

4.2.3.2 The Use of Existing Income Saving Methods

The study revealed that even if the youth rarely save, when they do save, the most used saving method is the Mobile money accounts that allow for funds transfer from one phone number to another. Mobile money account is revealed to be used by 74.2% of the respondents followed by the use of bank savings accounts at 36.5%.

Despite this use of these existing saving methods by the youth, they are actually not satisfied by them as illustrated on Figure 4.4 below.

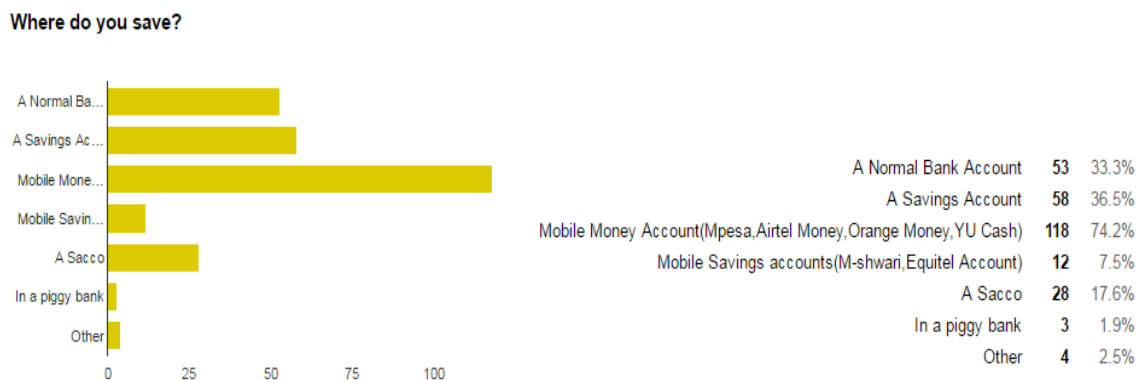


Figure 4.3: The Use of Existing Saving Methods

What is your satisfaction level with the current existing methods of income saving?

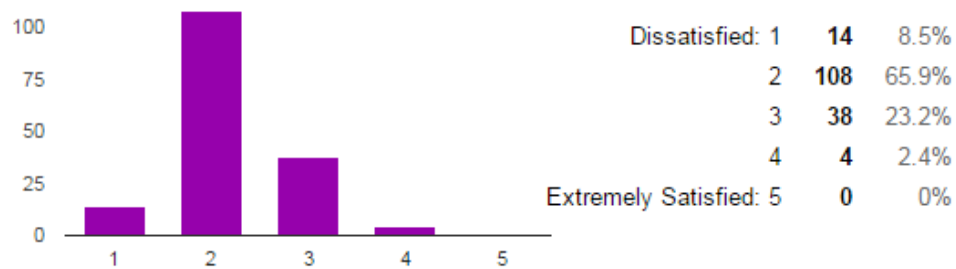


Figure 4.4: The Level of Satisfaction by Users in the Existing Saving Methods

4.2.3.3 Airtime Expenditures among the Youth

This research revealed that the youth must purchase airtime daily and they are willing to lose around 30% of it to a mobile value added service. The research revealed that over 70% of the youth spend more than Ksh.20 daily for airtime expenses as illustrated on Figure 4.5 below. On the other hand Figure 4.6 reveals that out of the total airtime the youth purchase daily, a minimum of Ksh.6 is deducted right off the top.

How much do you spend on Airtime daily?

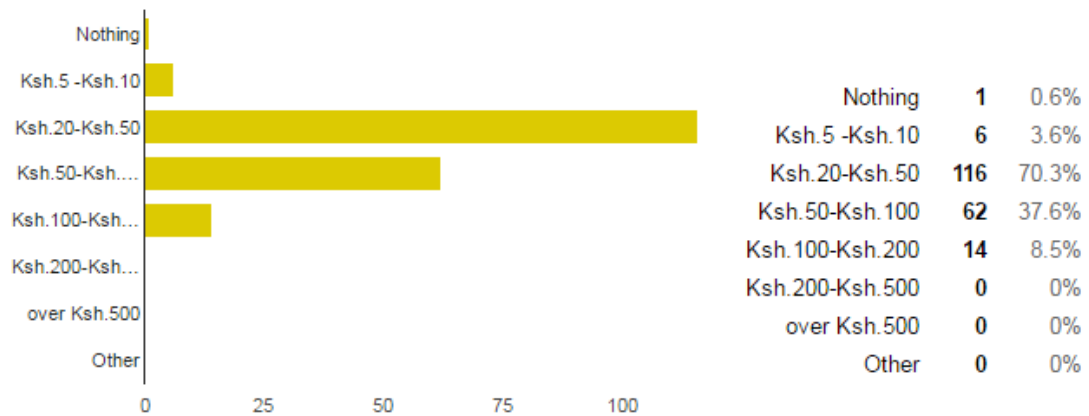


Figure 4.5: Daily Airtime Expenditures

What airtime amount is deducted daily by Mobile value added services you are subscribed to?



Figure 4.6: Daily Deductions by MVAS

4.2.3.4 Leveraging On Airtime Expenditure to Expedite Income Savings

As shown on Figure 4.7 below, 92.7% of the respondents agreed that if a system that deducts airtime and sets it aside for savings was presented to them, they would use it and thus improve on their frequency of savings.

Would you use an application that frequently deducts a portion of your airtime and sets it aside as savings?

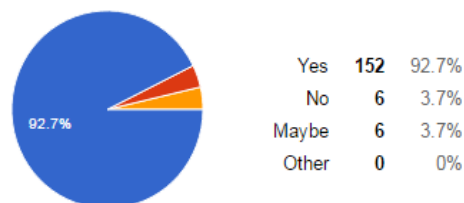


Figure 4.7: Leveraging On Airtime Expenditure to Promote Savings

4.2.3.5 Responses from the Interviewed Sponsors

All the 5 interviewed Sponsors that support a student at Strathmore University established that they would comfortably make deposits for these students if it was kept for savings. The fact that these deposits can be in form of airtime was even better since all of them agreed that they spend about Ksh.500 on airtime that is forwarded to the students weekly. Making this process automatic would reduce the students frustration calls since at times they forget to forward airtime and only do so after they receive calls from frustrated students who remind them to do so.

4.2.4 Data Analysis Conclusions

The responses received were positive and they facilitated in determining the need level of the application which can be determined as over 90% as illustrated on Figure 4.7 above. The data revealed the existence of infrequent savings among the youth aged 18 to 25 years. The data also enabled the researcher to identify the key weaknesses of the existing income savings that include: Requisition of several user documents to open an account, the need of the customer to constantly remember to set some money aside for savings if they wish to frequently save, the need of the customer to constantly be physically present at an institution to make a deposit and the mandatory use of money as the collection unit for savings. These led to the identification of key requirements that were vital in coming up with the solution. These requirements include: Convenience of deposit by remote deposits, Automatic deposit without the customer having to remember to initiate it and deductions that mimic daily airtime expenditures these customers have. Over 50 % of respondents also exhibited the need to: Prioritise Safaricom pre-pay subscribers as the first target group, the need to design the application on the Android platform, the need to design the saving model to work like the MVAS, the need to deploy the solution on a mobile platform, the need for the solution to be designed in a way that reduces procrastination and the need of allowing sponsors to be able to make savings on their behalf. These needs are as demonstrated on the statistical evidence on Figure 4.3, Figure 4.6: Daily Deductions by MVAS, Figure D. 2 and Figure D. 3

4.3 Prototype Development and Client Evaluations

Client evaluations were performed after initial prototype development so that the researcher would get feedback and suggested improvements from the users. The users that took part in the evaluations were supplied with post Questionnaires to rate the application on various aspects of usability, responsiveness, scalability, robustness and accuracy, that led to the improvements of the final design.

The initial prototypes led to the final improved version of the solution. The major concerns picked by the respondents were: to reduce the clutter on the user interface, to have a balanced colour use and to use words /symbols that the users can easily relate to.



Chapter 5: System Design

5.1 Introduction

This chapter covers the system design and architecture based on the requirements specifications identified from the analysis of the collected data. It defines the stakeholders of the system, the components of the system, data models of the system and process models of the system. Finally, the chapter reviews the database design and provides an illustration of the interface wireframes of the system.

5.2 System Requirements

Several functional, non-functional and technical requirements emerged from the analysis of the data collected in the research survey. These requirements informed the architectural design as depicted on Figure 5.1 below and various components that are crucial for the mobile solution to solve the research problem.

5.2.1 Functional Requirements

These are the core requirements the system must fulfil in order to be regarded as having solved the research problem. They include:

i. Set Save

This allows the saver to specify the percentage of airtime they wish to be deducted daily from their airtime account for savings. The saver also specifies the period they wish the savings to be held before maturity. The user can also edit either of these specifications as they wish.

ii. Direct Save

This allows a saver to specify any amount of airtime from 5 to 10,000 (which are the limit of transfer) to be directly transferred from their airtime account to their airtime savings account instantly. This is provided they have sufficient airtime in their airtime account to do so.

iii. Set Boost

This allows a sponsor to specify the percentage of airtime they wish to be deducted daily from their airtime account and transferred to an airtime saving's account that belongs to saver. The sponsor will also have to set a viable phone number of the saver they wish to be boosting with savings.

iv. Direct Boost

This allows a sponsor to specify any amount of airtime from 5 to 10,000 (which are the limit of transfer) to be directly transferred from their airtime account to a saver's airtime savings account instantly. This is provided they have sufficient airtime in their airtime account to do so.

v. Deduction service

This is an automatic process that performs the airtime deduction from an airtime account to an airtime savings account. The service takes place according to the set specifications of percentages and mode of deductions by the saver or sponsor. The saver or sponsor can at any time pause and restart the deduction service.

vi. Check Balance

This allows the saver at any time to send a request on the total amount of airtime they have saved so far in their airtime savings account.

vii. Withdraw

This allows the saver to withdraw their savings in form of airtime or money from their airtime savings account.

viii. Notification

This will notify the saver on the activities in the saving system and in their airtime savings account such as a new top up.

ix. Transaction Logging

This happens on the server side whereby every setting specification, deposit and withdrawals are recorded in order to maintain reliability of the system.

5.2.2 Non-Functional Requirements

These are part of the system that it can do without but they play a major role in ensuring the core functions are well supported. They include:

i. Security

This ensures that only an account user has the ability to specify the saving /boosting percentages, to specify the savings/boosting periods, to edit any settings and to make any withdrawals from the system. This is provided where by the client application user will have a unique four digit pin that allows them access to the application. The online web server on the other hand will only have administrator users that must have authorised usernames and passwords to view all the transactional reports of the system.

ii. User Support

This offers a help section where a user can learn more on how to use the system. It also offers instant notifications to the users to make them aware of significant events taking place in the system.

5.2.3 Technical Requirements

In order for the system to work, there are several platform and environmental requirements that need to be met. The platform on which the client mobile application should run on is Android API level 15 and above. The phone should have a prepaid Safaricom SIM card. The phone should also have the ability to send and receive SMS messages. The server GSM based mobile application should have a SIM card. It should have the ability to send and receive SMS and transfer airtime. It should also have the ability to connect to the online web server via the internet. The Web Application server should have a database management system and the ability to push messages to the various client mobile applications.

5.3 System Architecture

The mobile based solution comprises of several architectural components and processes that work together to facilitate complete functionality of the mobile based solution. These Architectural components and processes are as described in sections below and illustrated on Figure 5.1 below.

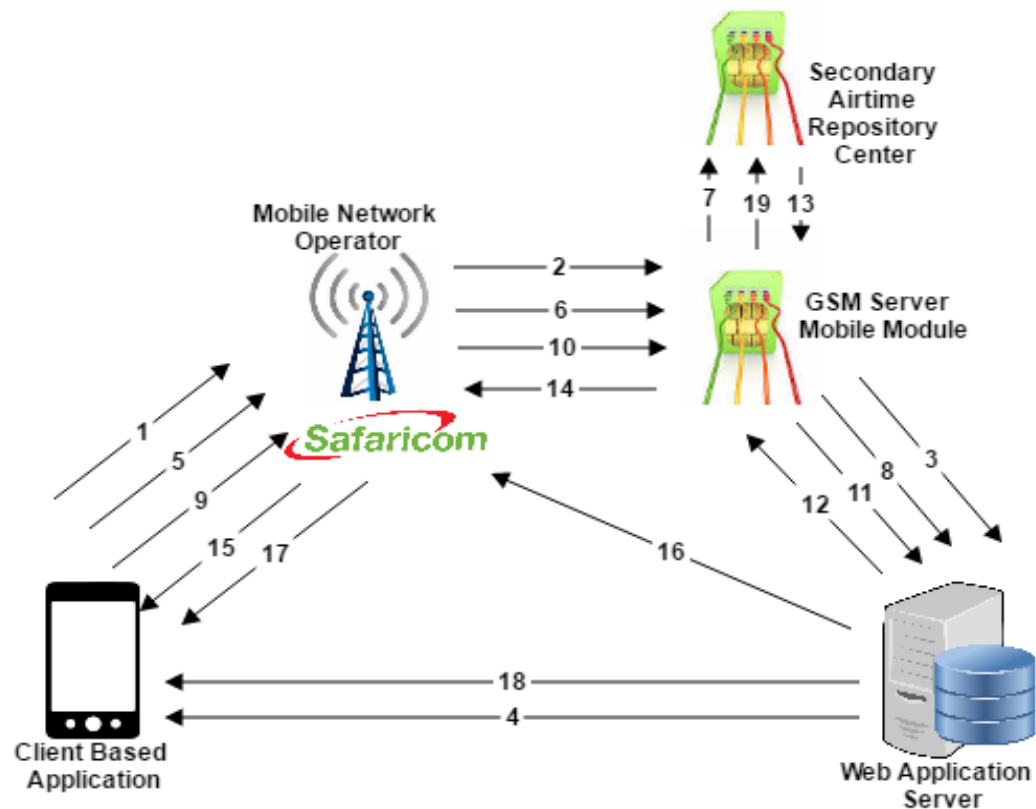


Figure 5.1 : The Mobile Solution Architecture

5.4 Architectural Components

The system comprises of five major components that work together to ensure the mobile solution functions according to the specified requirements. These components include a mobile client module, the mobile network operator, a GSM based application server, an airtime repository centre and a web application server.

5.4.1 A Client Based Mobile Module

This is the client phone and an Android based mobile application running on the user devices. This client side mobile application has two major processes. One that manages the user commands and another that runs continuously in the background as a service to perform all the necessary automatic processes. These user commands are the user specifications set as variables used in the automatic processes.

5.4.2 Mobile Network Operator (MNO)

This is the independent component of the application, upon which the system is built upon. Among the services the MNO provides are: the airtime transfer services, SMS services and mobile money transfer service. The free airtime transfer service by the MNO offers a means of deducting airtime from the client device to a server based device. The SMS service enables instant communication between the client based applications with the server based mobile application. The Mobile money transfer services on the other hand allows the web application server through the MNO , to forward money withdrawals to a client based application that has requested one.

5.4.3 A Server Based Mobile Module

This is a server application and server device that receives all the airtime deductions from all the various clients and the updates from transactions or settings change from the client module. It then sends all this airtime in a secondary repository centre for second level security purposes. This server application keeps a record of all the airtime saving's account holders, the total number of sponsors and the total amount of airtime in the repository. It also responds to all the requests from the client module, it sends requests to client module and continuously updates the accounts on the online web server.

5.4.4 Secondary Airtime Repository Center

This is a separate server account whose sole purpose is to hold all the airtime. Its core purpose is to offer second level security to abstract the airtime trail. It is also the account from which the airtime is distributed to third party airtime vendors that can convert it to money. It will have direct communication with the server based mobile module.

5.4.5 Web Application Server

This is an online server that holds the database module, notification module and withdrawal disbursement module and produces reports of the accounts. The database module keeps a record of all the user accounts and their transactions. The notification module pushes various important messages to the client based module.

The withdrawal disbursement module receives the money withdrawal requests from the server based mobile application .The web application server communicates with the MNO payment gateways to forward payments to the client mobile phone device.

5.5 Architectural Processes

These following processes numbered from Process 1 to Process 19 are based on the Architectural illustration on Figure 5.1 above.

5.5.1 Process 1, 2, 3 and 4

These processes flow from: sending of the user settings to the GSM server based mobile module, and then to the webserver that sends a confirmation of the same back to the client module.

5.5.2 Process 5, 6, 7 and 8

These processes flow from: the deduction of airtime either automatically or after a user request, which is transferred to the server mobile module that distributes the airtime to an external GSM based server that acts as a repository for the airtime. This transaction is then updated on the web server database system.

5.5.3 Process 9, 10, 11, 12,13,14,15,16,17,18 and 19

These processes flow from: a withdrawal request that is carried to the GSM mobile server and to the online webserver that records this transaction. Based on the type of withdrawal the web server sends two types of requests that are: process 12 and process 16. Process 16 is a request sent when the user has requested withdrawal as money and thus the webserver instructs the MNO gateway to make payments to the client module. Process 12 is a request made by the web server if the client module requested airtime withdrawal. The server instructs the GSM mobile server module to transfer airtime to the client module from the repository.

5.6 Stakeholders of the System

The Mobile solution has several key stakeholders that directly and indirectly interact with the system. The stakeholders are:

5.6.1 The Target Users

These are the target group that directly interact with the solution. To use the mobile solution, they have to install the Android application on their devices. They then activate the mobile application by specifying the percentage of their airtime they wish deducted for savings daily. They also specify the period in months for which the deduction should take place for savings to be regarded mature. Finally, they can request for withdrawals of their savings or request to view their current savings balance.

5.6.2 The Sponsors

These are the people who save on behalf of a target user, they chose to sponsor. To use the mobile solution, they also have to install the Android application on their devices. They are then required to input or select a phone number of a user they wish to sponsor. After that, they have to specify the percentage of their airtime they are willing part with and debited in a saver's airtime savings account. The deductions will occur on a daily basis.

i. Safaricom Mobile Network Operator

This stakeholder interacts indirectly with the mobile solution. The mobile solution uses their airtime transfer services, airtime balance services and their airtime as the unit for savings. The solution remains viable and running as long as the MNO services keep running in their current state.

ii. An airtime repository centre

This centre directly interacts with the mobile solution. All the airtime deductions from the youth and the sponsors are deposited here. Each activated user has an account where all their transactions are recorded. This centre also plays a key role in conversion of airtime to money and vice versa. It is from this same centre that the target users would request a withdrawal of their airtime savings.

5.7 Data and Process Modelling

5.7.1 Data Flow Diagram

These diagrams depict the flow of data and relationships between different components of a system. They show the high level details and how data inputs are transformed to data outputs via functional transformations. They show the functions required to run in a program and the data these functions need (LeVie, 2015).

i. Context Diagram

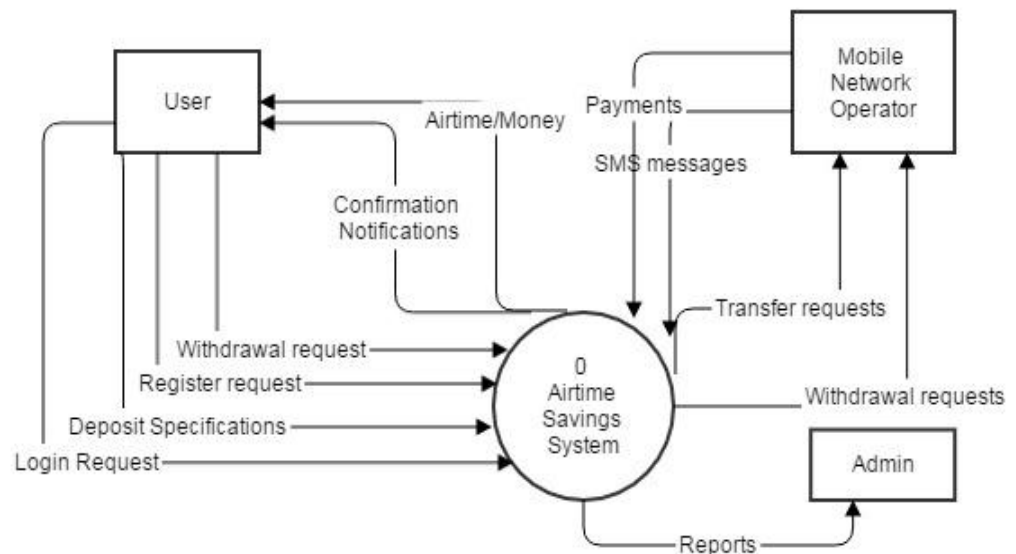


Figure 5.2: Context Diagram

This shows the basic interaction of the core system with all the external entities and the communications between them.

ii. Level 0 DFD diagram

This diagram defines the core processes and interactions between the various components that make up the system.

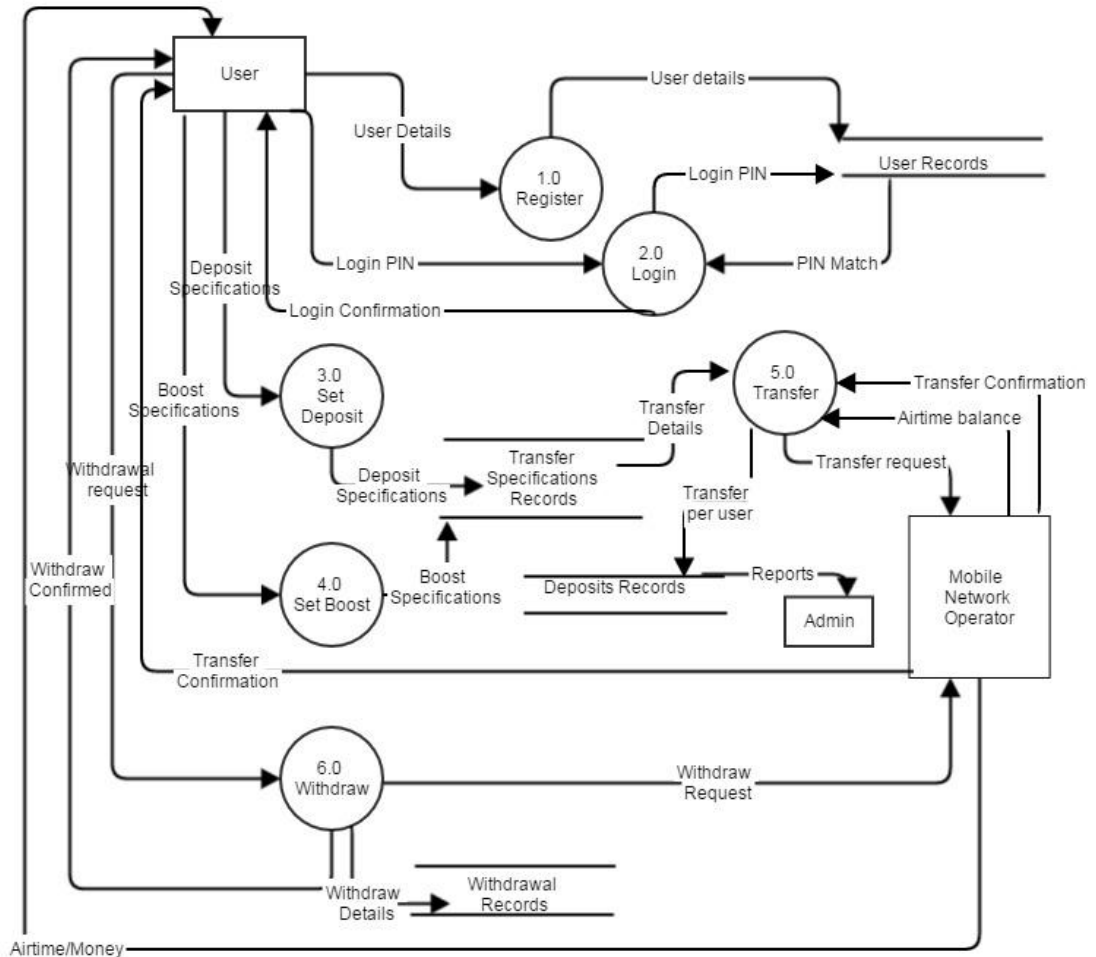


Figure 5.3: DFD Level 0

iii. Level 1 DFD Diagram

This diagram illustrates further break down of major transfer and deposit process in light with their more specialised functions in the system.

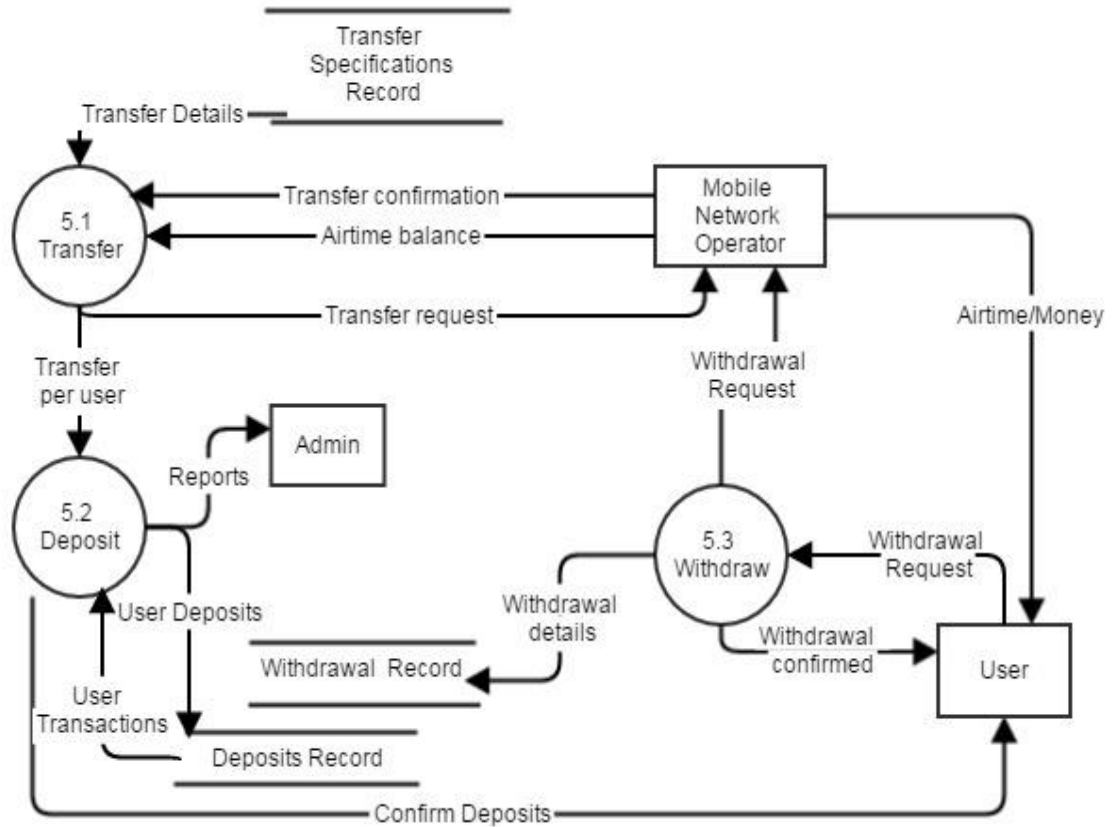


Figure 5.4: DFD Level 1

5.7.2 Use Cases Modelling

i. Use Case Diagram

Figure 5.5 below illustrates a use case diagrams are used to offer visual representation of the various roles in the system and how they interact with the functions of the system .It illustrates the activities performed by the users of the system, that is, the functional requirements from a user’s perspective (Ochodek, 2009).

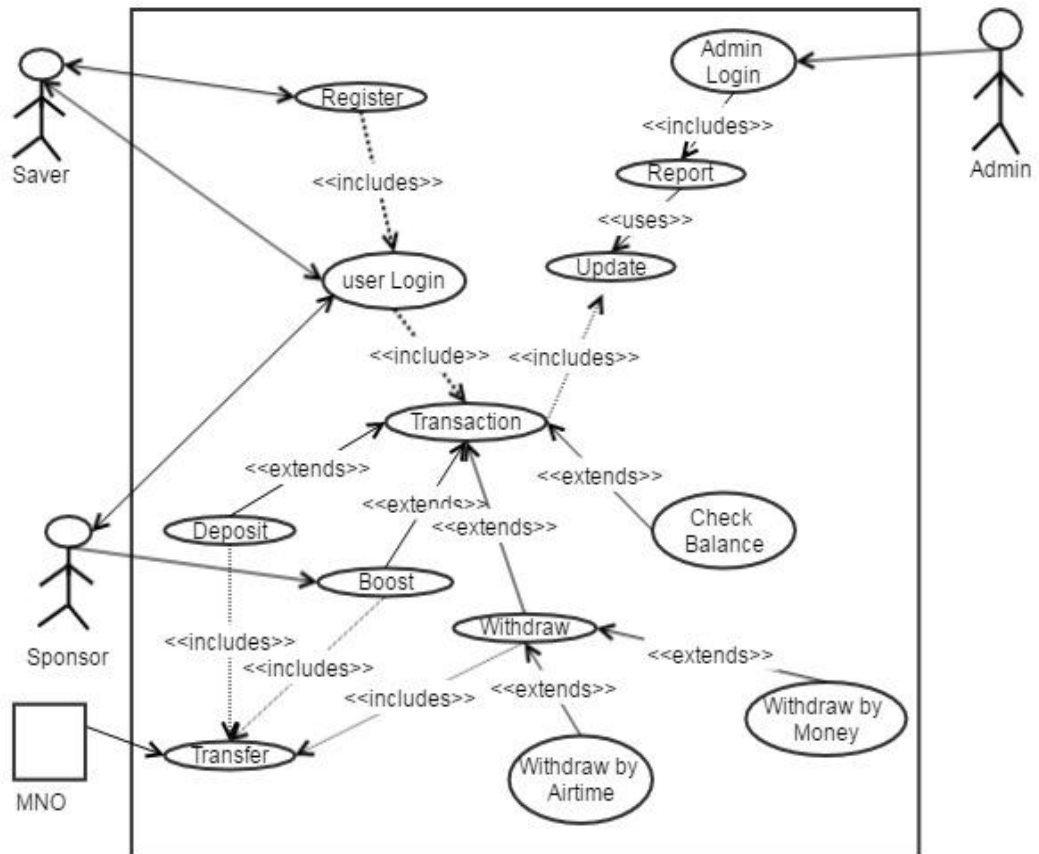


Figure 5.5: Saving Using Airtime Mobile Solution Use Case

ii. Use Case Description

It is the description of each of the classes within a use case (Badgerati, 2009). This section will look at the descriptions of various use cases in the system.

Table 5.1: Deposit Use Case

Use Case Name	Make an airtime deposit
Brief description	This explains how a user sets deposit specifications and how automatic deposits occur
Trigger	An airtime balance message received from the MNO
Participating Actors	A saver, MNO
Flow of Events	<ol style="list-style-type: none"> 1. The Saver sets the deposit parameters(percentage and period/Amount) 2. The system records the parameters 3. The system receives an airtime balance SMS from the MNO 4. The system transfers airtime to a saving user's deposit account if the balance meets the transfer threshold 5. The user gets a notification confirming the deposit
Alternative flows	<ol style="list-style-type: none"> 1a. The Deposit is paused thus user cannot make any changes to the deposit parameters 4a. Airtime balance does not meet transfer threshold notification given to user and exits
Entry Conditions	User has valid authentication , the deposit transfer is not paused and the mobile device has a SIM card that can send SMS
Exit conditions	User airtime account debited or user exits due to having inadequate airtime balance to make a deposit

Table 5.2: Boost Use Case

Use Case Name	Boost a Saver Use Case
Brief description	This explains how a user sets deposit parameters ,for a deposit to be made by a Sponsor to another user's airtime account and how such deposits occur automatically
Trigger	An airtime balance message received from the MNO
Participating Actors	A Sponsor, MNO
Flow of Events	<ol style="list-style-type: none"> 1. The Sponsor sets the deposit parameters(percentage and contact) 2. The system records the parameters 3. The system receives an airtime balance SMS from the MNO 4. The system transfers airtime from the Sponsor to another user's deposit account if the balance meets the transfer threshold 5. The Sponsor and the boosted user get a notification confirming the boost and deposit respectively
Alternative flows	4a. Airtime balance does not meet transfer threshold notification given to the Sponsor and exits
Entry Conditions	User has valid authentication , the boost transfer is not paused and the mobile device has a SIM card that can send SMS
Exit conditions	Boosted user airtime account is debited or the Sponsor user exits due to having inadequate airtime balance to make a boost transfer

Table 5.3: Transfer Use Case

Use Case Name	Transfer Airtime between accounts
Brief description	This explains the system automatically transfers airtime from one account to another based on the set deposit and boost parameters
Trigger	An airtime balance message received or requested at a particular time ,from the MNO for airtime that meets the transfer threshold
Participating Actors	MNO
Flow of Events	1. The system listens or requests for airtime SMS from the MNO 2. The system reads a received message to determine transfer amount 3. The system transfers airtime to a specified airtime account 4. The system get a transfer notification from the MNO
Alternative flows	1a.The system does nothing if there is no airtime SMS from the MNO
Entry Conditions	The transfer is not paused ,the airtime balance meets transfer threshold and the mobile device has a SIM card
Exit conditions	Airtime moves from one specified account to another

Table 5.4: Withdraw Use Case

Use Case Name	Make a savings Withdrawal
Brief description	This explains how a user can withdraw their airtime savings from a savings account either inform of airtime or money
Trigger	A withdrawal request by a saver specifying amount
Participating Actors	A saver, MNO
Flow of Events	1. The saver specifies withdrawal type 2. The saver specifies the amount to withdraw 3. The system sends a withdrawal request 4. The mobile device receives airtime or money depending on the prior specified withdrawal type
Alternative flows	3a.The mobile device cannot send SMS 3b. The System informs user request is not made and exits 3c.The withdraw request does not match available balance 3d. The System informs user request cannot be completed and reason then exits
Entry Conditions	User has valid authentication, the mobile device has a SIM card that can send SMS and receive mobile money
Exit conditions	Airtime or Money is received by the SIM card on the mobile device

Table 5.5: Update Use case

Use Case Name	Update remote servers
Brief description	This explains how the client system updates the server systems on any setting changes and the transactions
Trigger	A changed setting by the user or a transaction has taken place
Participating Actors	A user, An automatic transfer service
Flow of Events	<ol style="list-style-type: none">1. The user specifies saving or boosting setting2. The automated transfer service is triggered3. The system records the events and updates the remote servers
Alternative flows	<ol style="list-style-type: none">1.a The system does nothing if there is settings change2.a The system does nothing if there is service triggered
Entry Conditions	User has valid authentication to make changes The system is able to make and receive balance request message from Safaricom
Exit conditions	New information is passed to remote server as updates



5.7.3 Sequence Diagram

Figure 5.6 below shows the flow of interaction among the various modules of the system.

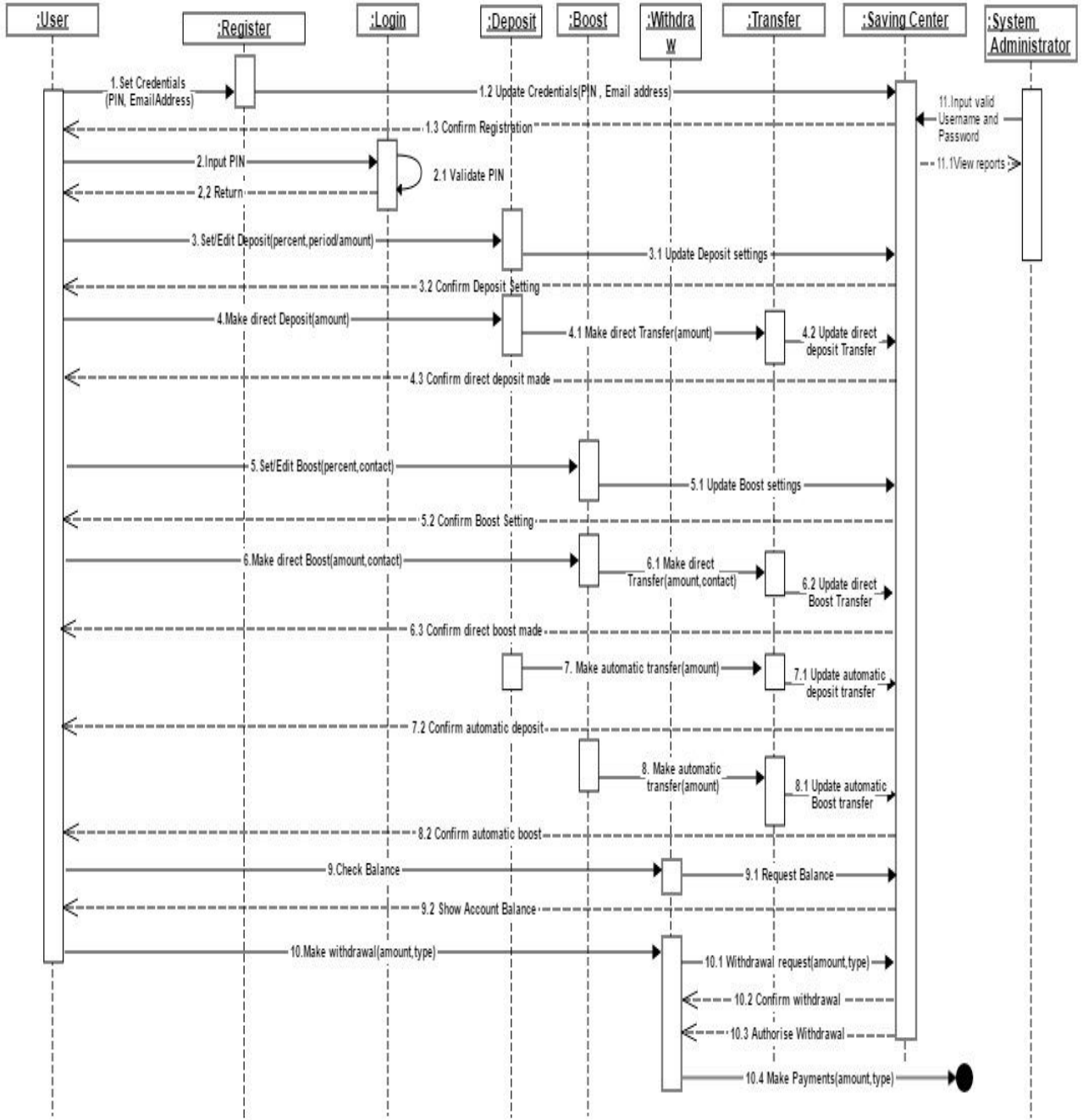


Figure 5.6 :The Mobile Solution Sequence Diagram

5.7.4 Design Class Diagrams

The design class diagram as shown on Figure 5.7 below depicts the class interections of the solution, the methods and the attributes. The classes enabled the development of actual objects of the system which have state changes and functions.

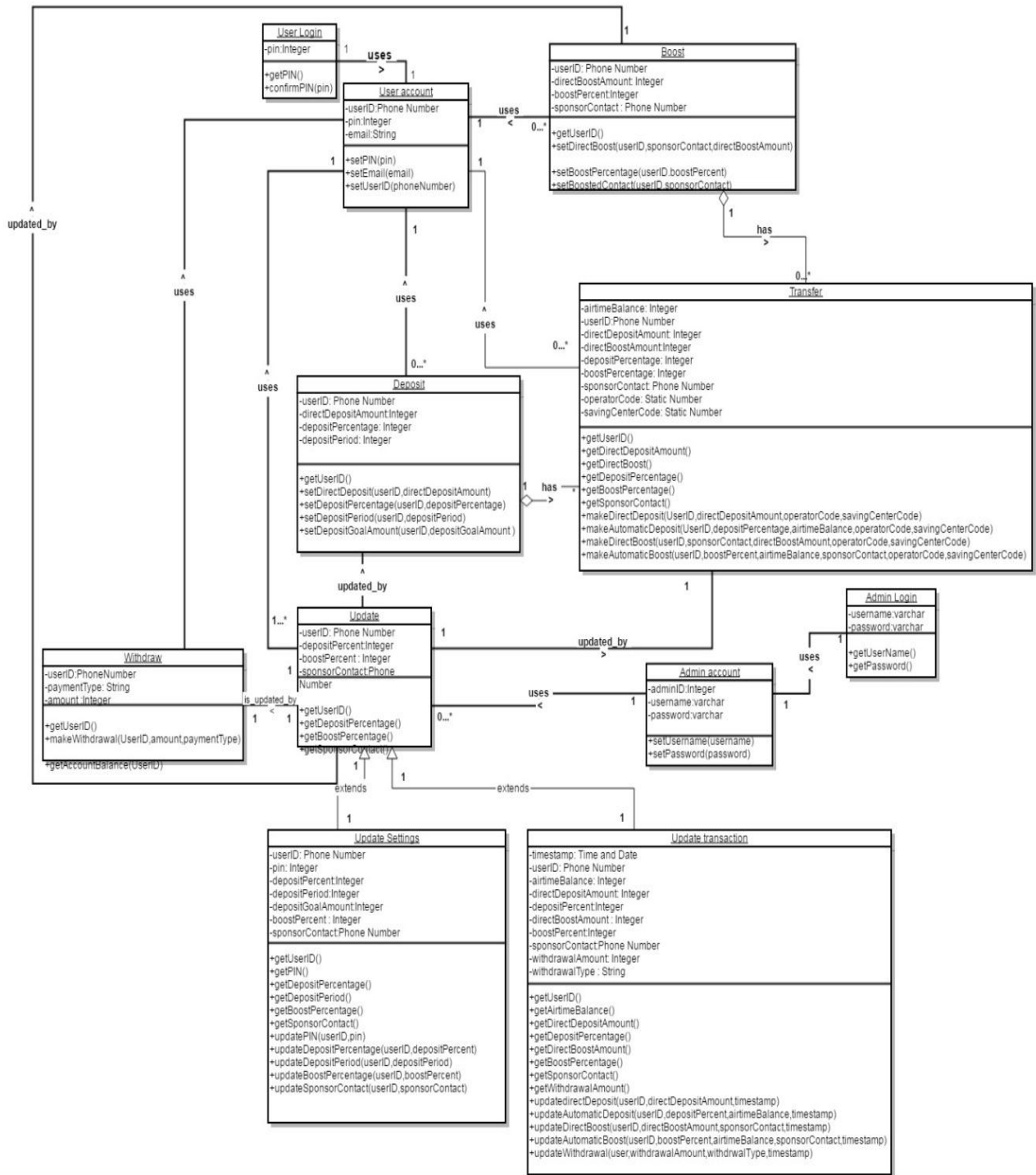


Figure 5.7: The Mobile Solution Design Class Diagram

5.7.5 Entity Relationship Diagrams(ER Diagram)

Figure 5.8 below shows the various entities that make up the mobile solution. The solution is made up six main entities that allow a user to save, a sponsor to boost a saver, a saver to withdraw and the system to balance the accounts of a saver. The various entities led to the design of the database schema with various tables and relations. The schema depicts the important keys and the normalised fields that ensure integrity of the data. The main table in the database is the saver's table, which relates to all the other tables except the admin table that carries data that is independent of the core functions of the system.

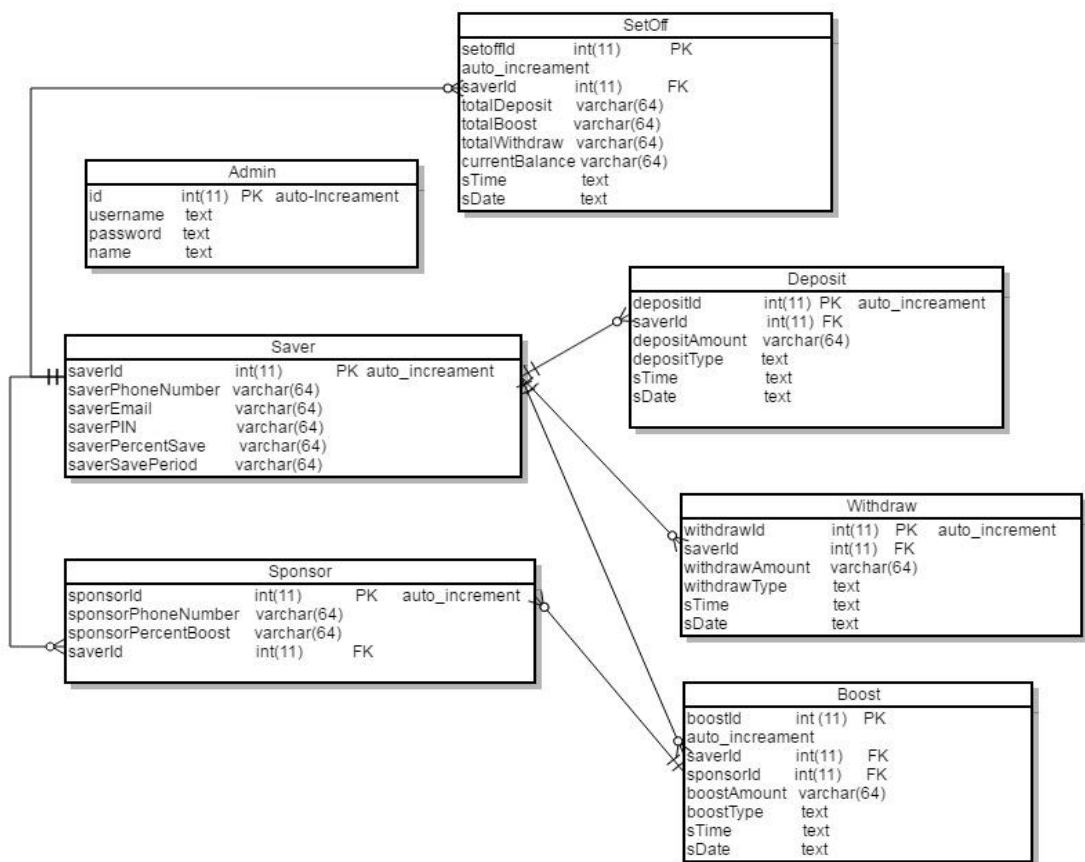


Figure 5.8: The Mobile Solution Entity Relationship (ER) Diagram

5.8 Database Design

In the design of the database several relational settings and security considerations were put in place.

5.8.1 Database Security

The data approach security design was set to ensure confidentiality of the sensitive data such as the PIN and the passwords for user and administrator logins respectively. This design ensured that the PINs and passwords provided at the registration of these users, were hashed. These PINs and passwords would be maintained in this irreversible hash even in the storage. Therefore, every time a user wants to login, the PINs and passwords they provide at login time will be passed through a hash function, where the hash they produce is compared to the ones associated with them in the records. If they match, the users will be able to login. The user settings and data in the client application were also maintained in an encrypted state. The system approach for security design entailed the placement of authentication points such as logins, in the system to ensure only authorised users could gain access and perform certain functions such as withdraw and changing of the settings. The system was also designed with sessions that did not allow any other person to use the history kept to access formerly accessed sections they do not have rights for.

5.9 User Interface Design

The solution is meant to have interface designs for the client mobile application and the server admin portal design. The client application has undergone design iterations after reviews of the quick designs by the sample users. The major concern picked from the respondent was to reduce clutter, to have a balanced colour use and to use words that a user can easily relate in the labelling of components. These designs are as outlined below.

5.9.1 Mobile Client Application User Login and User Registration Page Designs

Figure 5.9 below illustrates the login design that a first time user uses to set their PIN as well as for subsequent logins after they fully register to use the application. After setting the PIN the user is required to provide their email address on a registration message box where they accept the terms and conditions for using the application. This is as illustrated on the Figure 5.10 below.

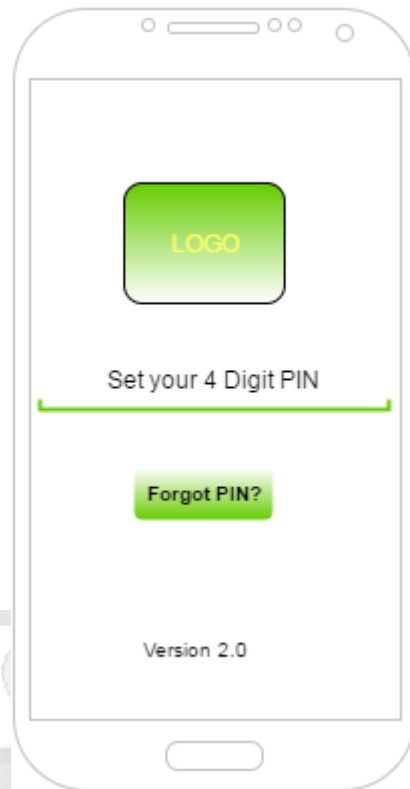


Figure 5.9: Mobile Client Application Login Design



Figure 5.10: Mobile Client Application User Registration Design

5.9.2 Mobile Client Application Home Page Design

After a subsequent Login by a user by providing the earlier set four digits PIN, the application lands them to the home page. The home page has three major functionalities that are represented by three buttons: depositing, boosting and withdrawing. All of the three functionalities can be enabled and disabled by the user at will by using the on and off buttons. The home page design is as illustrated on Figure 5.11 below.

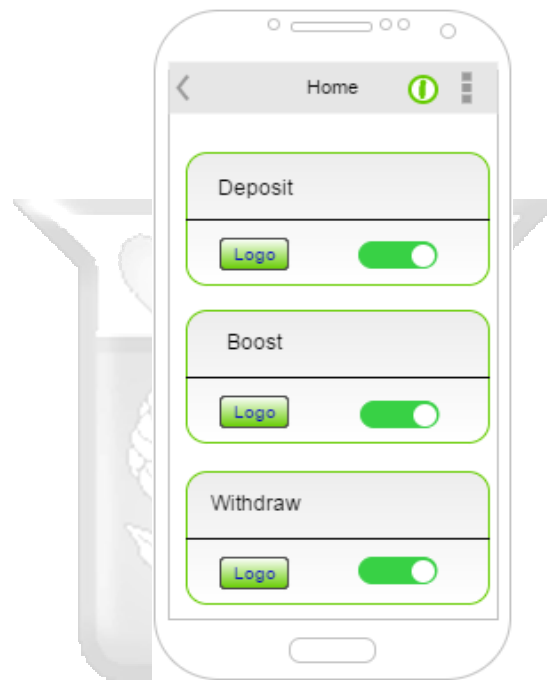


Figure 5.11: Mobile Client Application Home Page Design

5.9.3 Mobile Client Application Deposit, Boost and Withdraw Page Designs

While on the home page a user can select any of the three buttons to be directed to their respective pages that allow the user to specify the settings that these functionalities depend on to work. The designs of these functionality pages are as illustrated on Figure 5.12 below.

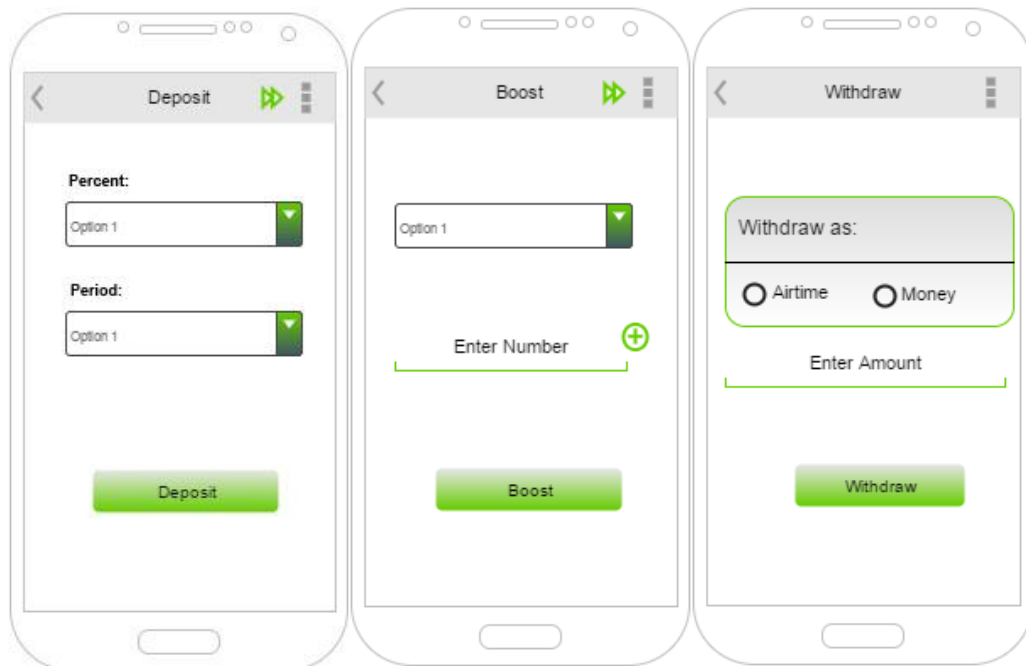


Figure 5.12: Mobile Client Application Deposit, Boost, Withdraw Page Designs

i. Deposit

On the Deposit page a user can select from a drop down list the % of their airtime they would wish deducted for savings daily. The user can also specify the maturity period of their airtime savings in month. The user can then commit the action by selecting the deposit button. The user can also edit all the set specifications by hitting the edit button that is hidden and only appears after if a deposit specification is committed.

ii. Boost

On the Boost page a sponsor user can select from a drop down list the % they would wish to be deducted daily and transferred to another user's account as savings. The sponsor can input the phone number of the saver they wish to boost or select the number from the phones contact list generated by the click of a button. The user can then commit the action by selecting the Boost button. The user can also edit all the set specifications by hitting the edit button that is hidden and only appears after a boost is committed.

iii. Withdraw

On the Withdraw page the user is provided with a set of two mutually exclusive options of airtime and money, where they have to select one. The user then inputs an amount they would wish to withdraw and press withdraw button.

5.9.4 Mobile Client Application Direct Deposit and Direct Boost Page Designs

While on the Deposit and Boost pages a user can press a menu icon on the top right of these pages to be directed to direct deposit and direct boost pages respectively. Direct deposit allows a user to manually deposit any amount of airtime for savings. On the other hand, Direct boost allows a user/Sponsor transfer any amount of their airtime to another user's savings account. These pages are as illustrated on Figure 5.13 below.

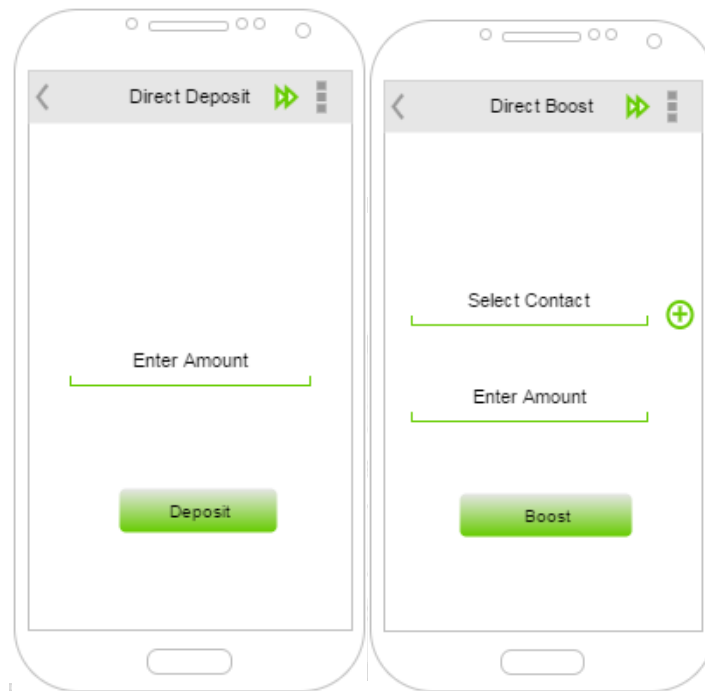


Figure 5.13: Mobile Client Application Direct Deposit and Direct Boost Page Designs

5.9.5 Web Administration Portal Design

The administrator of the system will be able to view reports of the total savings available, the savers in the system, the sponsors in the system and the transactions of the system. All these functionalities are only accessible once the Administrator logs in successfully to the Administrator Dashboard. The login page and Administrator pages are as illustrated on the Figure 5.14 and Figure 5.15 respectively.

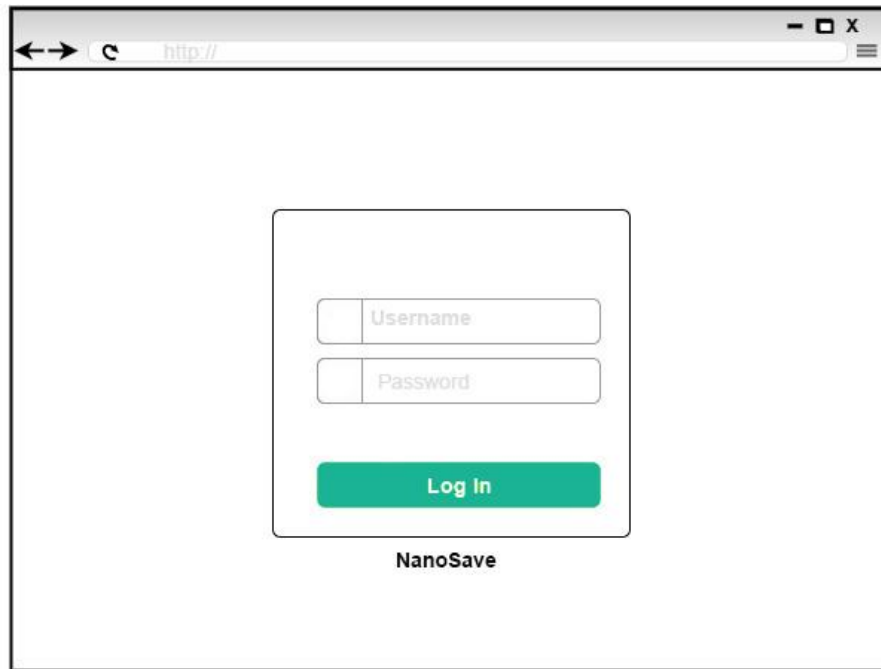


Figure 5.14: Admin Login Page Design

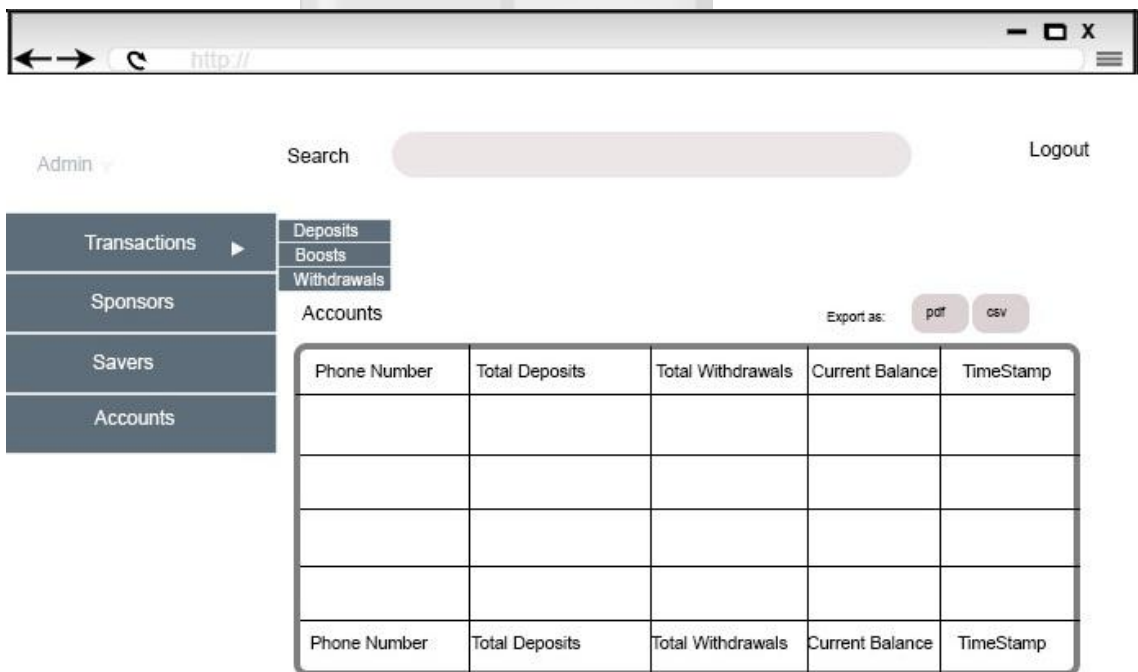


Figure 5.15: Administrator Dashboard Design

The table view design on Figure 5.15 will apply to all the functions, whereby each function will have its own column attributes. These functions include: Deposits, Boosts, Withdrawals, Sponsors, Savers and Accounts.

Chapter 6: Coding, Integration and Testing

6.1 Introduction

This chapter focuses on the outputs of the system designs in Chapter 5 that were implemented. These outputs are tested to reveal whether they work as designed. The implementation of the system will be examined in three perspectives; the implementation environment the implementation details and system testing.

6.2 Implementation Environment

This refers to the support systems surrounding the development of the system. This is the environment that supports the development of the mobile application client prototypes, server prototypes, the web portal and the database systems.

6.2.1 Client Mobile Application Prototype

The client mobile application prototype was developed on Android platform using Java programming language. The application was compiled using Android SDK build tool for API 15 and above. The SMS internal functionality of the client SIM card enabled communication from the client mobile application to the server application.

6.2.2 Server Mobile Application Prototype

The server mobile application prototype was developed on Android platform using the Java programming language as well as Android libraries and APIs. The application was compiled using Android SDK build tool for API 15 and above. JSON was used as the web service platform to transfer data to the web application from the server mobile application.

6.2.3 The Web Portal

The web portal was developed on bootstrap platform with PHP, CSS and JQuery scripting languages. The portal files were hosted on an Apache HTTP server.

6.2.4 The Database

The data updated from the server mobile application is stored in MySQL database. The database population is as prescribed by PHP files in the web server.

6.3 Implementation Details

This defines the major system components and their implementation procedures.

6.3.1 The Client Mobile Application

The client mobile application has eight functionalities that were derived as requirements from the intended user in the requirements elicitation stage. Six of these requirements have a user interface while the other two functions are services that run automatically at the background. These include:

i. Login , Registration and Home Page

This is the function concerned with the setting up a user to use the system. After installation of the mobile application is complete on a compatible Android device, the user is required to set a four digit Login PIN and provide an email address for registration as illustrated on Figure 6.1 below. This functionality ensures only the user with the right pin logs to set up the application. It is also the function that ensures a user can regain access to the application in case the user forgets their PIN. This PIN recovery is facilitated over the email address provided during registration. If this process is successful, the user is directed to the home page illustrated on Figure 6.2 below, which allows access to all the other functionalities of the application.

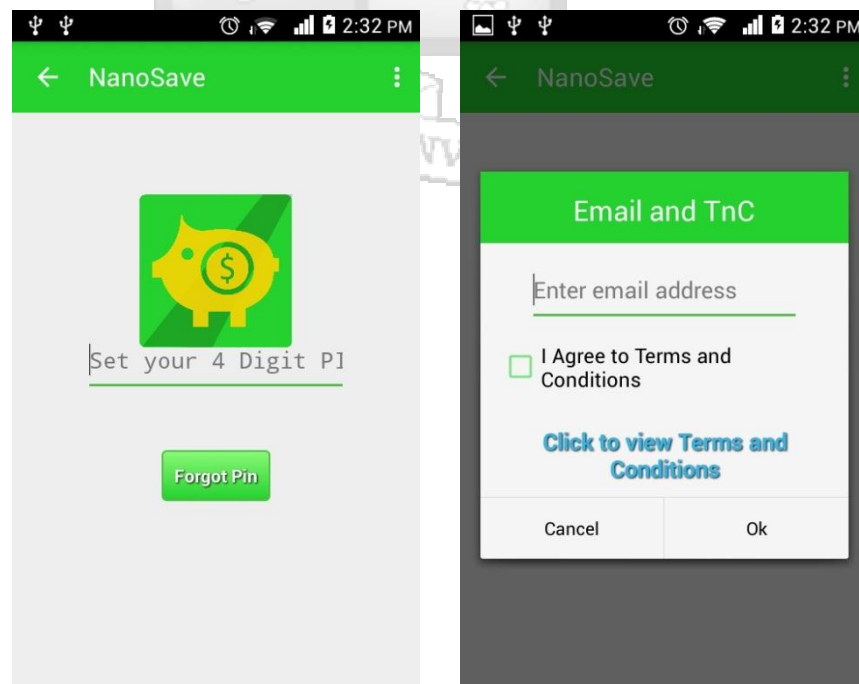


Figure 6.1: Login and Registration

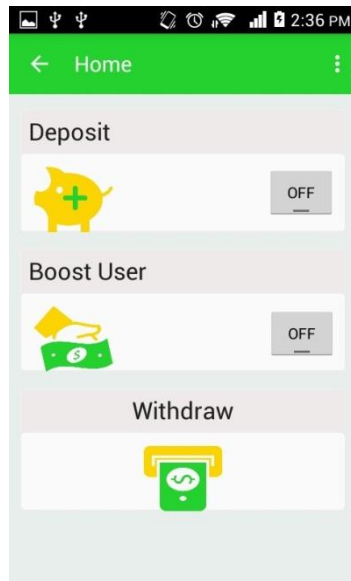


Figure 6.2 :Home Page

ii. Deposit

This is the function concerned with setting up and editing the percentage a user wishes to be depositing daily and the period which this depositing is to take place before it is considered mature. The Figure 6.3 below shows the Deposit page and parameter the user set.

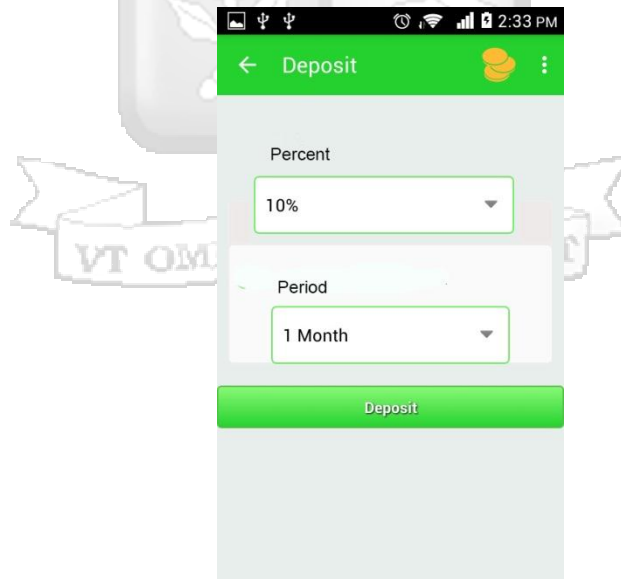


Figure 6.3: Deposit Setting

iii. Boost

This is the function concerned with setting up and editing the percentage a sponsor wishes to be depositing daily on behalf of another user and the contacts of the user they wish to be sponsoring. The below Figure 6.4 shows the Boost page and parameter the sponsor sets.

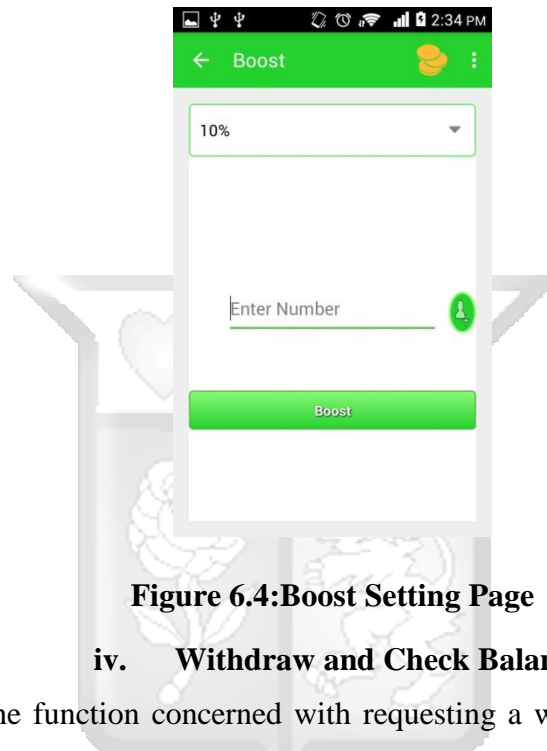


Figure 6.4:Boost Setting Page

iv. Withdraw and Check Balance

This is the function concerned with requesting a withdrawal and specifying the amount to withdraw. The user will have to also specify the form of withdrawal as either airtime or money. In the same page the user can request a notification of the total savings balance they have in their savings account. Figure 6.5 below shows the Withdraw page and parameter the user sets to make a withdrawal or check the savings balance.

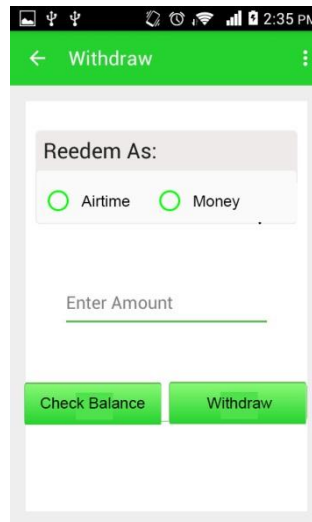


Figure 6.5:Withdraw Page

v. Direct Deposit

This is the function that allows the user to specify an amount of airtime they wish to be deducted from their airtime and transferred directly to their airtime savings account. If their airtime balance is sufficient enough to allow a transfer, this process occurs immediately the user taps the okay button. Figure 6.6 below shows the Direct Deposit page and parameter the user sets to make a direct deposit.

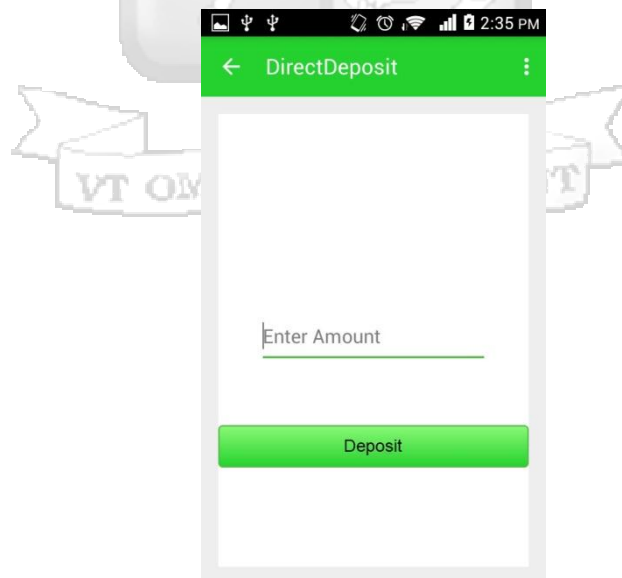


Figure 6.6:Direct Deposit Page

vi. Direct Boost

This is the function that allows a sponsor to specify an amount of airtime they wish to be deducted from their airtime and transferred directly to another user's airtime savings account. The sponsor also specifies the phone number of the user they wish to boost. If the airtime balance of the sponsor is sufficient enough to allow a transfer, this process occurs immediately the sponsor taps the okay button. Figure 6.7 below shows the Direct Boost page and parameters the user sets to make a direct boost.

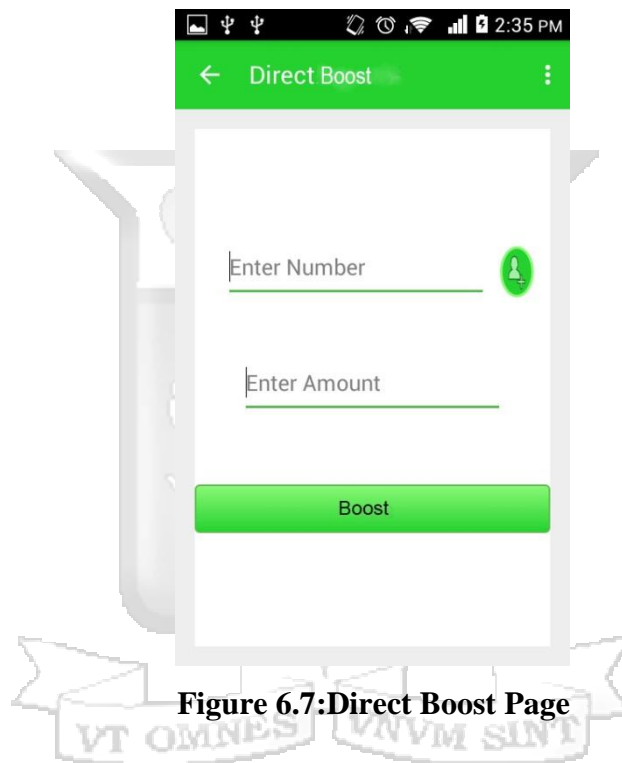


Figure 6.7:Direct Boost Page

vii. Listening and Transferring

This is a background function that manages the automatic deductions of airtime from a user's accounts to the airtime savings account. It ensures that the phone airtime balance checking process is triggered daily and the percentage specified by user is deducted and transferred. This process occurs daily and only successful if the user's airtime balance is sufficient enough to be deducted and meets the transferable threshold.

viii. Updating and Notification

This is also a background function that manages the process of updating all the setting changes and transactions that have taken place in every user account. It then allows for the user to receive notifications on the occurrence of specific transactions.

6.3.2 The Server Mobile Application

This Server mobile application contains two major functions that have no user interface. The Server Mobile application receives and dispenses airtime depending on user requests. It then updates the web server application on all the setting changes and transactions that have taken place among the client mobile applications.

6.3.3 The Web Server Application

The web server application manages three major functions that involve report viewing, recording keeping and user notification. The Administrator will be able to view a report of all the transactions and users. The system will automatically perform the record keeping and user notifications in the background.

6.4 System Testing

System testing was done by the developer and the target users of the system to ensure the functionalities of the system work and perform as intended and that the application measures up to the software standards of use such as usability, responsiveness, accuracy, robustness and scalability.

6.4.1 Developer Testing

The developer tests were conducted to ensure the functions perform as designed and that for each input, the outputs were as expected. This involved several types of tests that included:

i. Download, Installation and Compatibility Testing

This involved two developers who downloaded the application from the provided online link. They later installed the application on several phones that did not have the application installed before to ensure that the application can be newly installed on all the phones specified as compatible. Compatibility tests involved the application being installed on a variety of API platforms from level 15 to level 23.

The developers examined whether the mobile applications performed as expected.

The results of the test are as noted on Table 6.1 below.

Table 6.1: Installation and Compatibility Testing

Test Case Name: Installation and Compatibility Testing				
Date Tested: 25 th January 2016				
Tested by: David Kirui and Amos Ng'ang'a				
Test Description:				
Pre-Conditions				
Post-Conditions				
Test Steps				
Steps	Actions	Expected Response	Pass Or Fail	Comments
1.	Download and install Application from the Web	A downloadable application that install	Pass	Installed successfully
2.	Cross check each function works as expected	Outcomes of each function are correct	Pass	Ability to flow through all functions from start to exit
3.	Repeat the steps 1 and 2 for on phones running on Android version 4.0.3 to version 5.0	Install and performs well	Pass	None

ii. Login and Registration Testing

Table 6.2: Login and Registration Testing

Test Case Name: Login and Registration Testing				
Date Tested: 25 th January 2016				
Tested by: David Kirui and Amos Ng'ang'a				
Test Description:				
Pre-Conditions				
Post-Conditions				
Test Steps				
Steps	Actions	Expected Response	Pass Or Fail	Comments
1.	Tap on the application icon on the screen	The application opens and requests user to set PIN ,email and agree to terms of use	Pass	PIN set successfully and user will not be asked again on subsequent login to set these parameters
2.	Requests the PIN to Login after registration	Logins into the home page of the application	Pass	None

iii. Automatic Deposit and Direct Deposit Testing

Table 6.3: Automatic Deposit and Direct Deposit Testing

Test Case Name: Automatic Deposit and Direct Deposit Testing				
Date Tested: 25 th January 2016				
Tested by: David Kirui and Amos Ng'ang'a				
Test Description:				
Pre-Conditions				
Post-Conditions				
Test Steps				
Step s	Actions	Expected Response	Pass Or Fail	Comments
1.	Set the automatic deposit parameters	Airtime automatically transferred to the airtime savings account at some specific time of the day	Pass	None
2.	Specify amount for direct deposit	The amount immediately transferred to an airtime savings account	Pass	None

iv. Automatic Boost and Direct Boost Testing

Table 6.4: Automatic Boost and Direct Boost Testing

Test Case Name: Automatic Boost and Direct Boost Testing				
Date Tested: 25 th January 2016				
Tested by: David Kirui and Amos Ng'ang'a				
Test Description:				
Pre-Conditions				
Post-Conditions				
Test Steps				
Step s	Actions	Expected Response	Pass Or Fail	Comments
1.	Set the automatic boost parameters	Airtime automatically transferred to another user's airtime savings account at some specific time of the day	Pass	None
2.	Specify amount for direct boost	The amount immediately transferred to another user's airtime savings account	Pass	None

v. **Airtime and Money Withdrawal Testing**

Table 6.5: Airtime and Money Withdrawal Testing

Test Case Name: Airtime and Money Withdrawal Testing				
Date Tested: 25 th January 2016				
Tested by: David Kirui and Amos Ng'ang'a				
Test Description:				
Pre-Conditions				
Post-Conditions				
Test Steps				
Steps	Actions	Expected Response	Pass Or Fail	Comments
1.	Specify withdrawal as airtime	Airtime received by the user's phone number airtime account	Pass	None
2.	Specify withdrawal as money	Money is received by the user's phone number MPesa account	Pass	None

6.4.2 User Testing

User Testing was performed after prototype improvements so that the researcher would get feedback on the performance of the final product. The users took part in the evaluations were supplied with post Questionnaires to rate the application on various aspects of usability, responsiveness, scalability, robustness and accuracy.

i. Downloading and Installation of the Application

The prototype application was hosted on a web server whose link was shared to the test users via email. The users were able to download and test the application sufficiently.

Were there any issues in installing the application?

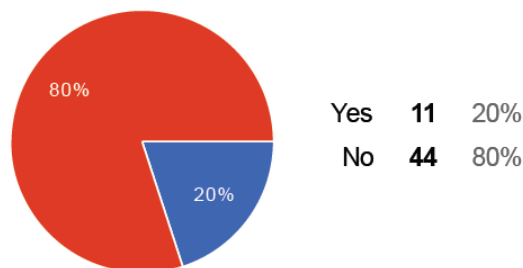


Figure 6.8: Installing the Application

Figure 6.8 above shows in percentage that a majority of the users did not find any challenges in installing the application. The few who did have a challenge attributed it to them being denied access due to their use of non Safaricom SIM cards.

ii. Usability

This usability evaluation was meant to test whether the users found the interaction with the mobile application friendly. It sorts to determine whether the users were able to navigate and use the application without asking for help. The usability of the mobile solution was rated high, where 98.2 % of the test respondents established the usability of the application to range from moderate to extremely usable as illustrated on Figure B. 1 in Appendix B below.

iii. Responsiveness

Responsiveness refers to how fast and how well the application responds to user's requests. It is concerned with the time it took for a user to get a response and extent of feedback a user receives as they interact with the application.

The responsiveness of the mobile solution was rated high where 100 % of the test respondents established the responsiveness of the application to range from moderate to extremely responsive as illustrated on Figure B. 2 in Appendix B below.

iv. Robustness

Robustness was tested in terms of how effective the application performed the processes without failing. The users would issue several requests at a time to test the application's tenacity. The robustness of the mobile solution was rated high where 98.2 % of the test respondents established the robustness of the application to range from moderate to extremely robust as illustrated on Figure B. 3 in Appendix B below.

v. Scalability

Scalability was tested in terms of the provisions the system had to allow for addition of other features that would enhance the system further. The scalability of the mobile solution was rated high where 98 % of the test respondents established the scalability of the application to range from moderate to extremely scalable as illustrated on Figure B. 5 in Appendix B below.

vi. Accuracy

Accuracy was tested to ensure that for every correct input, only correct outputs are expected without any variation. This tests checked whether the system adhered to the set parameters and settings accurately. The accuracy of the mobile solution was rated high where 98.2 % of the test respondents established the accuracy of the application to range from moderate to extremely accurate as illustrated on Figure B. 4 in Appendix B below.

6.5 Summary

The Evolutionary prototype software development methodology that was used allowed for iterative designs and development. The various quick designs eventually led to the implementation of the prototypes that were evaluated by the user to refine the requirements. The prototypes were implemented on specific environments that allowed for efficiency and effectiveness in the development. The final prototype was tested among a sample of intended users to ensure it met the development and functional standards.



Chapter 7: Discussion of Findings

7.1 Introduction

This chapter discusses the extent to which the developed solution achieved the set objectives of the study and the merits it brings about over the ones that existed before.

7.2 Explanation of Findings

The study commenced by using historical research methods to determine the existence of a problem and why the problem has not been dealt with using any existing solutions. This research led to the development of pre-questionnaires that were used to approve or disprove the hypothetical problem revealed from the secondary sources of data. The pre-questionnaire exposed the presence of the problem by providing statistical evidence from a sample of the affected target population. This information was analysed to identify the gaps and the proposed solution designed to address these gaps as well as the objectives of the research.

7.3 Discussions

The research objectives for this study were specified on Chapter 1, Section 1.3. The first objective was to determine how frequent the youth save their income. The study of literature by other researchers in Chapter 2, Section 2.2 revealed that there exists a culture of rare savings among the youth. To get further insights on the problem, a sample of the target users were issued with pre-questionnaires that were analysed to prove that a majority of them rarely saved as illustrated on Figure 4.2 above. Due to this problem, the development of the mobile solution to cater for this gap was justified.

The second objective was to review the existing income saving methods available for the youth in Kenya. The research sorts to reveal why the problem of infrequent savings existed yet there were saving methods in place. Chapter 2, Sections 2.3 and 2.4 of this research revealed the deficiencies in the existing systems that justified the research to intervene with a solution. This gap on the existing methods was later reinforced when the target user responses that depicted high dissatisfaction with the existing methods as shown on Figure 4.4 above.

The third objective was to develop a mobile based system that uses airtime as an income savings unit. From the study of existing literature works on Chapter 2, Section 2.5, it is revealed that the youth would rather spend on purchasing airtime than saving as shown on Table 2.3 above in Chapter 2.

After introducing the use of airtime as a saving unit on a mobile device and automatically deduct the airtime for savings, a majority of the target users were willing to use the system as shown on Figure 4.7 in Chapter 4, and thus justified the development of the solution. The fourth objective was to validate that the mobile based solution performed to the expected standards and functions. This was done in two major tests, by the developer and the intended users. The developer validated the solution to have worked as prescribed by the functional requirements as shown on Table 6.3 and Table 6.4. The system was then measured against standard software metrics using post-questionnaires supplied to the users, who validated the system to have performed to the expected metrics of usability, accuracy, responsiveness, robustness and scalability.

7.4 The Merits of the Developed Solution over the Existing Saving Solutions

The comparison of the developed mobile solution with the existing solutions revealed that: The mobile based solution offers more convenience than the existing methods. This solution offers mobility of the service which allows for remote deposits that are only present in two of the existing systems. The additional factor that the developed mobile solution offered over the existing mobile solution is the fact that it uses airtime as a unit for savings. The youth are easily detach from airtime as opposed to how they detach from actual money, thus offers more appeal to make savings. The developed solution also offers convenience by allowing for automatic deductions for savings. This ability to facilitate attraction of the youth plagued with procrastination as a major hindrance to saving as depicted on Figure D. 6 on Appendix D below. The mobile based solution was also modelled to be easily adoptable as compared to the existing methods. This was achieved by structuring the solution to be integrated seamlessly in their daily lives by morphing to a behaviour similar to Mobile value added services the youth currently use.

Finally the mobile solution was made very appealing to the target users who would be getting free airtime into their savings account from Sponsors that agree to it. This is appealing to the target users since most of them are dependent on a sponsor whereby they are not responsible for their own bills.

7.5 Conclusions

In conclusion, the mobile solution received positive feedback where 92.7% of the sampled respondents agreed to use the solution as shown on Figure 4.7 above. If the same response is replicated to entire target population, the economic status of the country and the youth would be elevated.



Chapter 8: Conclusions and Recommendations

8.1 Conclusions

In Kenya the major factors that have led to the infrequent saving by the youth are inadequacies in the existing income saving methods that are not tailored to attract them. The other factors are social factors whereby the youth lack the drive to save and therefore they remain in an endless loop of procrastination and excuses of having no money. In the current world people are embracing technology and always adopting the ones that offer for more value ,at a lower cost and more customized for them .The proposed mobile solution seeks enhance a savings culture shift among the youth by offering more value ,at a reduced cost and yet customized to their characteristics. This is achieved by use of a mobile solution that uses airtime as a savings unit and it performs the saving automatically. If this culture change takes root in Kenya, we are assured of a stronger economic future in the country as well as an emergence of a society with better financial management skills.

8.2 Recommendations

The mobile solution proved to be of great value to the youth and more could be done to enhance it even further for savings and financial empowerment. These recommendations include:

- i. The ability of the airtime to be deducted by the MNOs and not by a client application that runs on the user's device, so that the users that do not have Android devices could be able to use the system.
- ii. The ability of a user to participate directly in investment opportunities, using the airtime they have saved.
- iii. The ability for a user to save until a goal amount is achieved instead of only saving up to a certain maturity period alone.
- iv. The ability of one Sponsor to sponsor several savers instead of only one saver at a time

8.3 Suggestions for Future Work

The mobile solution focused on automatic deductions of airtime to set it aside for savings but much more can be done to enhance frequent savings such as:

- i. Automatic deductions of credit and debit card amounts per every transaction of a user to set the deductions aside as savings.
- ii. The setting aside of change received after payment of a service, as savings.



References

- Austrian, Karen, Ngurukie, & Corrinne. (2009). *Safe and Smart Savings Products for Vulnerable Adolescent Girls in Kenya & Uganda*. Retrieved 1 2015, 5, from Making Cents International:
http://www.makingcents.com/pdfs/resources/caseStudy10/PopulationCouncilMicrosave_CaseStudyNo%203_September2009.pdf
- Badgerati. (2009). *Software Engineering – Use Case Diagrams / Descriptions*. Retrieved 03 16, 2016, from Computer Science Source:
<https://computersciencesource.wordpress.com/2009/11/22/year-2-software-engineering-use-case-diagrams-descriptions/>
- Berg Insight. (2015). *Mobile Money in Emerging Markets*. Gothenburg- Sweden: Berg Insight.
- Bernheim, Douglas, B., Ray, D., & Yeltekin, S. (1999). *Self Control, Saving, and the Low Asset*. Unpublished.
- Boundless. (2016). *Sampling Techniques: Boundless Political Science*. Retrieved 02 25, 2016, from Boundless: <https://www.boundless.com/political-science/textbooks/boundless-political-science-textbook/public-opinion-6/measuring-public-opinion-46/sampling-techniques-272-1483/>
- Capital Campus in Campus Social. (2012). *Kenyan youths spend billions on entertainment and airtime*. Retrieved 1 5, 2015, from capitalfo.co.ke:
<http://www.capitalfm.co.ke/campus/kenyan-youths-spend-billions-in-entertainment-and-airtime-study-finds/>
- CNB Africa. (2015). *Is savings a priority for many Kenyans?* Retrieved from CNBAfrica.com: <http://www.cnbc africa.com/news/east-africa/2014/08/26/kenyans-saving-culture/>
- Communications Authority of Kenya. (2014). *Fourth Quarter Of The Financial Year 2013/14 , Quarterly Sector Statistics Report*. Nairobi: Government press.
- Construx Software Builders. (2002). *Evolutionary Prototyping*. Construx Software Builders Inc.
- Costa, F. D. (2002). Poverty and human rights: from rhetoric to legal obligations . *SUR:International Journal of Human rights*.
- Demombynes, G. (2012). *Can mobile phones be used to "bank" the poor?* Retrieved 1 5, 2015, from worldbank.org: <http://blogs.worldbank.org/africacan/can-mobile-phones-be-used-to-bank-the-poor>
- Dupas, P., & Robinson, J. (2013). *American Economic Review* ;<http://dx.doi.org/10.1257/aer.103.4.1138>. Unpublished.
- Edeki, C. (2015). Agile Software Development Methodology. *European Journal of Mathematics and Computer Science*, 22-27.

- Efron, S. (2013). *Action Research in Education: A Practical Guide*. New York: Guilford.
- Fengler, W. (2013). *Saving is the key to future growth for Kenya*. Retrieved from The World Bank: <http://blogs.worldbank.org/african/saving-key-future-growth-kenya>
- Financial Sector Deepening, Central Bank of Kenya. (2015). *Financial Inclusion in Kenya: Survey Results and Analysis from FinAccess*. Retrieved 1 2015, 5, from fsdkenya.org: http://www.fsdkenya.org/finaccess/documents/11-06-27_finaccess_09_results_analysis.pdf
- FSD Kenya. (2011). *Financial Exclusion in Kenya: Examining the Changing Picture 2006-2009*. Retrieved 1 5, 2015, from Financial Inclusion in Kenya: http://www.fsdkenya.org/finaccess/documents/11-06-27_finaccess_09_results_analysis.pdf
- FSD Kenya. (2014). *Kenya Financial Diaries: Shilingi kwa shilingi-The Financial lives of the poor*. Nairobi: FSD Kenya.
- FSD Kenya. (2016). *FinAccess Household Survey*. Nairobi: FSD Kenya.
- Gicheru, M. (2014). *82% of Kenyans Have Mobile Phones, Smartphone Uptake Is The Surprising One*. Retrieved 02 24, 2016, from Techweez: <http://www.techweez.com/2014/07/17/kenya-smartphones-share/>
- Hardie, S. (2014). *Saving for wealth*. Retrieved 1 5, 2015, from The shape of money: <http://www.theshapeofmoney.co.nz/retirement-planning/secrets-to-wealth/saving-for-wealth.asp>
- Herbling, D. (2012). *Kenyan youth spend most of their income on clothes, airtime*. Retrieved 1 5, 2015, from businessdailyafrica.com: <http://www.businessdailyafrica.com/Corporate-News/Survey--How-Kenyan-youth-spend-their-income/-/539550/1458982/-/ilhnfh/-/index.html>
- Idialu, K. (2014). *I Wanted To Develop A Recharge Card Powered Payment Platform*. Retrieved 10 09, 2015, from Techcabal: <http://techcabal.com/2014/01/10/wanted-develop-recharge-card-powered-payment-platform/>
- Invested Development. (2012). *Improving Informal Savings Groups by Mobile Technology*. Boston and Nairobi: Invested Development.
- Invested Development. (2012). *The Benefits of Informal Savings Groups*. Retrieved 1 5, 2015, from Invested Development site: <http://investeddevelopment.com/blog/2012/04/the-benefits-of-informal-savings-groups/>
- Ipsos-Synovate. (2011). *Kenya's Saving culture hurts growth, Investments prospects*. Nairobi: Ipsos-Synovate.
- Johnson, L., YungSoo, L., & Osei-Akoto, I. (2012). *Youth Savings Performance in Ghana, Kenya, and Nepal*.

- Jovanovic, I. (2008). *Software Testing Methods and Techniques*. Belgrade: DIV Inzenjering,d.o.o.
- Kenya Bureau of Statistics. (2009). *Kenya National Census*. Nairobi: Kenya Bureau of Statistics.
- Kimani, K. (2015). *Android is king in Kenya*. Retrieved 02 24, 2016, from MobiTrends: <http://mobitrends.co.ke/android-operating-system-market-share-in-kenya/>
- LeVie, J. D. (2015). *Understanding Data Flow Diagrams*. Retrieved 03 10, 2016, from ratandon: http://ratandon.mysite.syr.edu/cis453/notes/DFD_over_Flowcharts.pdf
- Mbai, J. K., & Chatterjee, S. (2015). *With Kenya's Youth, The Future Is Here: Invest to Reap Demographic Benefits*. Retrieved from The World Post: http://www.huffingtonpost.com/siddharth-chatterjee/with-kenyas-youth-the-future-is-here_b_8013228.html
- mHITs Limited. (2015). *Power at your Finger tips*. Retrieved 10 09, 2015, from Power Buy Namibia: <http://www.buypowernamibia.com/index.html>
- Ministry of Youth Kenya. (2006). *National youth policy* . Nairobi: Government of Kenya Press.
- MoETS. (2012). *Reforming Education and Training Sectors in Kenya*. p. Paper No. 4.
- Mondato. (2014). *In the Shadow of Mobile Money:International Airtime remittances* . Retrieved 10 09, 2015, from mondato.com: <http://mondato.com/blog/airtime/>
- Mondato. (2014). *The Risks and rewards of Airtime as Currency*. Retrieved 10 09, 2015, from Mondato.com: <http://mondato.com/blog/airtime-as-currency/>
- Morris, E. (2016). *Sampling from Small Populations*. Retrieved 02 25, 2016, from uregina.ca: <http://uregina.ca/~morrisev/Sociology/Sampling%20from%20small%20populations.htm>
- Mupaso, T. (2014). *Kenya has 67% smartphone penetration, way above the continent's figures*. Retrieved 02 24, 2016, from TechZim: <http://www.techzim.co.zw/2014/04/kenya-67-smartphone-penetration-way-continent-figures/>
- Nokia Telecommunications. (1999). *The Demand For Mobile Value Added services*. Oy: Nokia.
- Ochodek, M. (2009). *Introduction to Use Cases*. Retrieved 03 15, 2016, from Software Engineering: <http://www.se.cs.put.poznan.pl/knowledge-base/software-engineering-blog/introduction-to-use-cases>

- Okutoyi, E. (2014). *Poorer Kenyans over spending on mobile phones*. Retrieved 1 5, 2015, from itwebafrica.com: <http://www.itwebafrica.com/mobile/309-kenya/232582-poorer-kenyans-over-spending-on-mobile-phones>
- Onwuegbuzie, A. L. (2006). Linking Research Questions to Mixed Methods Data Analysis Procedures. *The Qualitative Report*, 11/3. 474–498.
- Onwuegbuzie, A., & R.B, J. (2004). Mixed Methods Research: A Research Paradigm Whose Time Has Come. *Educational Researcher*, 33/7, 14–26.
- Peake, A. (2013). *Kenya's ICT Sector, Mobile Money and the Transformation to a Middle-Income Country*. Unpublished.
- Quartz Africa. (2015). *The Kenyan government is starting to use its people for cheap funding*. Retrieved 10 08, 2015, from Quartz Africa: <http://qz.com/513198/the-kenyan-government-is-starting-to-use-its-people-for-cheap-funding/>
- Ramiirez, R. M. (2014). *Advancing Integrated Microfinance for Youth*. Freedom from Hunger.
- Ravi, A., & Tyle, E. (2012). *Savings for the Poor in Kenya*. New America Foundation ; www.Newamerica.net.
- Retirement Benefits Authority. (2009). *Young Savers Survey*. Nairobi: Retirement Benefits Authority.
- Robson, S. (2013). *Air Taxi to enable SA fare payments via mobile airtime*. Retrieved 10 09, 2015, from IT Web Africa: <http://www.itwebafrica.com/mobile/320-south-africa/232128-air-taxi-to-enable-sa-fare-payments-via-mobile-airtime>
- Safaricom. (2014). *Mobile banking initiatives helping Kenya's youth*. Retrieved 1 5, 2015, from theguardian.com: <http://www.theguardian.com/sustainable-business/mobile-banking-service-young-people-kenya>
- Salo, O., Ronkainen, J., & Warsta. (2002). *Agile Software Agile Software Development Methods: Review and Analysis*. VTT Publications.
- Sami, M. (2012). *Software Development Life Cycle Models and Methodologies*. Retrieved 03 22, 2016, from Software Engineering Practices: <https://melsatar.wordpress.com/2012/03/15/software-development-life-cycle-models-and-methodologies/>
- Skillsyouneed. (2016). *Writing your Dissertation: Methodology*. Retrieved 01 26, 2016, from skillsyouneed.com: <http://www.skillsyouneed.com/learn/dissertation-methodology.html>
- Sleepless Kenya. (2010). *M-Kesho: M-pesa Meets Equity Bank in Kenya*. Retrieved 02 03, 2016, from Sleepless Kenya: <https://sleeplesskenya.wordpress.com/2010/05/18/m-kesho-m-pesa-meets-equity-bank-in-kenya/>

- Strathmore University. (2015). *Corporate Facts & Figures*. Retrieved 02 25, 2016, from Strathmore University: <http://www.strathmore.edu/en/about-strathmore/corporate-facts-figures>
- Tanaya Kilara, C. M. (2014). *Analyzing the Business Case for Youth Savings*. Retrieved 1 5, 2015, from youthsave.org: <http://youthsave.org/>
- The Economist. (2013). *Airtime is money*. Retrieved 10 09, 2015, from The Economist: <http://www.economist.com/news/finance-and-economics/21569744-use-pre-paid-mobile-phone-minutes-currency-airtime-money>
- The Economist. (2013). *Airtime is money: The use of pre-paid mobile-phone minutes as a currency*. Retrieved 1 5, 2015, from economist.com: <http://www.economist.com/news/finance-and-economics/21569744-use-pre-paid-mobile-phone-minutes-currency-airtime-money>
- The Economist. (2013). *The use of pre-paid mobile-phone minutes as a currency*. Retrieved 1 5, 2015, from economist.com: <http://www.economist.com/news/finance-and-economics/21569744-use-pre-paid-mobile-phone-minutes-currency-airtime-money>
- Tuwakenya. (2012). *Mshwari Inside Out, Everything you need to know*. Retrieved 02 03, 2016, from tuwakenya: http://tuwakenya.appspot.com/post_read/110/Mshwari%20Inside%20Out,%20Everything%20you%20need%20to%20know
- Tyler Tappendorf, D. S. (2014). *Designing Mobile Microinsurance Products: Premium Payment Methods*. Retrieved 10 09, 2015, from CGAP: <http://www.cgap.org/blog/designing-mobile-microinsurance-products-premium-payment-methods>
- United Nations Capital Development Fund . (2012). *Listening to youth: Market research to design financial and non-financial services for youth in Sub-Saharan Africa*. Retrieved 1 5, 2015, from mastercardfdn.org: <http://mastercardfdn.org/what-we-are-learning/publications/youth-financial-inclusion>
- Wangui, J. (2014). *More youths investing at the NSE*. Retrieved from www.capitalfm.co.ke: <http://www.capitalfm.co.ke/business/2014/03/more-youths-investing-at-the-nse/>
- Washington University. (2012). *Challenges and Opportunities for Youth Saving*. St. Louis: Washington University, Center for Social Development.
- Waswa, G. M. (2011). *Information and Communication Technology (ICT) Access for Training and Employment*. 2011: Strathmore University.
- Waters, K. (2007). *What Is Agile? (10 Key Principles of Agile)*. Retrieved 02 25, 2016, from All About Agile: <http://www.allaboutagile.com/what-is-agile-10-key-principles/>

William, J., & Tavneet, S. (2010). *The Economics of M-PESA*. Washington, D.C: Georgetown University.

World Bank. (2014). *Global Financial Inclusion Database*. Retrieved 02 23, 2016, from datatopics.worldbank.org:
<http://datatopics.worldbank.org/financialinclusion/>

World Bank. (2014). *Mobile Phone Usage at the base of Kenyan pyramid*. Nairobi: iHub research.

Zollman, J., & Daryl, C. (2012). *Financial Capability: Are we Missing the Mark?* Retrieved 1 5, 2015, from [bankablefrontier.com](http://www.bankablefrontier.com/):
<http://www.bankablefrontier.com/assets/pdfs/BFA-FSD-InsightsBranchlessBanking.pdf>

Zollmann, J. (2014). *Shilingi Kwa Shilingi The Financial Lives of the Poor in Kenya*. Nairobi: FSD Kenya.



Appendices

Appendix A : Pre Questionnaire

Appendix A.1 :Target Users Questionnaire

This questionnaire is aimed at collecting data from the youth in Kenya aged 18 to 25 years in order for the researcher to quantitatively understand the existing state of income savings among the youth. This information will serve only for an academic purpose. There are no rights or wrong answers and your response will be highly appreciated.

i. Questions

1. What is your age? *Check Specific that apply*
 - a. below 18 years
 - b. 18 - 25 years
 - c. 26 – 35 years
 - d. Above 35 years
 - e. Other: _____
2. What education level are you currently pursuing? *Check all that apply.*
 - a. Higher education certificate
 - b. Diploma
 - c. Undergraduate
 - d. Post graduate diploma
 - e. Post graduate degree
 - f. Not a Student
 - g. Other: _____
3. Who is your telecommunications provider in Kenya? *Check all that apply.*
 - a. Safaricom
 - b. Airtel
 - c. Orange
 - d. Yu
 - e. Equitel
 - f. Other: _____

4. Are you prepaid or postpaid airtime subscriber? *Check all that apply.*
- a. Pre-paid
 - b. Post-paid
 - c. Other: _____
5. How much do you spend on Airtime daily? *Check all that apply.*
- a. Nothing
 - b. Ksh.5 Ksh. – 10
 - c. Ksh.20 - Ksh.50
 - d. Ksh.50 - Ksh.100
 - e. Ksh.100 - Ksh.200
 - f. Ksh.200 - Ksh.500
 - g. over Ksh.500
 - h. Other: _____
6. What is the average regular deduction of airtime on every Mobile value added services you are subscribed to? *Check all that apply.*
- a. Ksh.1 - Ksh.5
 - b. Ksh.6 - Ksh.10
 - c. Ksh.11 - Ksh.20
 - d. Ksh.21 - Ksh.50
 - e. Ksh.51 - Ksh.100
 - f. Ksh.101 - Ksh.500
 - g. above Ksh.500
 - h. I have not Subscribed to any Mobile Value Added Service
 - i. Other: _____
7. What Operating system does your phone run on ? *Check all that apply.*
- a. Android
 - b. iOS
 - c. BlackBerry
 - d. Java
 - e. Windows
 - f. I have no idea
 - g. Other: _____

8. Which mobile applications do you often install on your phone? *Check all that apply.*
- a. Games
 - b. Chat Applications
 - c. Utility Applications
 - d. Social Media Applications
 - e. None
 - f. Other: _____
9. What are the sources of your income? *Check all that apply.*
- a. Parent
 - b. Salary/Wage
 - c. My Business income
 - d. Other: _____
10. How often do you save from your income? *Check all that apply.*
- a. Daily
 - b. Weekly
 - c. Monthly
 - d. Quarterly
 - e. Yearly
 - f. Irregularly anytime
 - g. Other: _____
11. Where do you save? *Check all that apply.*
- a. A Normal Bank Account
 - b. A Savings Account
 - c. Mobile Money Account(Mpesa,Airtel Money,Orange Money,YU Cash)
 - d. Mobile Savings accounts(Mshwari, Equitel Account)
 - e. A Sacco
 - f. In a piggy bank
 - g. Other: _____

12. What makes frequent saving a challenge? *Check all that apply.*

- a. Inconvenience in the existing saving systems
- b. Lack of enough income
- c. Lack of time to act on saving
- d. Poor discipline to follow through
- e. Procrastinating
- f. Lack of an existing system that motivates it
- g. Other: _____

13. What is your satisfaction level with the current existing methods of income saving? *Mark only one.*

Dissatisfied ()1 ()2 ()3 ()4 ()5 Extremely Satisfied

14. Would you use an application that frequently deducts a portion of your airtime and sets it aside as savings? *Mark only one.*

()Yes ()No () Other: _____

If yes, What additional features would you want it to have and if No, Why would you not use it? _____

If yes, what percentage of you airtime would you want deducted for savings? *Check all that apply.*

- a. 10 %
- b. 20%
- c. 30%
- d. 40%
- e. 50%
- f. Other: _____

If yes , for how long would you want the savings to be kept before maturity? *Check all that apply.*

- a. One Week
- b. One Month
- c. Three Months
- d. Six Months
- e. One years
- f. Other: _____

15. Would you be willing to participate in testing this application once it is developed? *Mark only one.*

- a. Yes
- b. No
- c. Other: _____

16. Please share the email address from which you would wish to receive a free copy of the application that saves your airtime

Appendix A.2 :Personal Interview Questions

These are open ended questions directed to the key Sponsors that will be indirect users of the system. The interview was undertaken via telephone conversations.

Questions to a Parent/Sponsor

1. Would you save for your youth child? If yes, what amount and how frequently? If no, why not?
2. Do you share airtime or money for airtime purchase to your Child? How often?
3. Would you want the process of sharing your Airtime to your Child to be automatic? If so, would you want to share it with all your children at one instance?

Appendix B : Post Questionnaire

This questionnaire is meant to gather responses from the users to the test the system's functionalities, to enable system enhancement and to verify whether it met the performance requirements.

i. Download and Installation Instruction

- a) Download the prototype of the application called Nano Save from your email address.
- b) Select the downloaded .apk file and run it in your Android phone. This will install the application
- c) After installation is complete, you will be prompted to input your email, to accept the terms and conditions then you will be prompted to set a four digit PIN of choice. After providing all the mention requirements, the application will be ready for use.

Main Functionalities

After login in with the set PIN, the following are the main functionalities to test:

1. Deposit

Tap on the deposit button on the home page and you should be directed to the Deposit page. In this page, select the percentage of your airtime that would wish to be deducted daily for savings and select the period in Months you wish to save. Tap on the Deposit button and the settings will be committed. You will have to confirm the action to be effected, by selection Ok on a dialog box. The specifications will then not be editable unless the edit button is tapped and the entire process will have to be repeated.

2. Direct Deposit

On the top right of the Deposit page there will be a menu item. Tap on the item and you will land on the Direct Deposit page. Specify the amount to directly save and tap on the Deposit button. You will have to confirm the action to be effected, by selection Ok on a dialog box that will appear.

3. Boost

Tap on Boost button on the home page and you should be directed to the Boost page. At this point select the percentage of your airtime to be deducted daily from your airtime account and transferred to another user's account. You will also have to input the phone number of the user you will be boosting. You will have to confirm the action to be effected, by selection Ok on a dialog box. The specifications will then not be editable unless the edit button is tapped and the entire process will have to be repeated.

4. Direct Boost

On the top right of the Boost page there is be a menu icon. Tap on the icon and you will land on the Direct Boost page. Specify the phone number of the user you wish to Sponsor and the amount the tap on the Boost button. You will have to confirm this action to be effected, by selection Ok on a dialog box that appears.

5. Withdraw

Tap on Withdraw button on the home page and you should be directed to the Withdraw page that requires you to select the whether to redeem as money or as airtime then specify an amount to withdraw. Tap on the Withdraw button and you will be asked to confirm the action on a dialog box.

6. Check balance

On the bottom left of the Withdraw page, tap on the Check Balance button. A dialog box will appear for you to confirm the action before processing takes place.

ii. Test Questions

1. Were there any issues in installing the application? *Mark only one.*

a. Yes

b. No

If yes, please specify the issues _____

2. How would you rate the look and feel of the application? *Mark only one.*

Poor 1 2 3 4 5 extremely good

3. How would rate the usability of the application? *Mark only one*

Not Usable 1 2 3 4 5 Very Usable

4. How would you rate the responsiveness of the functionalities of the application?

Mark only one.

Not responsive 1 2 3 4 5 Very responsive

5. How would you rate the robustness of the application? *Mark only one*

Not Robust 1 2 3 4 5 Very Robust

6. How would you rate the accuracy of the application? *Mark only one*

Not Accurate 1 2 3 4 5 Very Accurate

7. How scalable is the application? *Mark only one.*

Not Scalable 1 2 3 4 5 Very Scalable

8. How adequate were security measures in the application? *Mark only one.*

Not Adequate 1 2 3 4 5 Very Adequate

9. Can the application address your infrequent saving habit? *Mark only one.*

a. Yes

b. No

Specify why? _____

10. Do the application offer the needed of convenience? *Mark only one.*

a. Yes

b. No

Specify why? _____

11. How effective would you consider the application to the current existing systems? *Mark only one*

Not Effective () 1 () 2 () 3 () 4 () 5 Very Effective

iii. Tests Results

The following figures illustrate the analysed results of the usability and functional test from the sample users.

a) Usability

How would rate the usability of the application?

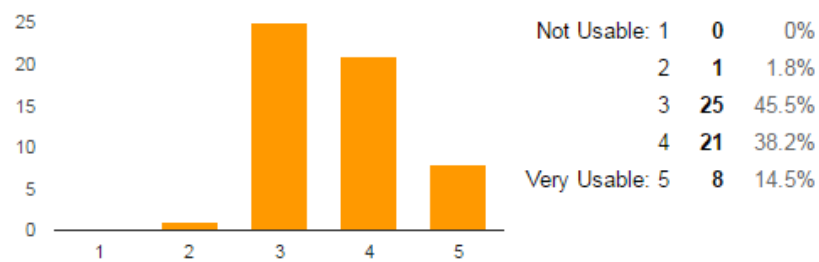


Figure B. 1: Usability

iv. Responsiveness to user commands

How would you rate the responsiveness of the functionalities of the application?

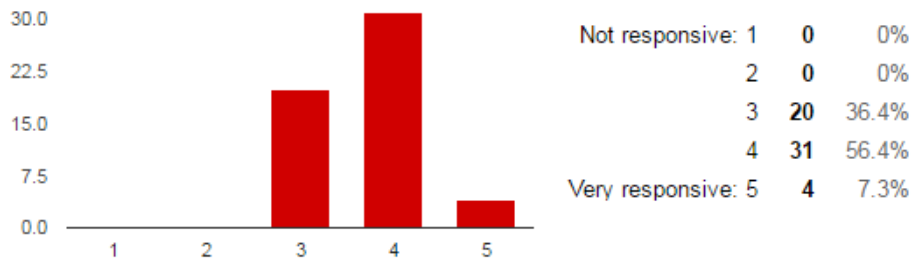


Figure B. 2: Responsiveness

v. **Robustness**

How would you rate the robustness of the application?

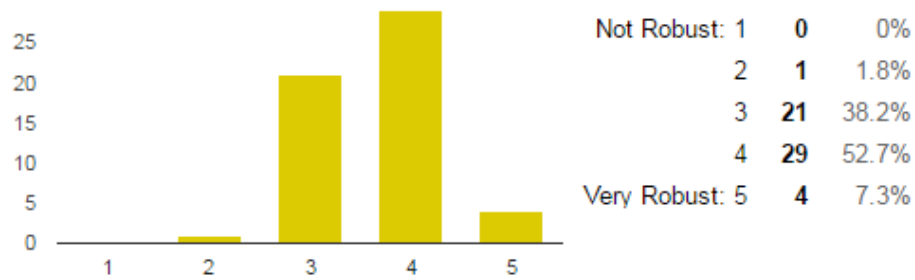


Figure B. 3: Robustness

vi. **Accuracy**

How would you rate the accuracy of the application?

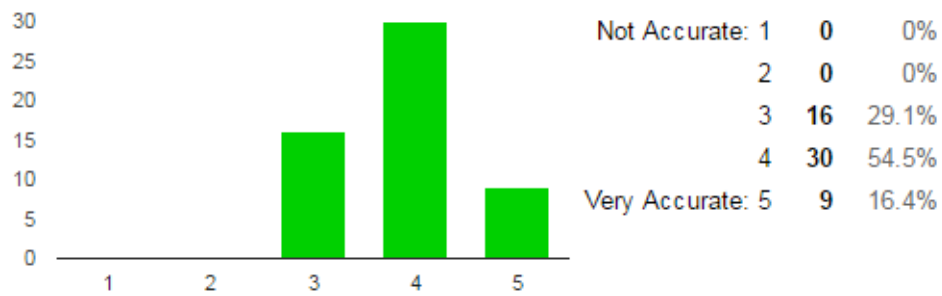


Figure B. 4: Accuracy

vii. **Scalability**

How scalable is the application?

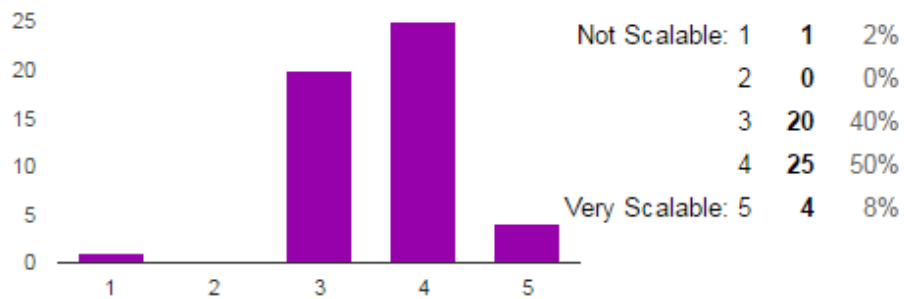


Figure B. 5: Scalability

Appendix C :Implementation Screen Shots

The following section illustrates the screen shots of the online web server administrator portal.

i. Login

Only a registered administrator who will have been provided with authorised username and passwords would login.

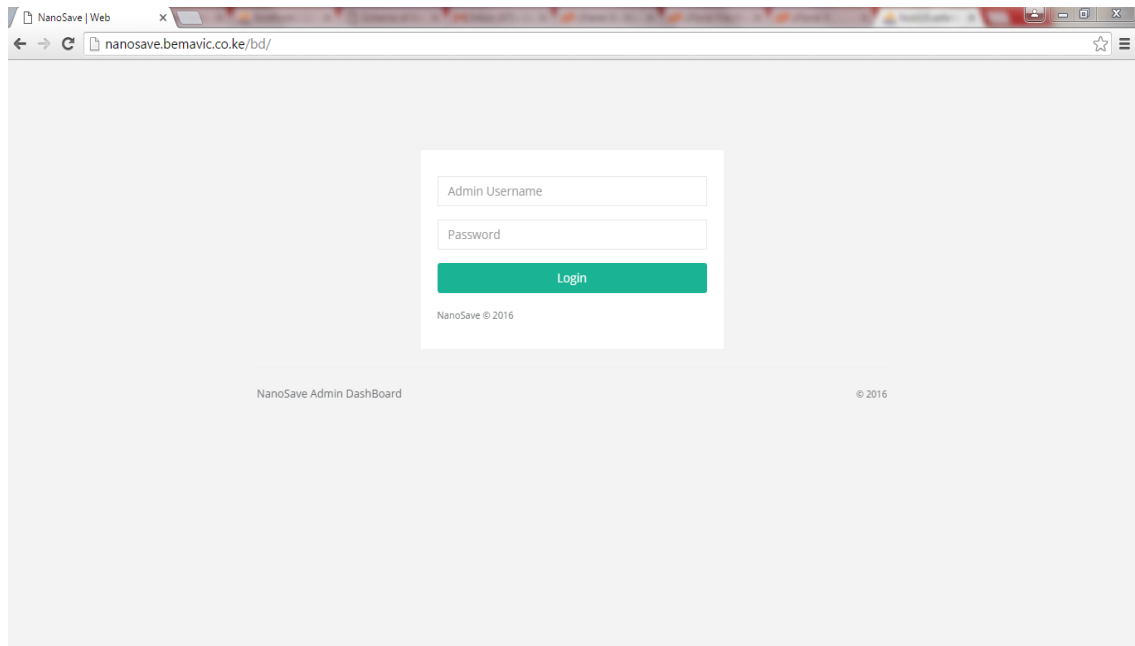


Figure C. 1: Administrator Login

i. Report view of Savers

The screenshot shows a web browser window with the URL `nanosave.bemavic.co.ke/bd/savers.php`. The page displays a table of savers with the following data:

NO	Phone Number	Email Address	Deposit %	Period
1	+254720577602	bennjuguna@gmail.com	10	6
3	+254722373317	elphas.khajira@strathmore.edu	20	3
5	+254722630039	ivy.mutiso@strathmore.edu	10	1
7	+254725640836	nixon.kurgat@strathmore.edu	20	3
9	+254715080766	harry.ochieng@strathmore.edu	30	6
11	+254723910612	felister.chepchumba@strathmore.edu	10	2
13	+254713190341	grace.gtonga@strathmore.edu	20	3
15	+254713038301	derrick.rono@strathmore.edu	50	1
17	+254715306726	larvinia.onduko@strathmore.edu	10	2
19	+254723939641	georgebuop@gmail.com	20	3
NO	Phone Number	Email Address	Deposit %	Period

Figure C. 2: Savers' Report

ii. **Report view of Sponsors**

Sponsors

Show 10 entries

Showing 1 to 8 of 8 entries

NO	Sponsor's Phone Number	Boost %	Boosted Phone Number
1	+254725420816	10	+254720577602
3	+254721383310	10	+254722373317
5	+254725355522	10	+254722373317
7	+254722967072	10	+254722630039
9	+254725727790	20	+254715080766
11	+254724620424	10	+254723910612
13	+254724795986	20	+254715306726
15	+254723919686	10	+254713038301
NO	Sponsor's Phone Number	Boost %	Boosted Phone Number

Figure C. 3: Sponsors' Report

iii. **Report view of Deposits**

Deposits

Show 10 entries

Showing 1 to 10 of 16 entries

NO	Saver's Phone Number	Amount Deposited	Deposit Type	Date Time
1	+254720577602	15	automatic	3/4/2013 12:00
3	+254722373317	5	automatic	12/1/2016 10:00
5	+254722373317	8	automatic	23/1/2016 0900
7	+254722373317	5	automatic	22/1/2016 0903
9	+254722373317	5	automatic	25/1/2016 0901
11	+254722373317	10	automatic	24/1/2016 0902
13	+254722373317	6	automatic	24/1/2016 0901
15	+254722630039	10	direct	16/1/2016 1300
17	+254722630039	5	automatic	17/1/2016 0901
19	+254722630039	5	automatic	17/1/2016 0900
NO	Saver's Phone Number	Amount Deposited	Deposit Type	Date Time

Figure C. 4: Report on Deposits

iv. **Report view of Boosts**

The screenshot shows the 'Boosts' report in the NanoSave Admin Dashboard. The page includes a search bar, a 'Log out' button, and a sidebar with navigation options: Transactions, Sponsors, Savers, and Accounts. The main content area displays a table with the following data:

NO	Sponsor's Phone Number	Boost Amount	Boost Type	Boosted Phone Number	Date Time
1	+254725420816	6	automatic	+254720577602	5/3/2016 14:00

Figure C. 5: Report on Boosts

v. **Report view of Withdrawals**

The screenshot shows the 'Withdrawals' report in the NanoSave Admin Dashboard. The page includes a search bar, a 'Log out' button, and a sidebar with navigation options: Transactions, Sponsors, Savers, and Accounts. The main content area displays a table with the following data:

NO	Saver's Phone Number	Amount Withdrawn	Withdrawal Type	Date Time
1	+254720577602	5	airtime	4/4/2016 13:00

Copyright NanoSave © 2016 NanoSave Admin Dashboard

Figure C. 6 : Report on Withdrawals

vi. **Report view of the Totals**

The screenshot shows the 'Account' report in the NanoSave Admin Dashboard. The page includes a search bar, a 'Log out' button, and a sidebar with navigation options: Transactions, Sponsors, Savers, and Accounts. The main content area displays a table with the following data:

NO	Saver's Phone Number	Total Deposits	Total Boosts	Total Withdrawals	Current Balance	Date Time
1	+254720577602	100	30	10	120	6/3/2016 15:00

Figure C. 7: Report on Totals

Appendix D : Data Analysis Illustrations

This section contains illustrations of the data analysis charts that depict the responses from the pre-questionnaire.

i. Education Level of the Target Users

What education level are you currently pursuing?

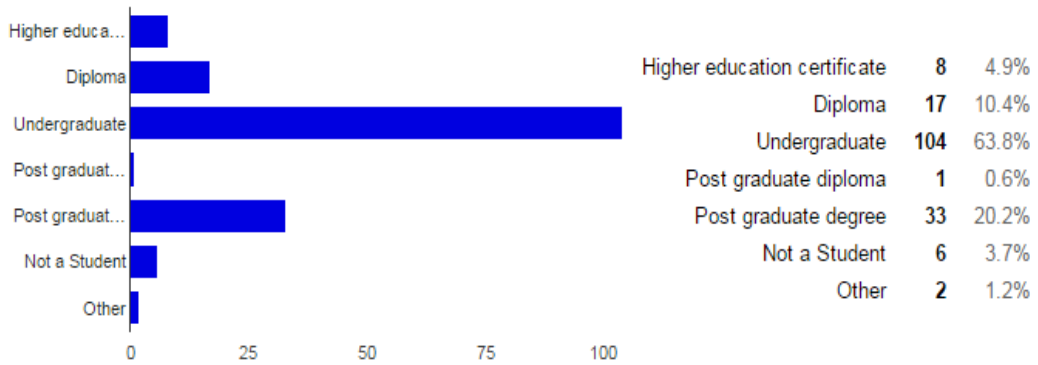
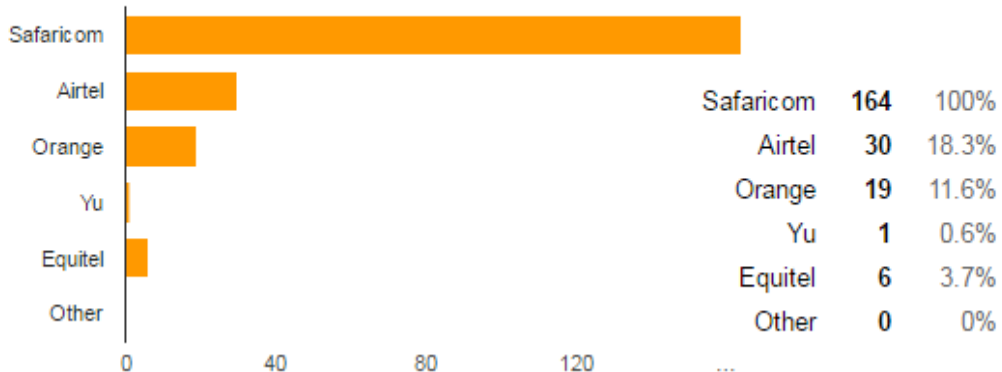


Figure D. 1 : Education Level of Target Users

ii. The Dominating MNO in Kenya and Majority Subscribers

Who is your telecommunications provider in Kenya?



Are you pre-paid or post-paid airtime subscriber?



Figure D. 2: The Dominating MNO and Majority Subscribers among the Target Users

iii. The Dominating Mobile Phone Operating System in Kenya

What Operating system does your phone run on ?

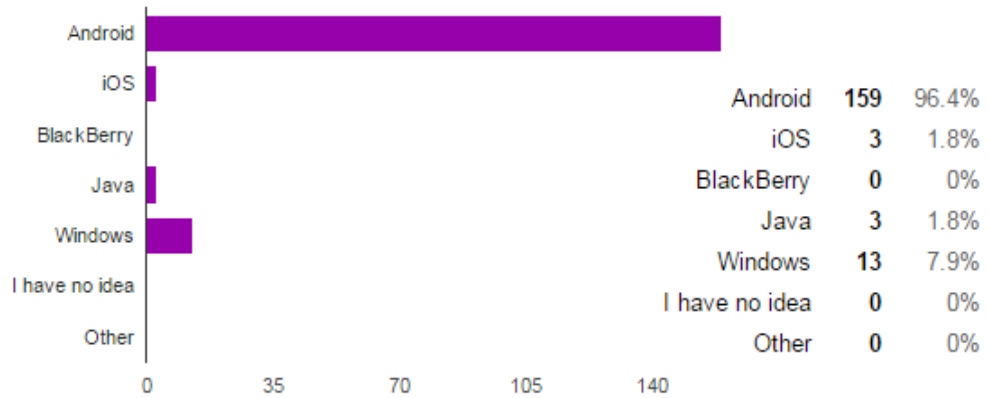


Figure D. 3: The Dominating Mobile OS among Target Users

iv. The Common Mobile Application Installed by the Target Users

Which mobile applications do you often install on your phone?

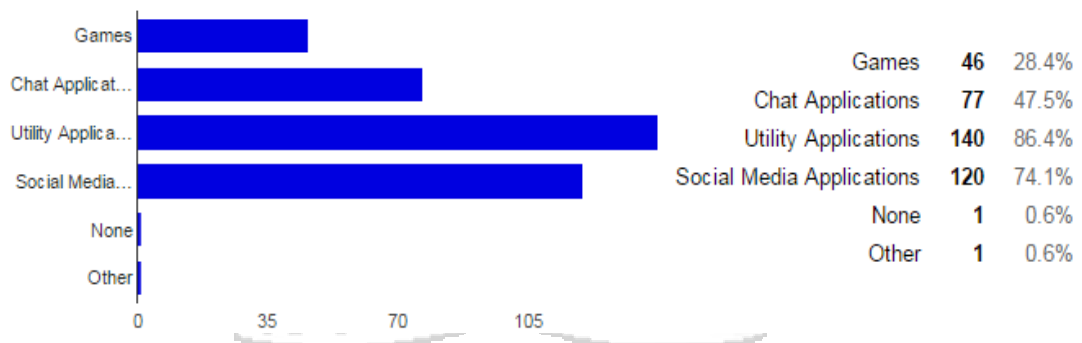


Figure D. 4 :The Common Type of Application Installed by Target Users

v. Sources Income for the Target Users

What are the sources of your income?

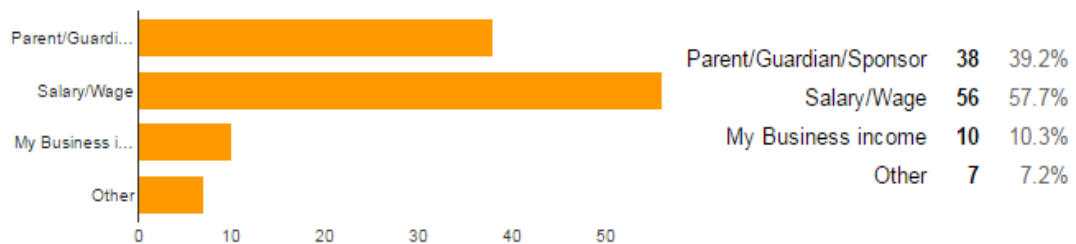


Figure D. 5: Sources of Income for Target Users

vi. Barriers of Frequent Savings

What makes frequent saving a challenge?

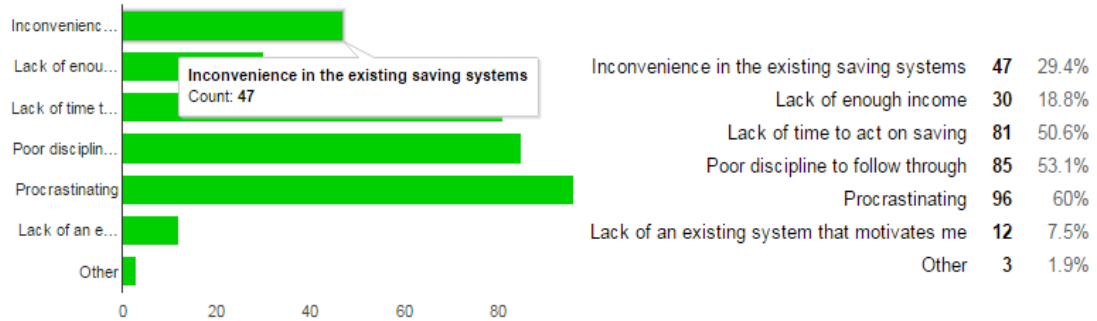


Figure D. 6 : Barrier to Savings among the Target Users

vii. Acceptable Airtime Deduction Amounts by Target Users

What percentage of you airtime would you want deducted for savings?

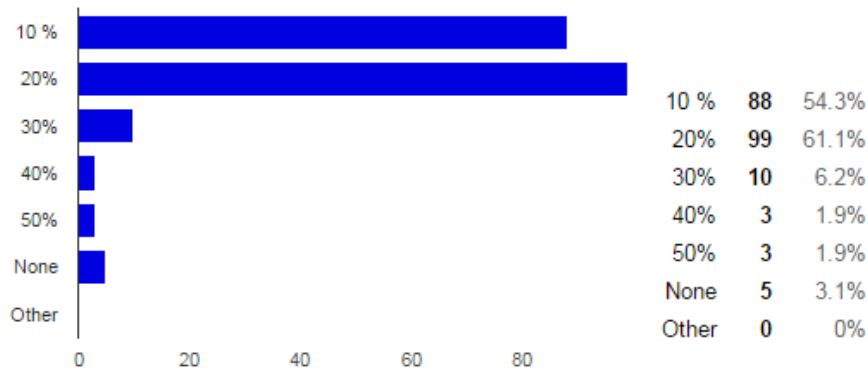


Figure D. 7 : Acceptable Airtime Deduction Amounts by Target Users

viii. Acceptable Savings Maturity Periods by Target Users

How long would you want the airtime savings to be kept before maturity?

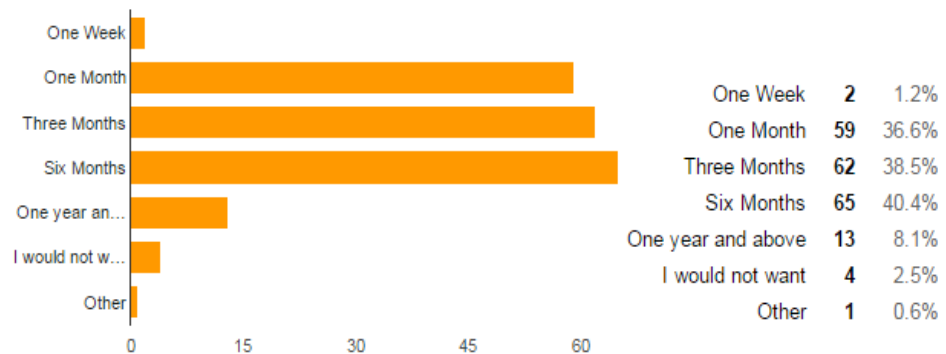


Figure D. 8: Acceptable Savings Maturity Periods by Target Users

Appendix E : Turnitin Plagiarism Check

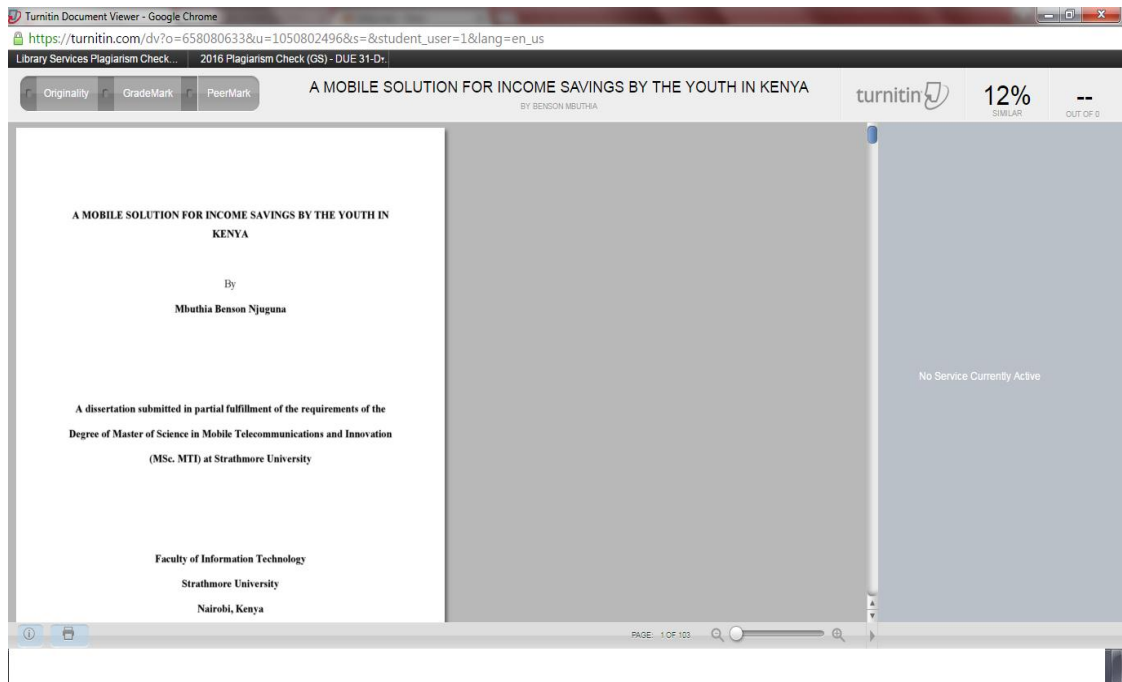


Figure E 1: Turnitin Report Screenshot

