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ADDIS ABABA UNIVERSITY

**College of Natural Science
School of Information Science
Department of Information Systems**

Designing E-Banking Cardless Transaction Services Framework for Banking Sectors in Ethiopia

ABEBAW TESHOME ABEBE

Addis Ababa, Ethiopia

JUNE 2021

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A Thesis Submitted to the College of Natural Science of Addis
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Declaration

I declare that this thesis is my original work and has not been presented for a degree in any other governmental or private university and colleges.



June, 4/2021

ABEBAW TESHOME ABEBE

This thesis has been submitted for examination with my approval as university advisor.



Advisor

June, 4/2021

Date

Dedication

I would like to dedicate this research to all my beloved families especially to my parents Ato Teshome Abebe and W/ro Zenebech Gobeze even if she was not alive and to my older brother Ato Mekete Teshome. They were always supporting me since childhood and they are my benchmarks in all aspects; really thank you.

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Abstract

Electronic banking signifies and encompasses the entire sphere of technology initiatives that have taken place in the banking industry and it is a generic term making use of electronic channels through ATM, Mobile phones, etc. for the delivery of banking services and products. From E-banking technologies, cardless EATM enable to withdraw cash from ATM without virtual or any card and increases enhanced utilization of ATM in banking sectors and allows banks customers to complete one or more banking transactions without the involvement of any bank official.

The main purpose of this research would be to identify, analyze and interpret the existing system challenges then to design and propose E-banking cardless transaction services framework relevant to enhance utilization of E-banking services and to evaluate the proposed framework along with the prototype. Different challenges related to existing E-banking carding system motivated the researcher to conduct this study.

The researcher used Design Science research approach to identify, analyze and interpret the existing carding system problems and DS research approach too to design and propose ECTS framework relevant to enhance utilization of E-banking services. Personal observations, document analysis and semi structured interview data collection methods were used and 23 respondents were involved on semi structured interviews.

Based on the study result, card expiration, captured, dispute and forgotten were the main challenges on the existing E-banking system and the remaining challenges have low impact on enhanced utilization of E-banking services. All of the respondents were used Mobile and ATM services and based on the findings, there was low utilization of E-banking services which requires the framework to be designed. ECTS framework was designed along with the prototype. Domain experts were evaluated both the framework and the prototype, then acceptable result was found from the evaluation. The integration of ATM and Mobile banking services and the ECTS framework development can enhance proper utilization of E-banking services but the researcher recommends to conduct the research by incorporating any more banks and branches then implementation of the designed ECTS framework also will be the vital issue.

Keywords: Electronic banking, Cardless, EATM, ATM, ECTS, framework

Table of Contents

Declaration.....	III
Dedication	IV
Acknowledgement	V
Abstract.....	VI
List of Tables	X
List of Figures	XI
List of Abbreviation and Acronyms.....	XII
CHAPTER ONE	1
INTRODUCTION	1
1.1. Background	1
1.2. Statement of the Problem	3
1.3. Research Questions	5
1.4. Objective of the study.....	5
1.4.1. General Objective	5
1.4.2. Specific Objectives	5
1.5. Significance of the Study.....	6
1.6. Scope of limitation of the Study	6
1.7. Organization of the Study	7
CHAPTER TWO	8
LITRATURE REVIEW	8
2.1. Over view of E-banking	8
2.1.1. EATM Cardless Withdrawal.....	10
2.1.2. Mobile Banking	10
2.1.3. Cardless ATM Banking.....	11
2.2. One Time Password (OTP) and Secret Code	11
2.3. Common Types of E-banking Technologies	12
2.4. Challenges of E-banking Services	15
2.5. Opportunities of Cardless E-banking Services	17
2.6. Advantage and Disadvantage of E-banking Cardless Services.....	18

2.7. E-banking Services workflow and Frameworks	20
2.7.1. Traditional ATM Transaction Workflow	20
2.7.2. Related Frameworks and Models	21
2.8. Design Science Framework Design Theory	24
2.9. Summary of Related Works	25
3.10. Research Gap	27
CHAPTER THREE	28
METHODOLOGY	28
3.1. Overview	28
3.2. Study Area	28
3.3. Research Approach	28
3.3.1. Design Science Research Approach	28
3.4. Research Design	29
3.5. Target Population and Sampling	32
3.6. Data Sources and Types	33
3.7. Data Collection Procedures	33
3.8. Data Analysis	33
3.9. Modeling Techniques and Tools	34
3.10. Instrument and System Evaluation	35
CHAPTER FOUR	36
DATA PRESENTATION AND ANALYSIS	36
4.1. Overview	36
4.2. Abay Bank Profile	36
4.3. Abay Bank E-banking Services Utilization Trend	36
4.5. DS Research Problem Identification and Analysis	39
CHAPTER FIVE	45
DESIGNING FRAMEWORK AND PROTOTYPE DEVELOPMENT	45
5.1. Functional Requirements	45
5.2. Nonfunctional Requirements	46
5.3. Existing and Proposed System Workflow	46
5.3.1. Existing System Workflow	46
5.3.2. Proposed System Workflow	47

5.4. Proposed system Database Design ERD	49
5.5. Proposed System Physical Architecture.....	50
5.6. Proposed ECTS Framework	51
5.7. Design Science Research Solution Design	52
5.7.1. Mobile Banking Module Screens	53
5.7.2. ATM Banking Module Screens	54
5.7.3. Prototype Sample Codes.....	56
5.8. System Configuration and Setup Procedures	60
5.9. Framework and Prototype Evaluation	61
5.9.1. Evaluation of the Framework.....	61
5.9.2. Evaluation of the Prototype	62
5.10. Discussion of Evaluation Result	64
CHAPTER SIX.....	65
CONCLUSION AND RECOMMENDATIONS.....	65
6.1. Conclusion.....	65
6.2. Recommendations	66
6.3. Future Research Works.....	67
7. References	68
8. Appendices.....	72
8.1. Appendix 1: Interview Questions.....	72
8.2. Appendix 2: Framework Evaluation Checklist.....	73
8.3. Appendix 3: Prototype Evaluation Checklist.....	74
8.3. Appendix 4: AAU Letter.....	75
8.4. Appendix 4: SMS Gateway.me and Sample Code	76

List of Tables

Table 1: Related works summary.....	26
Table 2: Respondents' data distribution.....	32
Table 3: Respondents Interview data	41
Table 4: Framework evaluation criterions	62
Table 5: Prototype evaluation criterions	63

List of Figures

Figure 1: Traditional ATM transaction process	21
Figure 2: Cardless ATM cash withdrawal process framework	22
Figure 3: Cardless ATM withdrawal diagram	22
Figure 4: E-banking Cardless Services framework.....	23
Figure 5: DS research process model.....	31
Figure 6: Existing system ATM Services	39
Figure 7: QDA Miner Respondents and Interview questions	40
Figure 8: Distribution of Interview Keywords.....	42
Figure 9: Interview data Pie chart.....	43
Figure 10: Usage of Interview Keywords	44
Figure 11: : Existing system workflow	46
Figure 12: Cardless Mobile banking workflow	47
Figure 13: Cardless ATM withdrawal workflow	49
Figure 14: Cardless system ERD	50
Figure 15: Proposed system physical architecture	51
Figure 16: Proposed Framework.....	52
Figure 17: Mobile banking login screen	53
Figure 18: OTP selection screen	53
Figure 19: Screen to enter receiver's mobile	54
Figure 20: Press CARDLESS button on ATM	54
Figure 21: Enter OTP screen on ATM.....	55
Figure 22: Enter Secret Code screen on ATM.....	55
Figure 23: Enter Mobile Number screen on ATM.....	56
Figure 24: Sample SMS	60

List of Abbreviation and Acronyms

APP	Application
ATM	Automated Teller Machine
COVID	Corona Virus Disease
DB	Database
DS	Design Science
EATM	Electronic Automated Teller Machine
E-banking	Electronic banking
ECTS	E-banking Cardless Transaction Services
ERD	Entity Relationship Diagram
EthSwitch	Ethiopian Switch
HTML	Hyper Text Markup Language
ISO	International Organization for Standardization
IT	Information Technology
OTP	One Time Password
PHP	Hypertext Preprocessor
PIN	Personal Identification Number
PSS	Premier Switch Solutions
QDA Miner	Qualitative Data Analysis software
S.C	Share Company
SIM	Subscriber Identification Module
SQL	Structured Query Language
UML	Unified Modeling Language
USSD	Unstructured Supplementary Service Data
XAMPP	Multiplatform Apache MySQL Perl and PHP

CHAPTER ONE

INTRODUCTION

1.1. Background

Electronic banking (E-banking) is the term mostly used in channel banking technology initiatives which have taken place in banking industry to deliver quality E-banking services for the customers'. It includes different electronic channels and E-banking services like Telephone, ATM, Mobile, Internet, Agent, etc. banking (Sekhon and Yap, 2010). This study predominantly focused on Mobile and ATM banking services to properly utilize E-banking services.

E-banking has arrived from contemporary IT development. Every second enlargement in IT and its acceptability by the banks has enabled them to use E-banking services extensively. IT revolution in banking sector has not only provided improved service to the customers but also concerned on operational cost. Therefore, tremendous change in E-banking technology, high costs, security and data privacy issues, and lack of trained human resource are some challenges faced by commercial banks in Ethiopia. E-banking is concerned with doing all transactions from home or office without visiting the branch, using ATM's, Telephones, Internet, Mobiles, etc. for doing banking services. In the revolutionary progress took place in the field of technology which has minimized the world to a global village and it has brought miraculous changes in the banking industry (Bahl, 2012).

According to the study of Nidhi (2016), E-banking is the term that signifies and encompasses the entire sphere of technology initiatives that have taken place in the banking industry and it is generic term making use of electronic channels through telephone, mobile phones, internet, etc. for delivery of E-banking services and products which includes Automated Teller Machine (ATM), Internet banking, Mobile Banking, Agent banking, cardless ATM withdrawal, etc.

Based on the study of Iyabode (2015), E-banking cardless transaction services means, conducting E-banking transactions like cash withdrawal, fund transfer and balance enquiry without virtual or any physical card by integrating ATM and Mobile banking services.

The study mainly focused on Electronic Automated Teller Machine (EATM) and Mobile banking relevant to enhance utilization of E-banking cardless services so that cardless EATM enable to withdraw cash from ATM without virtual or any card and increases efficiency of the ATM usage in banking sectors (Iyabode et al., 2015). Mobile banking involves the use of mobile phone to made different financial transactions on the customer account including cardless ATM withdrawal (Onodugo, 2015). Currently, different banks launched E-banking cardless cash withdrawal service and this facility helps customers to send money to anyone using Internet banking, Mobile banking or by using ATM with the help of receiver's Mobile number (Nidhi, 2016). E-banking services looked at as a determinant factor of customer satisfaction, loyalty and positive attitude in the E-banking business and satisfaction is proposed to have a mediating role in the relationship between utilization of E-banking services and profitable consumer behaviors (Casaló, Flavián and Guinalú, 2008).

Increasing usage of E-banking services reduces the likelihood of error, increases predictability of the E-banking system behavior and creates a comfortable environment which would positively influence customer towards the E-banking system and also, utilization is the effort required to use E-banking electronic devices (Sekhon, Yap et al., 2010). Some challenges that can affect enhanced utilization of E-banking cardless services in the current E-banking sectors are security issues, customers' awareness and trust factor, E-banking infrastructure issues, etc. (Nidhi, 2016).

The growth of E-banking services in most African countries has been slow for a variety of reasons, which include low levels of internet penetration, poorly telecommunications infrastructures, unaware of the opportunities offered by E-banking, lack of a suitable framework and security issues, inadequate E-banking systems and high rates of illiteracy (Teka, 2017). This study conducted at Abay bank S.C. head office under the area of E-banking and the research mainly emphasized on identifying, analyzing and interpreting the existing system problems then on designing and evaluating E-banking cardless transaction services framework including the prototype which helps to enhance utilization of ATM using Mobile banking.

In order to solve the problems and the challenges stated in relation to E-banking services, E-banking cardless transaction services would be used. This requires the integration of ATM and Mobile application leads to design E-banking cardless framework.

1.2. Statement of the Problem

According to the study of Kayanja (2019), the E-banking has come with many problems like the increase of cybercrime, ATMs machine break down, poor internet connection and lack of enough information on the available online E-banking products and issues related to carding system. Kayanja (2019) also stated that compared to ordinary banking system, E-banking is providing the best customer satisfaction of different customer needs. The old age is generally the shy of use of the ATM because of the perceived risk of failure of complexity, security and lack of personalized services.

On the Existing card system, since customers' information preferably customer account is integrated to the ATM card using magnetic strip, the customer account number including PIN can be easily accessed by third parties and fraudulent activities may be happened on the customer account (Iyabode et al., 2015). Due to this issue, the customers may not trust to use the existing carding system and may need any other design solution.

Most banks in Ethiopia including Abay bank S.C. get printed ISO 20022 standard ATM Visa and Master cards from other countries by paying foreign currency. This would have negative impact on our local economy but only domestic card personalization were started to be printed here in Ethiopia by PSS (<https://psseth.com/>, 2021) and EthSwitch S.C (<https://ethswitch.com/>, 2021) based on the information got from the local companies websites.

According to the report of global ATM market and forecasts to 2021 (www.atmmarketplace.com), there are 4 million ATMs' around the globe even if the use of EATM services has declined in recent years. In order to overcome the problem, most banks' in Ethiopia allocated more amount of currency to acquire effective E-banking systems relevant to enhance utilization of E-banking services. Based on the information got from EthSwitch S.C . website (<https://ethswitch.com/>, 2021) and as of September 2020 monthly report, in Ethiopia there are around 5,059 ATMs' off which 80 ATMs' owned by Abay bank. There are 15 million active ATM users in Ethiopia too

but the number of transactions per month as of July 2020 was only 2 million. This indicates that utilization of the electronic resources is low even if the E-banking sector required huge investment to acquire the E-banking systems.

Moreover, on the existing carding system security also an issue but the new E-banking cardless transaction services system works using One Time Password (OTP), Personal Identification Number (PIN), Secret code and registered Mobile number which is more secured. OTP, Secret code and registered Mobile number used as a security second layer but the old carding system only authenticated by PIN which can be a means to reduce utilization of E-banking services (Ahmad, Rifien et al, 2016). The above stated and similar problems can be easily overcome by using E-banking cardless transaction services design solutions which needs the integration of ATM and Mobile banking applications. Mobile payment is fast becoming a competitive alternative to existing payment channels, raises opportunities and reduces challenges for public policies and corporate strategies (Ling and Venkataraman, 2020).

A cardless withdrawal solution developed by integrating ATM and Mobile banking application might just give a foothold within the fight with other competitors. In E-banking services, using SMS messaging technologies for sending money to other people would be raised considerably which will attract more client customers and increases utilization of E-banking ATM (Istrate, 2014). Now a days, Electronic Automated Teller Machine (EATM) without any card can be designed to enhance the efficiency of the ATM usage in banking sectors across the globe because E-banking services using ATM card has many problems like fraud and theft (Iyabode et al., 2015).

Based on the data got from the semi structured interview and personal observations (Figure 7), the major problems identified in relation to existing E-banking carding system at Abay bank S.C. are:- ATM card expired, lost, cloned, damaged, skimmed, captured, disputed, additional cost (money and time) of issuance, forget wallet at home, account debited without paying and long reconciliation time, etc. Hegde and Sharath (2016), Iyabode, Nureni, et al. (2015) and Kinsman (2019) conducted empirical researches on card based E-banking area but the researchers did not considered problems like ATM card expiration, lost, cloned, damaged, skimmed, captured, disputed, additional cost (money and time) of issuance, forget wallet at home, account debited without paying and long reconciliation time issues. The framework and the design models they

proposed is also complex to implement and to use by end users. Additionally, the research conducted by Ahmad and Rifen (2016), needs special biometric features (finger print and face recognition) on ATM to do cardless transaction. Using the ATM having such special features on E-banking system was not cost effective but this study enables the customer cardless cash withdrawal from normal ATM using other means of authentication methods. Moreover, there was no research conducted in Ethiopia on E-banking Cardless Transaction Services.

In order to fill the identified gaps (some of the researchers did not considered the card system challenges, special biometric features on ATM was required which is not cost effective and no research conducted by this research title), a new cardless E-banking system is required. The current research mainly concentrated to identify, analyze and interpret the existing card system problems and then to propose a design solution on E-banking cardless services for Abay bank S.C and for any other banks having similar E-banking services.

1.3. Research Questions

The study mainly focused to answer the following research questions:

1. What are the challenges of the customers to use E-banking services?
2. What are the requirements to develop E-banking cardless services framework?
3. What kind of E-banking cardless transaction services framework is required?

1.4. Objective of the study

1.4.1. General Objective

The main objective of the research is to design E-banking cardless transaction services framework relevant to enhance utilization of E-banking services.

1.4.2. Specific Objectives

- ✓ To identify challenges of the existing E-banking system utilization.
- ✓ To identify requirements for the design of cardless E-banking services
- ✓ To propose a system and framework for cardless E-banking services
- ✓ To evaluate relevance of the proposed cardless E-banking services framework

1.5. Significance of the Study

The research would play an important role to assess, identify and investigate different issues related to E-banking services usage and relevant to fill identified problems, challenges and gaps stated under statement of the problem section.

The study will have theoretical significance to practitioners to solve specific and similar problems easily then to improve utilization of E-banking services and to recommend better solutions to problems and challenges of the existing system. This research is vital to solve problems of existing carding systems and proposing new cardless E-banking system theoretical framework to increase the customers' satisfaction and utilization of E-banking services too.

The study in relation to the proposed E-banking cardless services framework is relevant to improve the utilization of E-banking services and to have quality services in general and plays a vital role to increase the overall growth and productivity of the bank. The new system relevant to increase the customers' satisfaction by resolving different challenges. Once the required model would be designed and proposed, there will be effective and efficient utilization of E-banking resources relevant to achieve organizational missions, visions and goals as well.

The designed E-banking cardless transaction services framework can be serve as a guide line for different stakeholders'. Managers can have used it to formulate policies and procedures, experts and developers to develop different E-banking systems, for consultants it enables banks to have common E-banking platform. Moreover, researchers can use this study as a reference to conduct related researches in the future in the area of E-banking

1.6. Scope of limitation of the Study

The scope of the research confined to assess, investigate, analyze and interpret challenges of the existing carding system then propose and evaluate a theoretical cardless E-banking transaction services framework including the prototype. Implementation of the E-banking cardless services framework will be out of the scope of this research. Currently Abay bank has 276 branches, out of which 85 branches and most ATMs' owned Abay by bank and any other commercial banks in Ethiopia located here in Addis Ababa region. But due to homogeneity of research data, existence

of large number of population at head office main branch and any other constraints including international pandemic COVID-19, the study is conducted at Abay bank S.C. head office main branch found in Addis Ababa region.

Related to limitation of the study, the proposed system solution was not integrated to the existing system to validate when customers withdraw cash from ATM machine because of fear of security by the bank's higher officials. Lack of research work on the topic was also identified as one factor that affected the quality of this research work. Knowledge gap by the respondents on understanding utilization of E-banking cardless services during data collection process was also an issue. Due to shortage of time, the study limited on ATM and Mobile E-banking cardless services which enable to withdraw cash from ATM without ATM card. To reduce the complexity and to increase ease of use of the system, alphanumeric values was not functional for OTP and secret code. Moreover, free SMS gateway was used for SMS notification due to unable to get SMS short number from EthioTelecom. Moreover, due to shortage of time, primary data was collected from Abay bank main branch customers using semi structured interview and personal observations apart from the secondary data collected using document analysis.

1.7. Organization of the Study

This research organized and contains six chapters. **Chapter One** stated about introduction and background of the study, statement of the problem, significance of the study, research questions, objectives and scope of the study. **Chapter Two** stated literature reviews, **Chapter Three** explain about methodology of the study, **Chapter Four** also indicates data presentation and analysis section, **Chapter Five** explain about designing E-banking cardless transaction services framework and prototyping, **Chapter Six** stated about conclusions, recommendations, limitation of the study and future research work. At last references and appendices also included in this document.

CHAPTER TWO

LITRATURE REVIEW

2.1. Over view of E-banking

E-banking is the term used for online banking and outgrowth of PC banking which uses the web. A paradigm shifts in marketing practices resulting in high performance in the banking industry (Auta, 2010). It includes Internet, Mobile, Agent, EATM and POS channel E-banking services.

Cardless banking facilities allow consumers, either unbanked or banked, to electronic cash withdrawal, fund transfer, etc using an ATM, Agent banking, Mobile or Internet banking (Jones 2008). Isaacs (2011) stated that cardless facilities provide consumers with access to banking services like transferring funds to individuals no matter whether or not they are banked or unbanked. In addition, Innova (2015) refers to cardless banking as a service that allows consumers to authorize another individual to withdraw money from ATM without using ATM card.

Cardless E-banking facilities are a platform that gives individuals with access to banking services without requiring the usage of a card. Consumers may use other forms of cardless banking, which include ATMs, Agent banking, Mobile applications and Internet banking to access their accounts and make transactions using their own personal details to gain access. There are four sorts of cardless banking services available, which include cardless cash withdrawal, Mobile banking, Internet banking and Agent banking (Kinsman, 2019). Mobile banking mode of E-banking fundamentally employments versatile phones as the electronic gadgets. It gives client the chance to do E-banking transactions on their account with bank system as long as their phones registered and administered by the E-banking system (Statista, 2017). Internet banking is a get of the bank to perform E-banking financial transactions through a secured authentication mechanism and utilizing the web application and Agent banking means the conduct of banking business on behalf of a financial institution through an agent using various service delivery channels (Pikkarainen et al., 2004). Moreover, E-banking cardless technology enables to withdraw cash from ATM without any cards (Iyabode et al., 2015) which can be Mobile, Internet and Agent banking

E-banking services came into existence in United Kingdom and United States of America in 1920's and it became famous during 1960's through electronic funds transfer and credit cards. Currently, E-banking technology has different services including E-banking cardless services (Bahl, 2012). E-banking services generally referred to as E-banking and application of its concepts, techniques, policies, and implementation strategies to banking services. It has become a subject of fundamental importance and concerns to all or any banks and indeed a pre-requisite for local and global competitiveness. Due to emergence of global economy, E-banking has increasingly become an inevitable tool of banking business strategy (Onodugo, 2015).

According to the study of Onodugo (2015), the benefits of E-banking services improve customer service, reliability of transaction, satisfy and redundancy of storage space. Enhanced utilization of E-banking services looked as a determinant factor of customers' satisfaction, loyalty and positive attitude. The E-banking business and satisfaction is proposed to have a mediating role in the relationship between utilization of E-banking services and consumer behaviors. In the same way, satisfaction is considered as a key antecedent of both consumer loyalty and attitude (Casaló, Flavián and Guinalíu, 2008).

Increasing utilization of E-banking services reduces the likelihood of error, increases predictability of the E-banking system behavior and creates a comfortable environment. It would positively influence customer disposition towards the E-banking system and also, utilization is the effort required to use E-banking system (Sekhon, Yap et al., 2010).

According to the study of Nielsen (2012), enhanced utilization of E-banking services defined in terms of five key quality components namely:

- **Learnability:** How easy is it for users to accomplish basic tasks the first time they encounter the design
- **Efficiency:** Once users have learned the design, how quickly can they perform tasks
- **Memorability:** When users return to the design after a period of not using it, how easily can they reestablish proficiency

- **Errors:** How many errors do users make, how severe are these errors, and how easily can they recover from the errors
- **Satisfaction:** How pleasant is it to use the design

2.1.1. EATM Cardless Withdrawal

EATM is an electronic banking outlet that permits banks customers to finish one or more banking transactions without the help of any bank official or teller. It is a self-service technology in financial service delivery usually adopted by financial institutions to succeed in their customers outside the banking hall. The user of existing EATM machine uses card to access their account to perform one or more financial transactions. Several problems are related to the usage of carding system. In E-banking industries, using Electronic Automated Teller Machine (EATM) without virtual or any card can be designed relevant to withdraw cashes effectively and efficiently from ATM which increases efficiency of the ATM usage in banking sectors (Iyabode et al., 2015).

EATM transactions are found safe, reliable and inevitable lately for fulfilling the financial commitments. Traditional approach for using ATM mandates involvement of debit or credit card. However, people have got problem when their account lacks balance amount or when they forgotten holding ATM card and struggle to finish the transaction. Parallel to ATM usage, Mobile phones' usage, has also been an inevitable trend. Establishing a connection between these E-gadgets has ignited a simple and effective approach to made E-banking transactions without the involvement of debit or credit card referred to as cardless transaction (Hegde, and Sharath, 2016).

2.1.2. Mobile Banking

Mobile banking involves the usage of Mobile phone for the settlement of financial transactions. It supports account balance enquiry, fund transfer, recharge phones, changing users' password and bill payment. Cardless ATM withdrawal as well as secured messaging for confirmation of receipt to the beneficiary is also meant for low value transactions. Speed of completing the transaction is the key issue having exciting potential, given the low infrastructure requirements and a rapidly increasing Mobile phone penetration (Onodugo, 2015).

The increased prevalence of Mobile phones provides exciting opportunities for the growth of Mobile banking. Three billion people were expected to own Mobile phones in the globe by 2012 (Goyal, Pandey and Batra, 2012) which shows that when the number of Mobile banking users will increase, it will create an opportunity to utilize the ATM E-banking services effectively without acquiring any additional cost.

2.1.3. Cardless ATM Banking

ATM exchanges electronic financial transactions without the usage of an ATM card, employing a portable client gadget or Mobile phone. The Mobile phone communicates with the ATM using the mobile application. The ATM communicates with the portable client gadget through ATM application which may incorporate communication through any remote machine. A portable client gadget may give exchange data or confirmation data to ATM or to a verification framework in communication with ATM. The exchange may be related with the users' E-banking account or another account. It may produce an energetic esteem which may be utilized as a watchword, a verification esteem, an account identifier or an exchange identifier (Varadarajan, 2011).

Managing an account using cardless ATM banking is the moment prevalent get to channel banking system in order to manage an account administration behind customers' account management by the bank. It offers competitive advantage within the homogenous advertise of retail managing an account items and administrations. It is critical that banks accomplish benefit quality and client fulfillment to stay competitive through cardless ATMs'. The outcomes about assign banks to stay competitive through ATM managing an account endeavors ought to be applied in giving responsive ATM administrations. Encourage venture in more up to date ATM advances may have minimal returns in making competitive advantages. All banks were introducing more recent ATM innovations that upgrade ease of use and unwavering quality of ATMs but contrasts are within the arrangement of responsive administrations which expand the ATM administrations arrangement (Iyabode et al., 2015).

2.2. One Time Password (OTP) and Secret Code

OTP stands for one-time password which is one-time PIN or dynamic password randomly generated (Basavegowda and Seenappa, 2014) by E-banking system while a user initiate cardless

OTP request using Mobile phones. It is a password that is valid for only one and specific transaction which will be invalid after cardless cash withdrawal would be done.

Moreover, OTP is one time and more secured alphanumeric password generated by the bank's cardless E-banking system when the user requests the E-banking cardless transaction services using the Mobile banking applications. On E-banking cardless transaction services, OTP used as a second security layer mechanism because the E-banking card system only authenticated by PIN (Hegde and Sharath, 2016).

According to the study of Basavegowda and Seenappa (2014), Secret code is widely used in many applications like data transfer, sharing data, login to emails, Electronic banking, etc. So, system users should give high attention on it to have strong authentication mechanism to secure all applications as much as possible. On cardless E-banking system, the Secret code entered by the system users and kept on the mind of the account holder, then should be shared to the beneficiary when requested.

2.3. Common Types of E-banking Technologies

The following are the common types of E-banking technologies used in banking sectors to modernize the customers E-banking services:

Point of Sale (POS):- This mode of E-banking technology handles Cheque confirmation, credit authorization, cash store and withdrawal, and cash installment. It improves electronic finance exchange for the reason of deals (Fenuga, 2010). In this way, clients account would be charged promptly with the esteem of buy in an outlet like a petroleum station or grocery store. The suggestion of this is often regularly that clients can make installment for products and administrations without fundamentally coming in touch with physical cash since the cost would be charged on the buyer's card and credited on the seller's account (Ajayi, 2014).

- **Internet banking:** - It is a get of the bank to perform budgetary exchanges through a secured entrance utilizing the web application. Clients can utilize it to see one's account detail, cash exchange, paying bills and related account administrations through the web. However, for cash withdrawals, it gives clients get to nearly any sort of managing an account exchange at the press of a mouse (Pikkarainen et al., 2004). The innovation of E-banking highlights a universe of

conceivable applications. Online managing an account for occurrence gives the chance of paying bills and performing exchanges of any kind of E-banking transactions. The accessibility of online data has given managing an account and client with effective vehicle for E-banking services administrations (Natasha et al, 2014).

- **Mobile banking:** - This mode of E-banking fundamentally employs versatile phones as the electronic gadgets. It gives client the chance to do E-banking transactions on their account with bank system as long as their phones registered and administered by the E-banking system. SMS using phones might empower the client to check account and to do cardless transaction on it (Statista, 2017). Since more than 62% of the world populace is utilizing portable phones, managing an account is much helpful way to address E-banking system problems for huge number of clients. On the other hand, it is completely self-service and helpful to utilize mobile applications and does not require extra costs like managing account in the web. Additionally, most SMS notifications are free of charges in this channel banking system (Statista, 2017).

It is an expansion of the winning installment framework of a bank on E-banking system. It is exceptionally nearly like Internet banking, sharing numerous highlights. One of the foremost straightforward enhanced utilization of E-banking technologies is to utilize the portable phone's which coordinates browser to get the customers' account on the web location (Malik, 2014). Other execution incorporates SMS or USSD communications between the phone and the bank system, on which no application really should be conveyed on the client's portable phone. E-banking mobile applications that are sent to the client uses different communication strategies in order to get the bank's servers (Istrate, 2014).

- **Telephone banking:-** Clients get to their bank through landline phone rather than portable phone. In this case, clients will call to their bank call centers to get E-banking services or finance exchange administrations. The clients must have their claim get to pass codes to commit these exchanges. In early times, Phone managing account was prevalent in western nations. Sometimes recently, portable phone and internet banking ended up common issues and nowadays such sorts of technologies are commonly advertised to faithful clients who runs tremendous speculations (Natasha et al, 2014).

- **ATM:-** Based on the study of Nidhi (2016), ATM may be a computer controlled device that apportions and gives other administrations to clients who distinguish them with an individual recognizable proof number (PIN). The physical carriage of cash and visit to the banks' branches is being decreased due to the involvement of ATM. The foremost advantage of ATM is; it allots cash at any time of the day indeed because it needs not to be found inside the bank premises. In stores, shopping malls, fuel stations, etc., unlike the typical strategy where clients have to be line for a very long period of time to pull back cash or exchange stores. The ATM is the most well-known E-transaction management technology within the world and is known since of its comfort (Fenuga, 2010).

With ATM, it is simple to withdraw cash or to see customer account transactions. In any case, in spite of its ubiquity, the ATM has done small or no in decreasing the amount of cash inside the economy (Vyas, 2012). This can be since most clients utilize ATM as it were for cash withdrawal. In spite of the fact that ATM machines can perform other capabilities like finance or cash exchange, versatile cash credit energize and bills payment, cash withdrawals and adjust request stay the foremost popular applications by clients. This can be generally much appreciated to numbness and thus the nonappearance of shippers and ATM machines are basically utilized for cash withdrawals (Ajayi, 2014).

- **Bankers automated clearing services:-** The robotization center of the instrument is to decrease the number of clearing days and move forward on security course of action within the course of settlement and collection of Cheque. This includes the utilization of Ink Character Peruses (ICR) for Cheque handling which enable to encode, studied and sort out changes while ask for Cheque books can be made through electronic devices (Ajayi, 2014).
- **Card System:-** It could be an interesting electronic installment sort, which includes utilization of shrewd cards. It can be utilized as credit card, charge card and indeed ATM cards. Whereas ATM cards make cash withdrawal helpful, credit cards, charge cards and E-wallets like portable cash makes merchants' shopping a part more helpful. Credit and charge cards like Visa and Master card can be utilized to buy from shippers on the web (Vyas, 2012).

2.4. Challenges of E-banking Services

E-banking has many benefits in banking sectors but the service is affected by the following challenges too apart from the problems related to the card system:

- **Security Hazard:** The issue related to the security has gotten to be one of the major concerns for banks. A huge bunch of clients denies to utilize E-banking services due to instability and security concerns. Besides, security could be a huge challenge for marketers' and buyers' dissatisfaction have to be settled to extend the online E-banking services usage (Nidhi, 2016).
- **The Trust Factor:** Believe is the greatest jump to E-banking for most of the clients. Customers' account management is favored by the clients when customers believe on the online security. Believe is among the noteworthy components that affect the customers' eagerness to lock in an exchange with web vendors (Sanchez-Franco, 2009).
- **Customer Mindfulness:** Mindfulness among shoppers around the E-banking system administrations and methods is still at lower side in managing an account division. Banks are not able to spread appropriate data utilization, benefits and office of E-banking presidencies were not in good location. Less mindfulness of unused innovations and their benefits is among one of the foremost positioned boundary within the advancement of E-banking (Poon, 2008).
- **Privacy hazard:** The hazard of uncovering private data and fear of personal robbery is one of the major components that hinder the shoppers whereas picking for E-banking administrations. Most of the shoppers accept that utilizing E-banking administrations make the personal robbery helpless. The clients stress around their security and feel that bank may use their data for promotion and other purposes without the consent of customers (Yousafzai, Pallister et al, 2003).
- **Strengthening the open back:** In creating nations, within the past, most E-finance activities have been the result of joint endeavors between the private and public sectors. Create offices just like the World Bank to empower open bolster for E-finance related activities (Nidhi, 2016).

- **Availability of Work force administrations:** In display times, banks are to supply a few administrations like social keeping money with budgetary conceivable outcomes, particular upgradation, computerization, imaginative mechanization and superior client administrations. Subsequently, banks must be able to supply total faculty benefit to the clients who come with desires (Nidhi, 2016).
- **Implementation of worldwide innovation:** There is a situation to have a satisfactory level of foundation and human capacity building some time recently the creating nations can receive global technology for their local requirements. In creating nations, numerous customers either do not believe or do not get to the vital foundation to be able to prepare E-banking services (Chavan, 2013).
- **Non-Performing Resources (NPR):** Non-performing resources are also another challenge to banks'. Vehicle advances and unsecured credits increments NPR so that each bank need to pay attention approximately standard reimbursement of credits (Bajracharya, 2016).
- **Competition:** The national banks and private commercial banks have got the competition from internal and outside modern banks. Gifted and specialized labor is to be utilized and result arranged focused on staff will be designated (Battilossi and Cassis, 2002).
- **Handling Technology:** Creating or obtaining the correct technology, deploying it ideally and after that leveraging it to the greatest degree is basic to realize and keep up biggest benefit and proficiency. Early adopters of innovation obtain critical competitive progresses overseeing innovation is subsequently a key challenge (Malik, 2014).

Apart from the above listed issues, according to Bahl (2012), E-banking services have also the following challenges:

- ✓ The most dominant issue interfacing by E-banking is that security, it is not safe and secure all the time and there may be loss of data due to technical problem.
- ✓ E-banking are facing challenges of illiteracy, lack of computer knowledge and lack of confidence to use internet.

- ✓ E-banking are facing challenges of limited trained employees and improper use of technology.
- ✓ E-banking challenges of trust, because consumer is not habitual, they want to have the bank's receipt.
- ✓ There is also a problem of poor communication infrastructure, weak telecommunication and weak internet signals while using E-banking services.
- ✓ Legal and security issues is also the most crucial part of E-banking systems which lacks security measures, rules, regulations and cyber law.
- ✓ In E-banking mode of communication is only English but English language is the main hurdle to accept new things for some customers.
- ✓ E-banking concerns on economical mode, but average income is low so not able to achieve good communication equipment and banks' needed heavy investment to develop effective infrastructure for E-banking services.

2.5. Opportunities of Cardless E-banking Services

Based on the study of Nidhi (2016), utilization of E-banking services has the following opportunities:

- **Untapped rural markets:** Contributing to 70% of the full populace may be largely undiscovered advertise for managing E-banking customer account. In all urban zones, E-banking services were entered but the banks must reach to rural towns and villages where the lion's share of population lives there.
- **Multiple Channels:** Banks can offer so numerous channels to deliver their E-banking services administrations such as cardless E-banking services, ATM, Phone or mobile banking, Internet banking through web, Agent banking, POS, etc.
- **Competitive Advantage:** The advantage of embracing E-banking gives a competitive advantage to the banks over other players. The usage of E-banking is beneficial for bank in numerous ways because it decreases taken a toll to banks, progresses client connection, increments the topographical reach of the bank, etc. The benefits of E-banking have gotten to be opportunities for the banks to oversee their managing account commerce in distant better higher way.

- **Increasing E-banking users and devices literacy:** To utilize E-banking it is exceptionally vital or beginning prerequisite that individuals ought to have information about E-banking innovation. They can effortlessly utilize the E-banking administrations. The quick expanding E-banking clients can be a huge opportunity and managing an account industry ought to apply this opportunity to attract more E-banking clients to extend utilization of E-banking services.
- **Worthy Customer Service:** Commendable client, administrations are the most excellent brand envoy for any bank for developing its commerce. Each engagement with client is an opportunity to create a client confidence within the bank. Whereas expanding competition client administrations has gotten to be the spine for judging the execution of banks.

2.6. Advantage and Disadvantage of E-banking Cardless Services

According to the study of Ohki and Urushihara (1999) and Bhosale and Sawant (2012), cardless E-banking services have the following advantages and disadvantages:

➤ **Advantages of cardless E-banking services:**

- ✓ Withdrawal money any time, you can make Withdrawal and cash deposits at virtually any ATM 24/7 is accessible.
- ✓ No need to carry ATM card.
- ✓ No need to bring withdrawal receipt to bank.
- ✓ Faster than bank because no long line or queue.
- ✓ Provides strong authentication
- ✓ Hidden costs of ATM card management like card personalization, delivery, management, re-issuance, help-desk, and re-issuance can be avoided.
- ✓ Account holder may transfer for another person which will have valid identification for same account.
- ✓ Complaints regarding card such as stolen cards, regenerating new cards, maintaining and recording of cards etc. will be eliminated. Thus it is helpful to bank to reduce cost, time and efforts for card process.

- ✓ Flexible account access allows service users to access their accounts as per their convenience.
- ✓ Due to strong authentication method, no one is able to access others' customers account.
- ✓ Users having authenticity to change their PIN code for security purpose.

Moreover, according to the study of Aleen Greenspan (2007), the expected benefit of cardless E-banking services includes the following:

- **Improve customer service:** Cardless E-banking services empowers banks give modern, quicker and way better benefit to its clients. In this manner, bringing up the banks to worldwide benchmarks and improving competition among the banks. These can be within the shape of record exchange, signature confirmation inside minutes, etc.
- **Reliability of transaction:** Cardless E-banking services makes a difference to guarantee precise and opportune exchanges not at all like when done physically, which is inclined to human blunders that can cause misfortunes.
- **Satisfy:** Cardless E-banking services innovation guarantees the security of bank managing with its clients. Risky managing an account hone can cause colossal loses to the bank hone can cause colossal loses to the bank, particularly within the cause of distortion of account proprietors. The E-banking innovation anticipates this through its signature confirmation avoiding unauthorized get to into the computer.
- **Redundancy of Storage Space:** Cardless E-banking services innovation makes a difference to diminish the usage of records, which are obsolete, subsequently and lessening utilization of capacity space.

On the other hand, the following are some of the disadvantages of E-banking cardless services:

Concurring to the think about David West (2006), within the creating landmass of Africa, E-banking innovation gadget imports are not as it were exorbitant but moreover request competent masters for operation and upkeep. Typically, more conspicuous within the banking industry, where the E-banking services applications are inferred from remote technology, it creates extra costs such as remote preparing for bank staff and execution pros. This is often a drawback for underbanked

customers for they would require more information for the operational viewpoints of the interfacing of such gadgets, which they do not have.

False exercises may happen utilizing both big and moo innovation which implies when an internet client is hoodwinked into unveiling his or her secret data such as login subtle elements. Watchword or when a buyer gets an SMS expressing that a bank official will contact them to confirm or overhaul their managing account subtle elements, which is sent to the customer by an account programmer. The programmer at that point calls the customer beneath the guise that he or she is the bank official and commits false action with their banking details (Yeboah and Amanor, 2014).

SIM swap extortion could be a trick whereby the programmer contacts the consumers arrange administrator. Inquiries for their cell phone number to be reassigned to a modern SIM card in arrange to pick up get to private data such as their portable managing an account one-time stick utilized to E-banking services (Muller and Uhde, 2013).

Similarly, based on the study of Ohki, Urushihara et al (1999), cardless E-banking services drawbacks are, If PIN or password are forgotten, you will have a problem in Withdrawal money on ATM machine, registered mobile number network is very important and ATM may be offline.

2.7. E-banking Services workflow and Frameworks

2.7.1. Traditional ATM Transaction Workflow

Based on the study of Hegde and Sharath (2016), the traditional card system ATM services activities workflows shown below on Figure 1, which is relevant to identify and capture the existing card system process challenges. On the existing card system, there are many challenges as stated on statement of the problem and as shown on below Figure 1, authentication of the customer made by only PIN code.

These challenges and security issues need to be resolved by the new system too. Moreover, to develop E-banking transaction services conceptual model and theoretical framework, need to clearly know the traditional and the current EATM services workflows. On traditional ATM cash withdrawal, the customer need to insert ATM card along with PIN code but related to the card,

there were so many issues. Especially, security issues would be resolved by the proposed E-banking cardless transaction services framework enhances utilization of E-banking services.

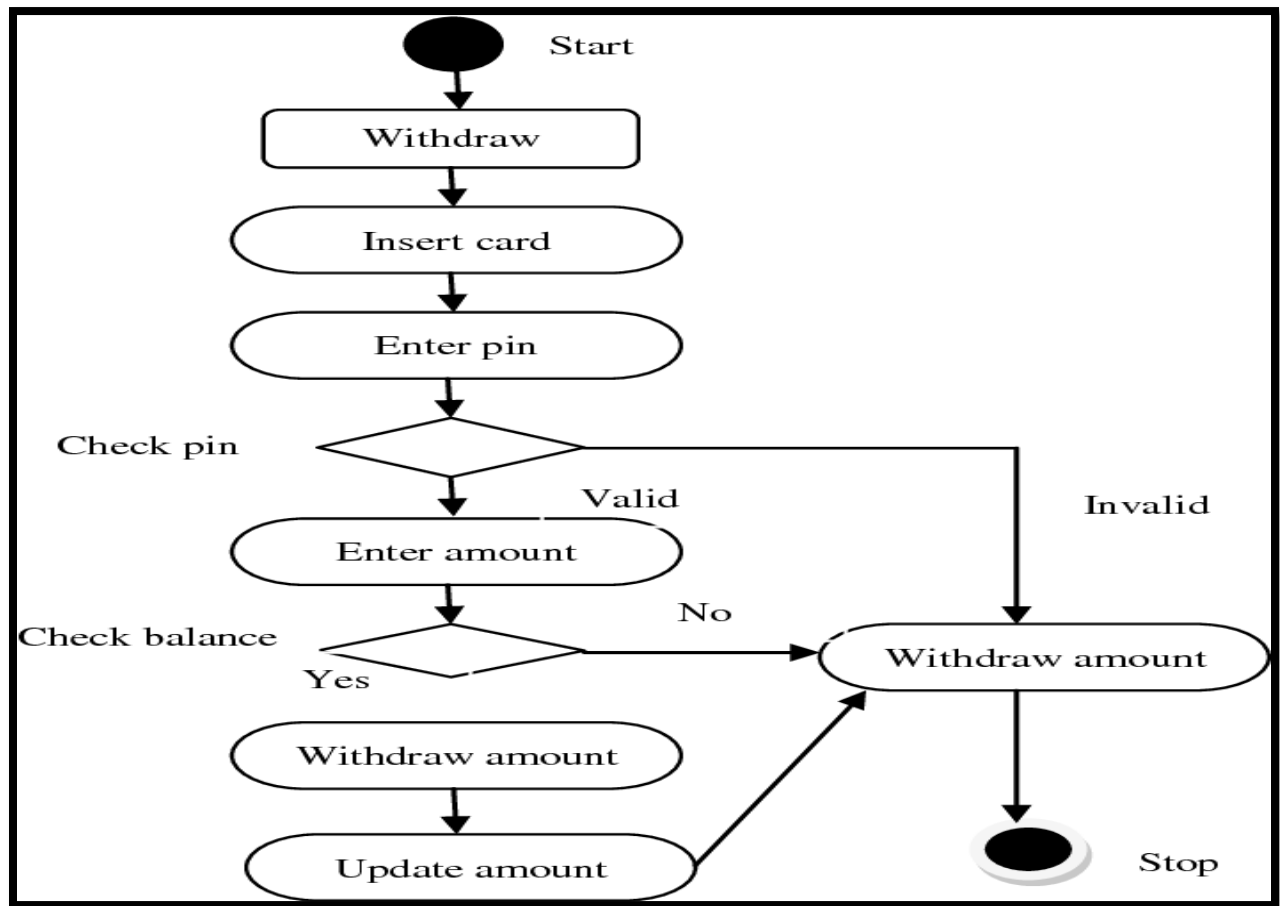


Figure 1: Traditional ATM transaction process

(Source: Hegde and Sharath, 2016)

2.7.2. Related Frameworks and Models

Even if many published materials were reviewed to do this research, the following are some of the major related frameworks and conceptual models designed in relation to E-banking services:

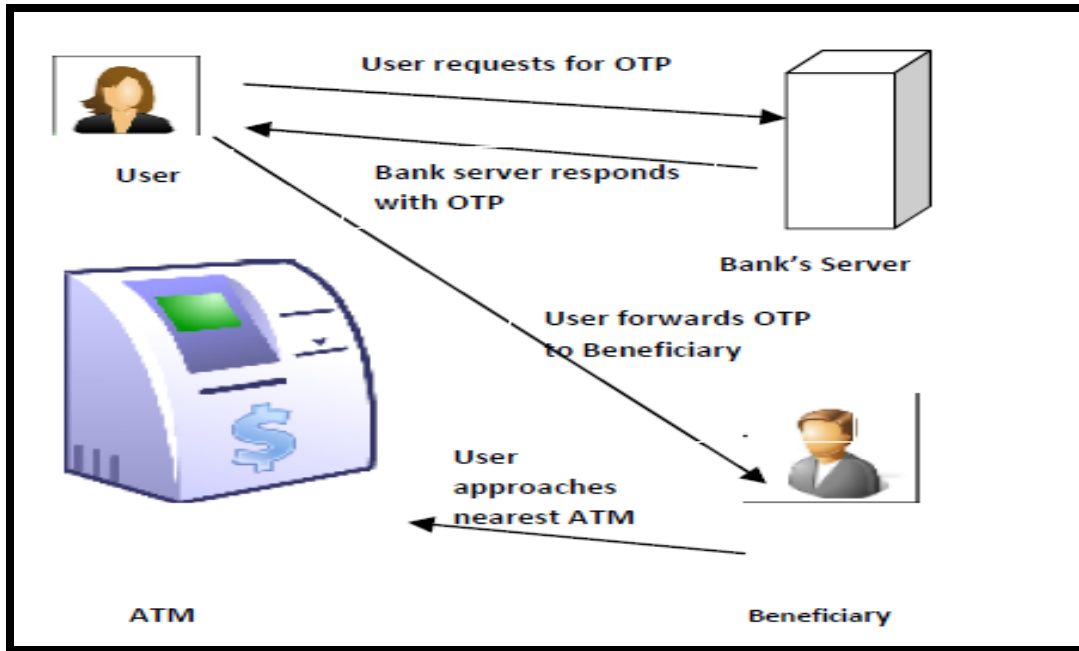


Figure 2: Cardless ATM cash withdrawal process framework

(Source: Hegde and Sharath, 2016)

The framework indicated above on Figure 2, do not clearly show all the main functionalities and modules of the cardless E-banking system. Apart from that, the challenges of the customers were not clearly indicated. Secret code was missed in this framework. So, the current researcher needs to develop a framework that can show the basic functionalities, workflows, challenges and other security mechanisms.



Figure 3: Cardless ATM withdrawal diagram

(Source: Ahmad and Rifen, 2016)

The diagram indicated above on Figure 3 did not show the major steps that the customers need to follow for cardless ATM withdrawal and just it is a graphical representation of the whole processes. The ATM also had special biometric features which was not cost effective. So that the major processes were not incorporated on this framework based on the order were:- From mobile side, user open the mobile application or USSD, enter PIN, enter mobile number, select generate OTP, enter amount and secret code. Then system generate OTP and send SMS to the customer. In the same way an ATM, user should press cardless withdrawal button from ATM, enter PIN, enter mobile number, OTP and secret code, system made withdrawal transaction, customer account debited, ATM dispense cash and send SMS to the account holder. All these main steps were not stated as a result, the current researcher clearly identify the major steps and shown on analysis section.

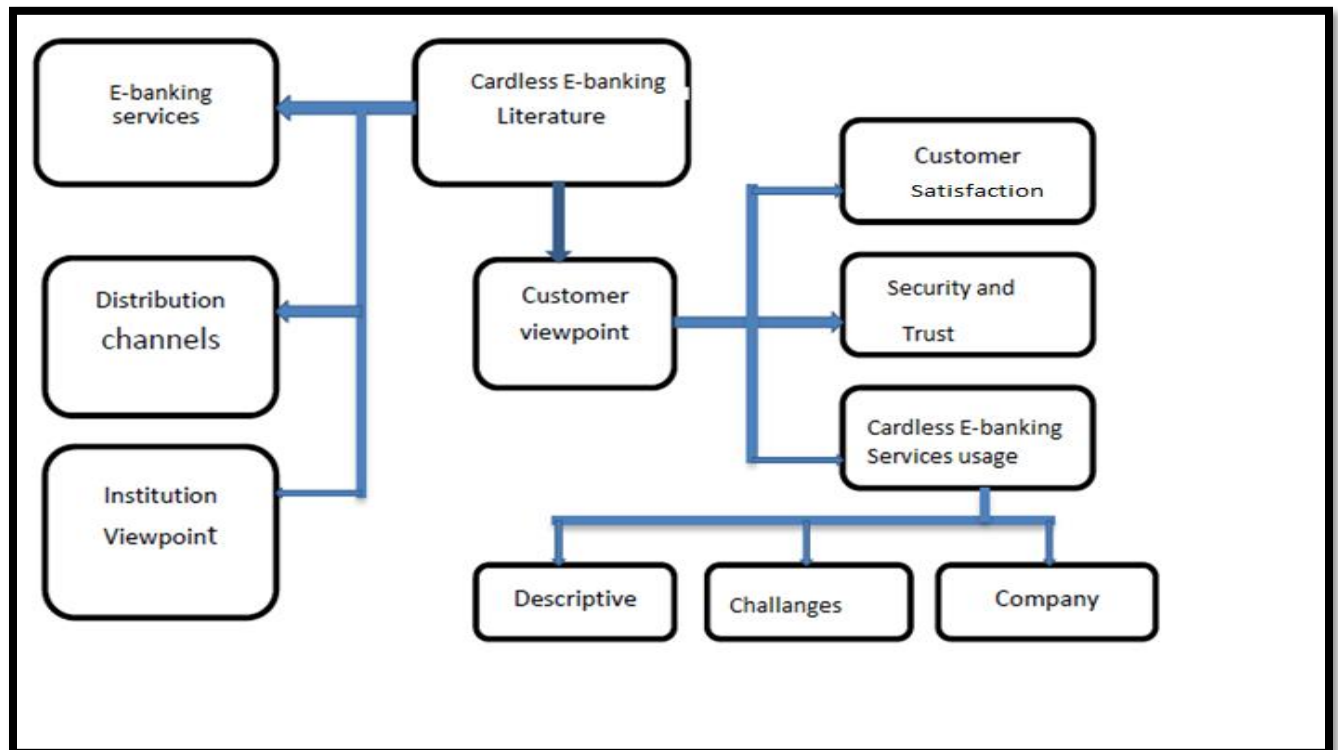


Figure 4: E-banking Cardless Services framework

(Source: Iyabode, Nureni, et al., 2015)

The framework shown above on Figure 4, seems complex, cardless E-banking should be under E-banking services and also customer satisfaction, security and trust should be kept under challenge component. The researcher used the words institution and company in different places having the

same meaning which can confuse the readers. The challenges related from customer viewpoint were security, trust and customer satisfaction, but these are not the only challenges and there are other challenges that affect utilization of E-banking services. These challenges also need to be directly linked with challenges at branch rather than customer viewpoint subsection. Moreover, the researchers did not consider other E-banking services challenges.

2.8. Design Science Framework Design Theory

Design Science (DS) research approach looks to amplify the boundaries of human and organizational capabilities by identifying problems, creating artifacts and evaluating artifacts relevant to solve identified organizational problems. In DS paradigm, understanding of existing system challenges, proposing its solutions and evaluate the solution accomplished within the building and application of the planned artifact (Hevner (2004)). In this study, DS framework design theory which can be used as a mirror and guideline to deliver the final framework would be followed. The final deliverable of this study becomes framework relevant to increase utilization of cardless E-banking services. Based on the study of Offermann (2009), DS research approach has three main stages namely problem identification, solution design and evaluation. So, DS research theory would be used to propose the expected theoretical framework and to evaluate the designed artifact including the developed prototype.

Design theory has been characterized in different ways emphasizing different presumptions. For illustration, it is expected by numerous to be prescriptive. Dividers et al. (1992) characterized it as, “a Design Theory could be a prescriptive hypothesis based on hypothetical underpinnings which says how a plan prepare can be carried out in a way which is both viable and feasible”. Prescriptive inquire about, which centers on progressing things, stands in differentiate to the graphic inquire about, which centers on understanding things (Walk and Smith, 1995) but hypothesis would not be used on the current research.

It considered by numerous to be viable and plan hypotheses comprise of information of a commonsense character; i.e., for practical purposes (Goldkuhl, 2004). It could be a sort of DS theory that decides activities. The recognizing trait of speculations for plan and activity is that they center on how to do something. It gives explicit medicines on how to plan and create a system, whether it could be a mechanical item or an administrative intercession (Gregor and Jones, 2007).

DS theory is also principles-based. Marcus et al. (2002) emphasized the part standards in their definition of design theory components incorporates a set of client necessities determined from part hypothesis which is not included in this study, standards administering the advancement handle and standards administering the plan of a framework. A few feeling against plan standards as hypothesis incorporate standards of shape, work, and usage among their design theory components (Gregor and Jones, 2007).

It accepted as dualist build and respect both plan as an item and plan as a handle. Simon (1996) expressed DS theory with two basic components to be specific the shape of the plan and the shape and organization of the plan prepare. Dividers et al. (1992) partition the components of DS theory into two classes as plan item and plan handle. Besides, Hevner et al. (2004) recognize rules for plan as an artifact and for plan as a look process.

2.9. Summary of Related Works

In order to prepare this research document, plenty number of documents were reviewed and the most related once would be summarized by the following Table 1. As shown below on Table 1, empirical related works are summarized by using author, title, objectives, methodology and key findings.

Table 1: Related works summary

No	Author(s)	Title	Objectives	Method	Key Findings
1.	Hegde and Sharath (2016)	Cardless ATM cash withdrawal: a simple and alternate approach	Propose Cardless ATM cash withdrawal system	Qualitative	The developed system is simple and effective and would definitely be preferred by all kinds of users.
2.	Iyabode, Nureni, Adebayo and Olamide (2015)	Cardless electronic automated teller machine with biometric authentication.	The basic aim of this research work is to design a cardless ATM.	Design Science	There is a positive and significant relationship between ATM Usage and Customers' Satisfaction.
3.	Istrate and C.M (2014)	Cardless withdrawal system for mobile banking applications	To analyze the opportunities present in the current banking environment represented by mobile technologies	Qualitative Case study	Combine all capabilities with a cardless withdrawal system commanded from the mobile application
4.	Asrar Mohammed (2018)	Secured and Usable Framework Design for Mobile Financial Service	To design secured and usable framework for Mobile Financial Service	Qualitative	Increase security and enhanced utilization of Mobile Financial Service
5.	Kinsman (2019)	Cardless banking in the Nelson Mandela Metropole: A means of financial inclusion for the excluded	To determine their perceptions and intentions of cardless banking among underbanked consumers.	Quantitative research approach using surveys	Underbanked consumers have positive perceptions of the complexity, trial ability and compatible advantages of using cardless banking.
6.	Ahmad, Rifien et al. (2016)	Cardless Automatic Teller Machine Biometric Security System Design Using Human Fingerprints	To propose an enhanced feature to improve the service of ATM cash withdrawal in less time with more level of security.	Mixed(DS and Qualitative)	The research increase the speed of cash withdrawal almost 3 times fast; could have positive impact on the customer's satisfaction
7.	Ahmad, Rifien et al.(2016)	AES Cardless Automatic Teller Machine (ATM) Biometric Security System Design Using FPGA Implementation	To give a freedom to the user by changing the card to biometric security system to access the bank account using Advanced Encryption Standard (AES) algorithm	Design Science	Enable secure banking transaction with a low real and high performance and very suited for restricted space environments for small amounts of RAM or ROM.

3.10. Research Gap

The main research gaps of this study were, Hegde and Sharath (2016), Iyabode, Nureni, et al. (2015) and Kinsman (2019) conducted related empirical researches on E-banking area but the researchers did not consider challenges of card base E-banking system stated on statement of the problem section. Similarly, the framework they proposed was also complex to implement and to be used by end users. Additionally, the research conducted by Ahmad and Rifan (2016), needs special biometric features like finger print and face recognition on the ATM to do cardless transaction which is very expensive. But, the current study enables the customer to do cardless cash withdrawal from normal ATM using other means of authentication methods. Moreover, there was no research conducted in Ethiopia on E-banking Cardless Transaction Services research title.

CHAPTER THREE

METHODOLOGY

3.1. Overview

In this chapter, research approaches, research design, study area, data collection methods, target population, sampling techniques, instruments and tools used will be stated. The main emphasis of this chapter is to discuss the rational explanation behind the methodological choices and considerations. Moreover, the chapter primarily clarifies and answers the what, why and how aspects of the research relevant to clearly identify the existing carding system problems and then to propose cardless E-banking transaction services framework.

3.2. Study Area

The study was conducted in Ethiopia at Abay bank S.C. head office found in Addis Ababa region. Abay bank is one of privately owned commercial bank established on July 14, 2010 and started operation on November 4, 2010. Also, the study mainly focused on E-banking area with specific emphasis of designing E-banking cardless service.

3.3. Research Approach

In this study, Design Science research approach was applied. Interview, observation and document analysis data collection procedures was used to identify, analyze and interpret the existing E-banking card system related problems. Additionally, Design Science research approach also functional to design the proposed framework, to develop the prototype and to evaluate the developed software.

3.3.1. Design Science Research Approach

In order to design the proposed theoretical E-banking cardless transaction services framework, Design Science (DS) research approach was used as the research is an artifact development and the deliverable of this study would be a kind of artifact or framework.

According to Hevner, et al. (2004), DS research approach looks to amplify the boundaries of human and organizational capabilities by creating modern and imaginative artifacts. DS research is used to create and evaluate IT artifacts intended to solve identified organizational problems.

Within the DS paradigm, information and understanding of existing system issues and its solutions are accomplished within the building and application of the planned artifact (Hevner, et al 2004).

Based on the study of Hevner and Chatterjee (2010), DS researchers work on understanding, explaining, and improving information systems. They study artifacts like algorithms, human/computer interfaces, languages, and system design methodologies. Understanding ends up in knowledge for predicting how some aspect of a phenomenon behaves.

Design uses knowledge plus innovation to make new improved artifacts that surpass what was available previously. In practice, design itself involves considerations of the internal, external, and also the interface between the inner and the external which is design is the know-how for implementing an artifact that satisfies a group of functional requirements.

DS research approach is the other side of the IS research cycle, creates and evaluates IT artifacts intended to unravel identified organizational problems. Such artifacts are represented during a very structured form which can vary from software, business logic, and rigorous mathematics to informal language descriptions.

DS research in IT often addresses problems associated with some aspect of the design of a system. Hence, the instantiations produced is also within the sort of intellectual or software tools geared toward improving the process of knowledge system development. Constructing a system instantiation that automates a process demonstrates that the method can in fact, be automated (Hevner, March, et.al., 2004).

3.4. Research Design

Based on the study of Elshalom (2016), research design refers to the overall strategy that the researcher selects to integrate the components of the study in a coherent and logical way and ensuring that the researcher will address the research problem effectively. It constitutes the blue print for the collection, measurement and analysis of data.

According to the study of Henos (2018), research design is a blue print of research and it shows the overall activities including data collection, sampling, data analysis and other aspects of a research.

Based on the study of Getnet (2017), most IS researchers follow behavioral or Design Science (DS) research paradigm. The behavioral science paradigm looks to create and confirm hypotheses that clarify and anticipate human or organizational behavior. On the other hand, the DS paradigm looks to amplify the boundaries of human and organizational capabilities by creating innovative artifacts.

The DS research process model developed by Offermann (2009) would be followed which was relevant to achieve the general and specific objectives of this research and to design the required E-banking cardless transaction services framework. Based on the study of Offermann (2009), DS research approach has three main stages namely problem identification, solution design and evaluation. The researcher will follow these steps in order to deliver the final and expected framework and to develop the prototype.

As indicated below on Figure 5, the first step is problem identification in which existing system problems are clearly identified, analyzed and interpreted. System problems are challenges related to E-banking carding system. Therefore, to resolve all the problems related to the carding system, the researcher designed and proposed E-banking cardless transaction services framework which is relevant to enhance utilization of E-banking services.

Finally, the proposed framework need to be evaluated to know the right framework was proposed or not and in this study, the researcher prepared evaluation checklist using different evaluation parameters. Based on the evaluation checklist (see Appendix 2 and 3), E-banking and IT experts were evaluated the framework and the developed software.

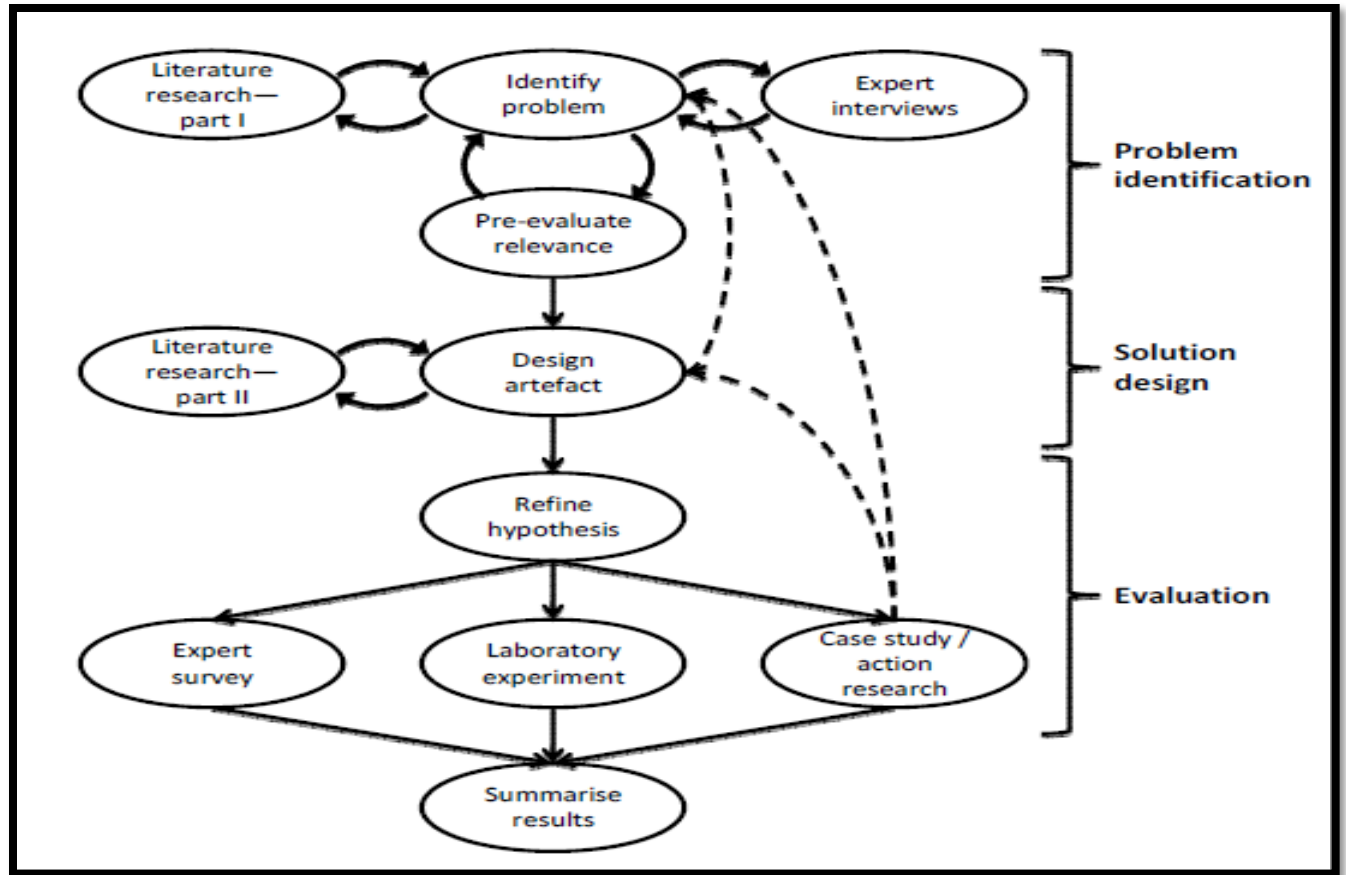


Figure 5: DS research process model

(Source: Offermann et al, 2009)

In relation to DS research process model indicated above on Figure 5, identified problems were challenges stated on statement of the problem which were related to the existing carding system. The DS research methodology mainly focused on problem identification, solution design and evaluation. The design solution of this study was a framework having the objectives to enhance proper utilization of E-banking services. In order to design the framework and to develop the sample cardless E-banking services software, object oriented method or prototyping was used. Moreover, to evaluate the system, interview questions evaluation checklists were prepared and applied.

3.5. Target Population and Sampling

The target population of the research were Abay bank external and internal customers include managers and accountants, cashiers, tellers, E-banking experts and IT experts. The selected respondents are those employees who can give relevant and rich information about the research problem:- So that to select the respondents, purposive sampling used as a sampling technique. Purposive sampling is a nonprobability sampling technique and the research data would be stored, analyzed and interpreted using thematic data analysis method and tool too.

Due to homogeneity of research data at branches, large number of populations, main branch found at head office and main branch is the first pioneer branch, the current research mainly focused at Abay bank head office. Based on the information got from Abay bank, the researcher found some internal customers utilizing both ATM and Mobile banking services actively and frequently. From the internal customers, the researcher purposively selected 23 respondents based on the criteria that can provide relevant and rich information about the issues. The respondents' research data distribution looks like the following one:

Table 2: Respondents' data distribution

No	Respondents	Count
1.	E-banking experts	5
2.	IT experts	3
2.	Managers	3
3.	Accountants	4
4.	Cashiers	3
5.	Tellers	2
6.	Other external Customers	3
GrandTotal		23

3.6. Data Sources and Types

The main data sources relevant to conduct this research would be Abay bank head office customers like branch managers, E-banking experts, IT experts, accountants, cashiers, tellers and other external customers, organizational documents, organizational websites, published documents, thesis and dissertations, etc. For this research, both primary and secondary data sources are used. Since the research methodology was Design Science, data was collected using face to face interview, personal observations and document analysis methods.

3.7. Data Collection Procedures

In order to collect required research data, semi structure interview and personal observations could be applied to know how the existing system works, to identify and analyze the current system problems. Moreover, published journal articles, websites, thesis and dissertations, magazines, newspapers and organizational documents would be analyzed in the research.

The study of Ryan, Coughlan and Cronin (2009) states that individual interview could even be a valuable method of gaining insight into people's perceptions, understandings and experiences of a given phenomenon and will contribute to in-depth data collection. However, the interview is quite a conversational interaction between two people and requires considerable knowledge and skill on behalf of the interviewer.

Moreover, according to the study of Myers and Newman (2007), interview is one of the most important data gathering tools in research, yet it has remained an unexamined craft in Information Systems research. The interview is used in DS research of all kinds for problem identification, whether positivist, interpretive or critical realist. Interview is frequently used in case study research too. This method is also appropriate to gather relevant data for this research.

3.8. Data Analysis

Based on the study of Braun and Clarke (2012), to explore and interpret the E-banking services research data, thematic analysis method was used and thematic analysis is accessible, flexible, efficient, effective and well-known method of data analysis.

Since thematic analysis gives flexibility for the researcher as stated above, this study involves the analysis of data collected through interviews, observations and document analyses and thus the

study will follow formalized procedures to explore the interview data too. To conduct this research using thematic data analysis method, open-ended interview questions were prepared and semi structured interviews, personal observations and documents analysis applied using the thematic analysis method.

Moreover, in order to answer “What are the challenges of the customers to use E-banking services?” and “What are the requirements to develop E-banking cardless services framework?” research questions, thematic analysis method used and QDA miner thematic software were used. Moreover, “How we design E-banking cardless transaction services framework?” research question answered by DS research method and more related with the development of the framework, so object oriented system analysis and development method would be applied.

3.9. Modeling Techniques and Tools

Although there are numerous sort of relevant tools and techniques to conduct thematic data analysis researches, few sophisticated tools are available to researchers for conducting a rigorous and relevant thematic analysis (Nowell, Norris et al., 2017).

Even if there are different kinds of thematic data analysis tools, the researcher used QDA Miner lite software in order to store, analyze and interpret interview data because QDA Miner is sort of user friendly software for survey data management. In order to design the framework, the researcher used object oriented framework development method using UML tool because the study mainly focus on clearly identifying and analyzing the existing system challenges then design and evaluate the framework and the prototype to enhance utilization of E-banking services.

Additionally, to deploy the prototype the researcher used local desktop computer as a server. XAMPP is more powerful and having Secured Sockets Layer (SSL) features. So, to develop the ATM and Mobile banking modules of frontend and backend applications, XAMPP multiplatform software (Apache, MySQL and PHP) were used. In order to design the ERD class diagram, MYSQL Designer and Microsoft word 2016 shapes were applied. Moreover, personal Mobile phone is used as SMS gateway to send SMS to the customer using msggateway.me free application.

3.10. Instrument and System Evaluation

According to the study of Yin (2003), validity and reliability are applicable to quantitative research and DS researches concerned with trustworthiness, dependability and transferability. Therefore, to address DS research issues related to thematic analysis, the researcher used QDA Miner software to manage the database, triangulation data collection methods with description of the research procedures and to make the research process transparent.

According to Offermann (2009), system evaluation would be performed using DS research evaluation method. The main parameters used to evaluate the proposed artifact were ease of use and usefulness to the task. Evaluation checklist was prepared to gather data from the selected respondents relevant to evaluate the artifact and the developed software. E-banking and IT experts would be participated to evaluate the proposed framework and the developed prototype to know the right framework was designed or not.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.1. Overview

This chapter mainly focused on the description, analysis and interpretation of the data collected to identify, analysis and interpret the existing E-banking carding system challenges in Abay bank S.C. The data relevant for this research collected from different respondents using open-ended semi structured interview questions, personal observations and different document analysis procedures. Semi structured interview was conducted with different Abay bank internal customers including E-banking experts, IT experts, Managers, Accountants, Cashiers, Tellers and Other Internal Customers.

The data analysis was done using free and lite version of QDA Miner software and the data collected through interview were compiled, presented and analyzed using tabular, graphical and chart formant.

4.2. Abay Bank Profile

Abay bank takes its name from “Ethiopia’s mighty river, the Great Abay, is a dramatic spectacle and a symbol of natural strength and grandeur. It is not only a magnificent sight to visit, but also a river with immense potential for our country’s development.

This tremendous natural strength similarly explains why the bank was named Abay. The bank is established to foster growth and development by promoting and financing different sectors, thereby generating employment opportunities and accelerating capital formation, by ensuring a safe, stable and sound financial system.”

4.3. Abay Bank E-banking Services Utilization Trend

Based on the information got from E-banking department of Abay bank and own survey, the following were the major E-banking services given by the bank:

- **Abay Online Banking:-** Abay online banking enables the customers in control of their money. Users can now access their Abay bank account online, and can do banking transactions wherever they are, whenever they want. These services include: Balance inquiry, Short statement, Fund transfer, Loan request, Loan inquiry, Card information inquiry, Activation and deactivation of cards, Request and replacement of cards, Ordering and opposing check book, Bills payment, Daily and previous day's foreign exchange rate, Salary payment and more.
- **Abay Card Banking:-** Enables to get access to customers' cash and to make banking transactions anytime through Abay ATMs. Abay card banking provides the following services: Cash withdrawal, Balance inquiry, Short statement, Statement request, Fund transfer, Order a Checkbook, Check stop payment order and Other services.
- **Agent Banking:** It aims to extend its banking services to unbanked customers. According to the NBE Directives, Agent: means a person engaged in a commercial/business activity and has been contracted by a financial institution to provide the services of the financial institution on its behalf. Agent banking means the conduct of banking business on behalf of a financial institution through an agent using various service delivery channels. Thus, Abay Agent banking provides banking services near to their premise through kiosk, supermarket, pharmacy, and other outlets. It is branded as "Abay Bedeje" which implies that the banking service has come closer to home or premises. The Agent Banking services includes: Saving Account Opening, Mobile Account Opening, Deposit & Withdrawal on mobile account, Payment, etc.
- **Abay Mobile Banking:** The Mobile banking channel offers banking services for all mobile platforms using android app, iOS app and USSD. Abay banking Mobile banking Services serves not only those users who have account at the bank but every mobile subscriber.

The Mobile banking channel provides informational as well as transactional services.

Informational Services:

- ✓ **Balance Request:-** Balance request tells the customer the currently available balance within their account at Abay bank.
- ✓ **Short Statement Request:-** Short statement tells the customer five recent transactions done on specific account.

- ✓ **Cheque book request:-** Customers can place a request for cheque books as long as their account has cheque facility.
- ✓ **Financial and banking news**
- ✓ **Geolocations:-** ATM, branches and Agent locations as well as distance from customer to these places were available.
- ✓ **Forex Rates:-** Customers can see the current foreign exchange rates using their mobile apart from the information posted on the bank website.
- ✓ **Contacts:-** Abay bank contact information also visible and customers can communicate the bank staffs at any time using the information provided.

Transactional Services:

- ✓ **Money Send or Transfer:-** Money send refers to a kind of money transfer a person does to another person's account or to his phone number if the person is a walk-in customer. If the person is a walk-in customer, then he or she is supposed to see the bank agents to collect the money.
- ✓ **Utility Payments:-** Payments refer to the kind of transaction a person makes with the bank agents or some other merchants. For example, to find an agent of Abay bank engaged in retail business or restaurant and pay bills through the mobile phone.
- ✓ **Cash Deposit:-** Deposit refers to the kind of transaction a person does to credit an account. To carry out deposit a person who is going to deposit must be a customer of Abay bank. Walk-in customers are not allowed to do deposit money to any account.
- ✓ **Cash Withdrawal:-** Cash Withdrawal refers to the kind of transaction a person does to debit his own account or to debit GL account which has been credited after person-to-person or account-to-person cash out transfer. In the latter case, the person at the receiving end is expected to bring withdrawal reference number. To do this transaction the customer is expected to get cash out reference number and cash withdrawal can be done in one of the following channels like branches and Agents.

- ✓ **Bill Payments:-** Bill Payments are those transactions a person does to settle the periodic payments with companies who had made agreements with Abay Bank. Customers can settle water, electric and telecom utility payments.
- ✓ **E-Top up:** Refers to the kind of transaction a person does to fetch airtime recharging number from the app by carrying out the amount of airtime denomination number.

As indicated below on Figure 6, Abay bank gives the following E-banking ATM services and the current researcher wanted to add one ATM functionality called “Cardless Services” as shown below written in red colors without requiring any additional biometric features including face recognition and fingerprint on the ATM machine.



Figure 6: Existing system ATM Services

(Source: Abay bank E-banking system)

4.5. DS Research Problem Identification and Analysis

In this study, two categories of interview semi structured questions were prepared. One type of interview was used to collect data from all respondents. The second category interview question was used to collect data from experts. A total of 23 respondents were participated to answer 18 semi structured interview questions.

Similarly, all selected respondents for the semi structured interview uses both Mobile and ATM E-banking services. Moreover, all interview discussion was transcribed using Micorsoft Excel 2016 and then imported to QDA Miner lite software for analysis (see Figure 7).

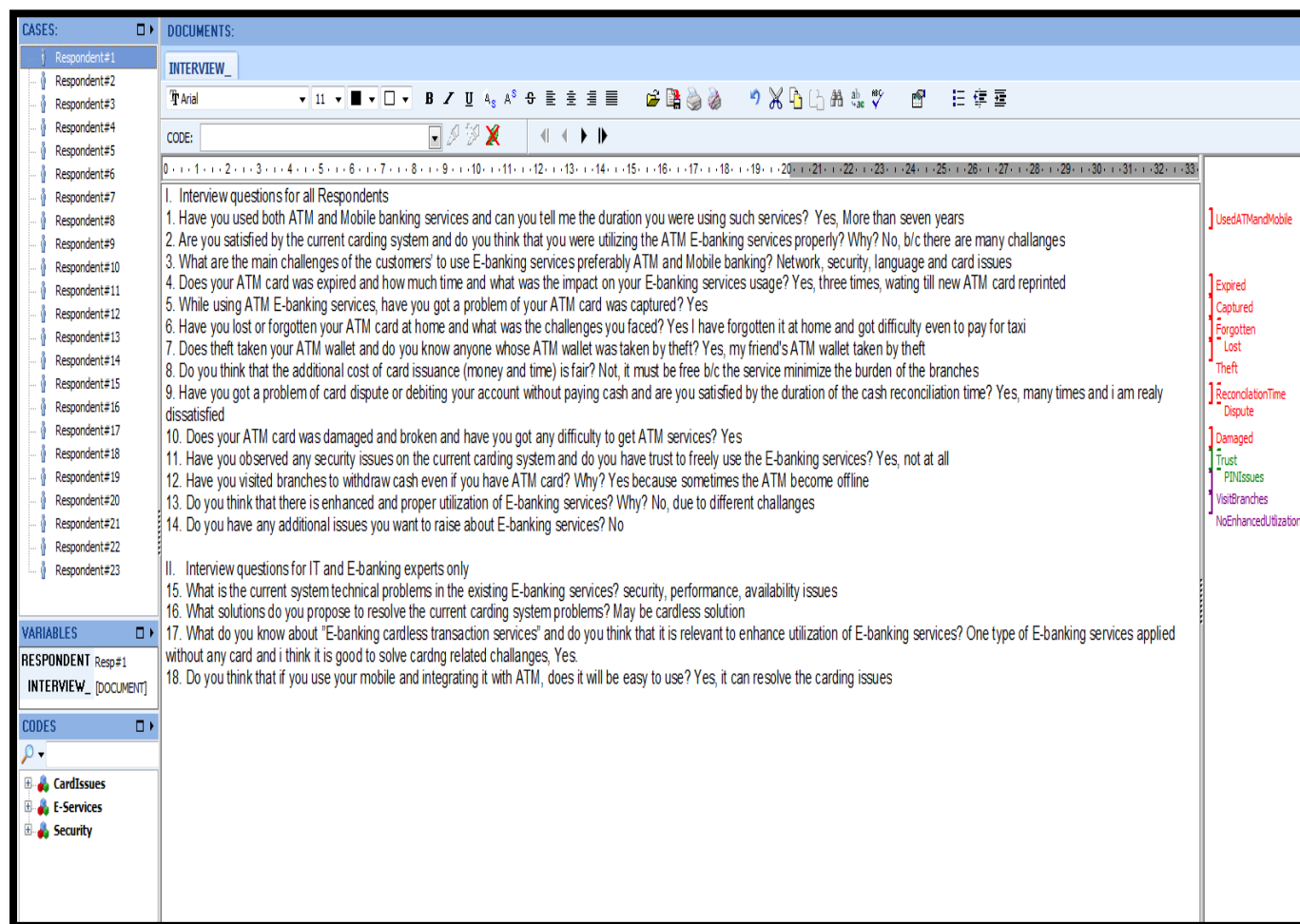


Figure 7: QDA Miner Respondents and Interview questions

(Source: Appendix 1)

Based the above Figure 7, three main themes which includes CardIssues, E-Services and Security which is emerged from empirical data were identified and the analysis need to be organized based on those themes. The interview data collected from the respondents would be presented, analyzed and interpreted based on the following options. As indicated below on Table 3 which was generated from QDA miner, the major issues related to existing carding system were card captured, cloned, damaged, disputed, expired, forgotten, lost, long reconciliation time, skimmed, theft and additional cost of issuance. In the same way, all the respondents have got a problem ATM card

expiration and ATM card dispute is also one of the major issue which affect enhanced utilization of E-banking services. Due to the above listed existing carding system and any other related challenges, there is no enhanced utilization of ATM E-banking services. As a result of this, the bank customers were forced to visit branches in order to get E-banking services.

Sometimes, the customers' account would be debited without paying cash and cash reconciliation time which is the time taken by the bank to return the money to the customer is too long. So that, most of the customers were not satisfied by the E-banking services and this issue also need to be resolved. Generally, based on the analysis result, ATM card expiry, capture, dispute, forgotten and reconciliation time, were the major and critical challenges that affect enhanced utilization of E-banking services. For more clarification, the analysis result of the interview data summarized on Table 3 below too.

Table 3: Respondents Interview data

(Source: Appendix 1, QDA Miner analysis result)

Category	Code	Count	%Codes	Cases	%Cases
CardIssues	AdditionalCost	10	4.20%	10	43.50%
CardIssues	Captured	21	8.90%	21	91.30%
CardIssues	Clone	2	0.80%	2	8.70%
CardIssues	Damaged	10	4.20%	10	43.50%
CardIssues	Dispute	21	8.90%	21	91.30%
CardIssues	Expired	23	9.70%	23	100.00%
CardIssues	Forgotten	19	8.10%	19	82.60%
CardIssues	Lost	15	6.40%	15	65.20%
CardIssues	Others	4	1.70%	4	17.40%
CardIssues	ReconciliationTime	18	7.60%	18	78.30%
CardIssues	Skimmed	2	0.80%	2	8.70%
CardIssues	Theft	9	3.80%	9	39.10%
E-Services	NoEnhancedUtlization	20	8.50%	20	87.00%
E-Services	UsedATMandMobile	23	9.70%	23	100.00%
E-Services	VisitBranches	15	6.40%	15	65.20%
Security	PINIssues	17	7.20%	17	73.90%
Security	Trust	7	3.00%	7	30.40%

The bar graph shown below in Figure 8, shown the distribution of issues related to E-banking services challenges. Based on the graph card expiration, captured, dispute and forgotten were the

major distributed keywords which indicates these were the main challenges on the existing E-banking services. Card cloning and skimming were also the list distribution key words and issues. All of the respondents were used Mobile and ATM services and there was low utilization of E-banking services.

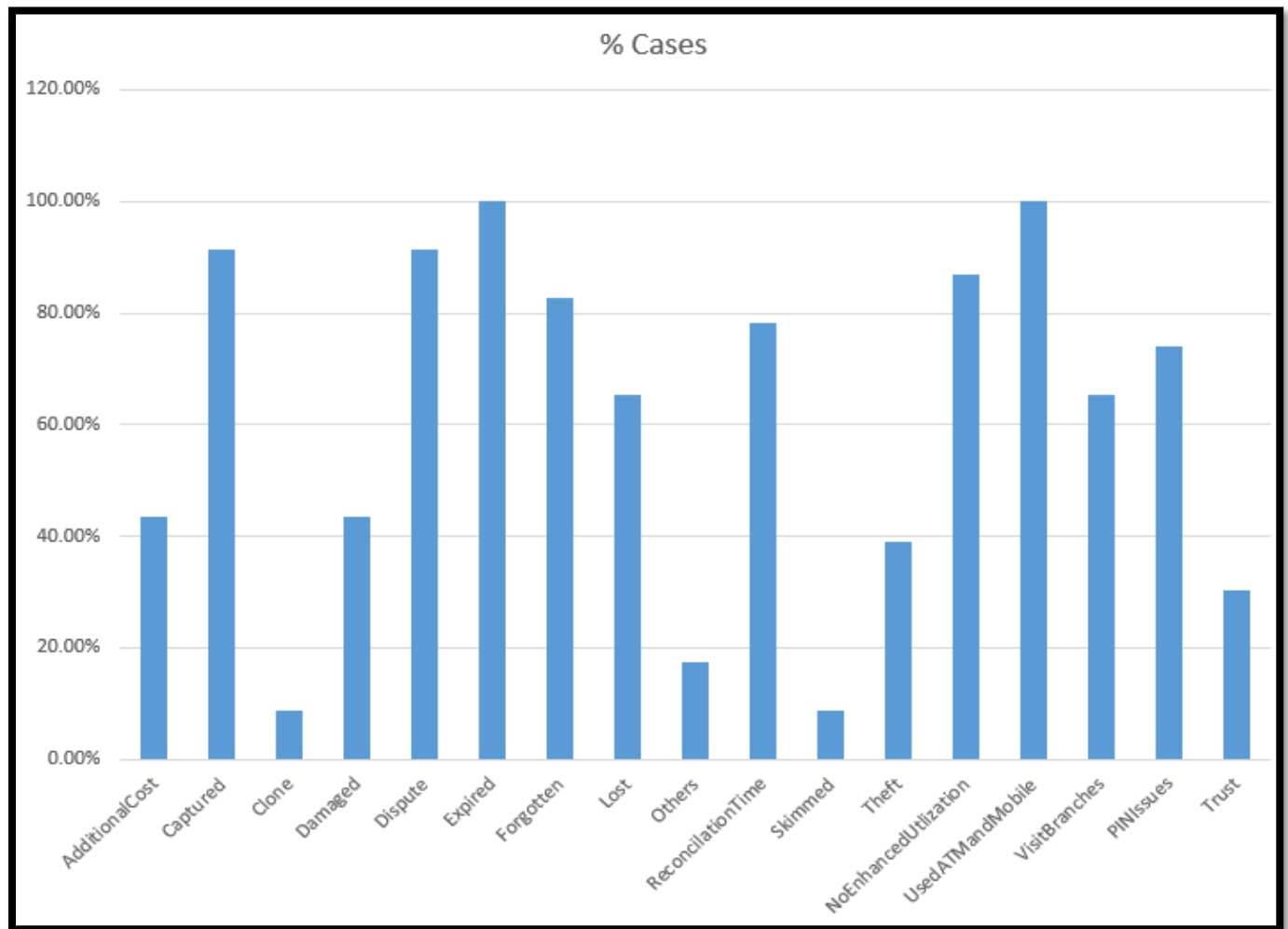


Figure 8: Distribution of Interview Keywords

(Source: Appendix 1, QDA Miner analysis result)

The pie chart indicated below on Figure9, also shows the distribution of keywords and major challenges in E-banking services. So that ATM card expired, disputed, forgotten, reconciliation time, PIN issues, captured were the most distributed keywords in the interview process which directly shows these were the critical issues. All of the respondents were used ATM and Mobile services but they thought that there is no enhanced utilization of ATM services.

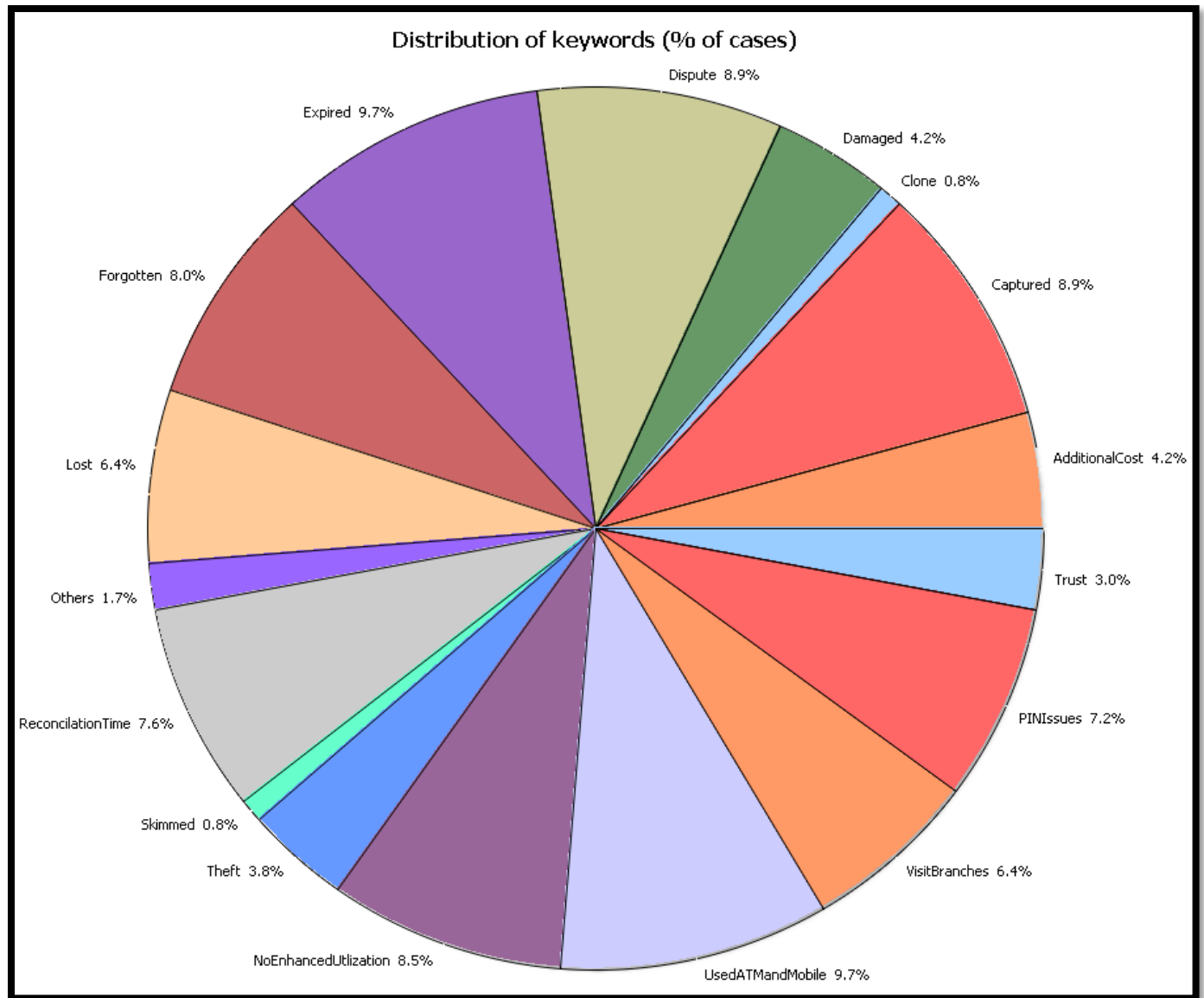


Figure 9: Interview data Pie chart

(Source: Appendix 1, QDA Miner analysis result)

According to the following Figure 10 generated from QDA miner, words written in bold and large font indicates that these words were more frequently used in the interview process and these words are captured, dispute, expired, forgotten, reconciliation time, no enhanced utilization, used ATM and Mobile, visit branches and PIN issues. Words which were not written in bold also shows that the words were not frequently used in the interview. Clone, skimmed, trust and others were the list frequently used terms during the interview process.



Figure 10: Usage of Interview Keywords

(Source: Appendix 1, QDA Miner analysis result)

Based on the analysis, discussion and the result got from QDA Miner as shown above on table, pie chart and bar graph, the following were the major findings and can be summarized as stated below:

- ATM card expiration, lost, cloned, damaged, skimmed, captured, disputed, additional cost of issuance, forget wallet at home, account debited without paying and long reconciliation time were the challenges of E-banking services.
- ATM card expiration, dispute, forgotten, reconciliation time, captured and PIN issues were the most critical challenges on existing ATM E-banking services.
- There is very low utilization of ATM services due to the above challenges.
- ATM card skimming and cloning were the least critical challenges.
- Security is the most critical challenges on E-banking carding system

From the above findings, it can be concluded that in existing card system there is no enhanced and proper utilization of E-banking services due to those challenges. So that, to address those issues and to increase enhanced and proper utilization of E-banking services, cardless E-banking services framework need to be designed.

CHAPTER FIVE

DESIGNING FRAMEWORK AND PROTOTYPE DEVELOPMENT

In this chapter the researcher mainly focused on designing the proposed framework, prepare a prototype, evaluate the proposed framework and prototype using different evaluation metrics like simplicity, completeness, consistency, integrity, security and usability.

According to Creswell (2003) framework is a foundation for programmers before start coding the actual system application. The framework need to be designed to resolve the existing E-banking carding system related challenges and to enhance proper utilization of E-banking services. The research also mainly focused to address the basic design requirements that have been gathered from the interviews within Abay bank and to model ideas gathered from different literatures. Therefore, the framework would be designed based on the requirements collected through interviews. Finally, based on the framework, a sample prototype was developed for ATM and Mobile banking modules along with SMS notifications.

5.1. Functional Requirements

Based on the current study, E-banking services affected by different challenges and there were no enhanced and proper utilization of E-banking services preferably on ATM E-banking services. As informed by different E-banking and IT experts during the interview time, a new system need to be designed that can address the existing carding system challenges and agreed to design ECTS framework. The main functional requirements of the system were the following:

- ✓ Cardless cash withdraw from ATM
- ✓ Insert registered Mobile number, PIN, OTP and Secret Code
- ✓ Check the validity of registered Mobile number, PIN, OTP and Secret Code
- ✓ Check customer account balance
- ✓ Debit customer account and handle transactions
- ✓ SMS notification for the beneficiary

5.2. Nonfunctional Requirements

The following were some of nonfunctional requirements of the system:

- ✓ Increase security features on E-banking services and to have trust by the customers
- ✓ Develop user friendly design interface and application to fulfill ease of use
- ✓ Feedback for wrong entry
- ✓ Strengthen performance of frontend and backend applications
- ✓ Scalability, maintainability, availability, etc. of the system

5.3. Existing and Proposed System Workflow.

5.3.1. Existing System Workflow

As indicate below on Figure 11, authentication of the user done only using PIN code which shows that security was not strong but in the new system authentication can be done using registered mobile number, PIN, OTP and Secret code which makes the system more secured.

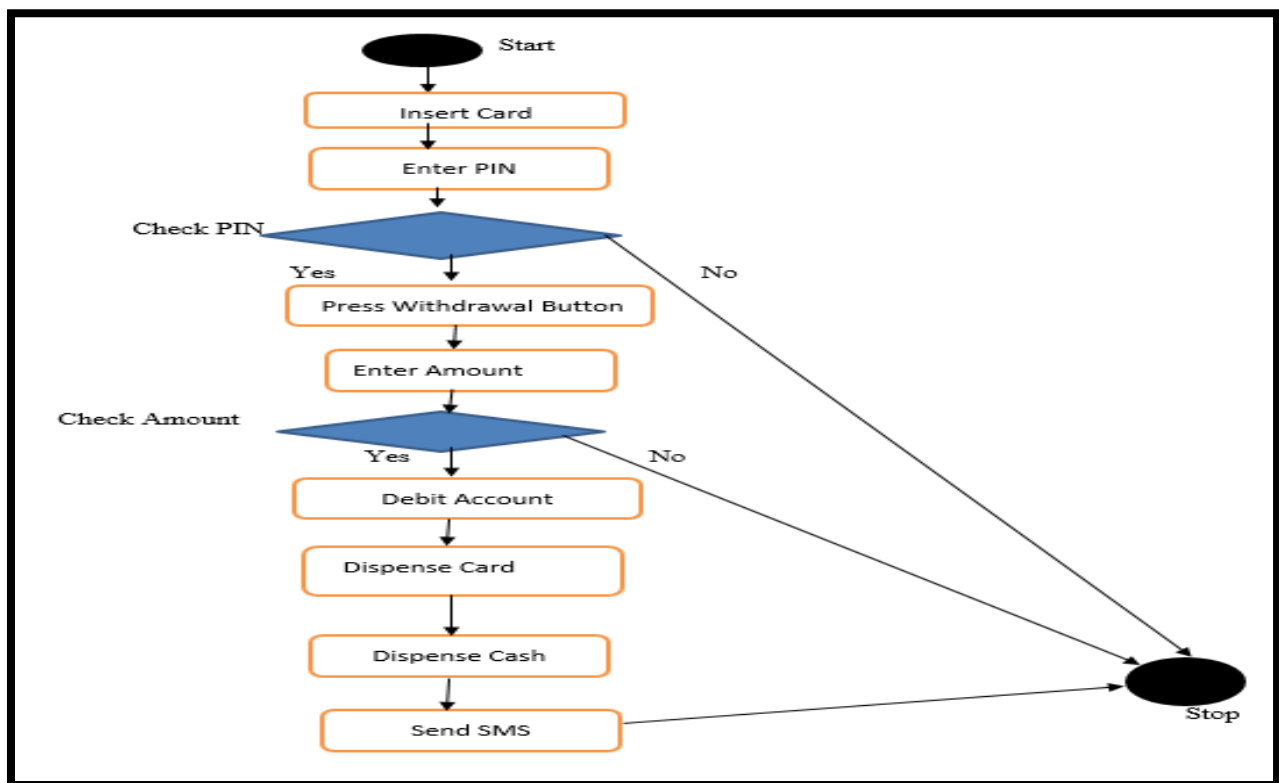


Figure 11: : Existing system workflow

5.3.2. Proposed System Workflow

5.3.2.1. Mobile Banking Workflow

In order to design the actual ECTS framework it is better to know how the ECTS works and Figure 14 shows the work flow from mobile side and these are the steps: User “Open Mobile App/USSD” then “Enter PIN”, here the system checks whether the PIN is correct or not and if incorrect the system stops generating the OTP. If correct, move to “Enter Mobile No”, if the mobile number is not valid, the system stops generating the OTP and if it is correct, move to “Select Generate OTP”, next “Enter Amount and Secret Code”, here the system check the customer account balance and if there is insufficient amount, the system stops generating the OTP and if there is sufficient amount, system generate the requested OTP. Finally, the system sends SMS to the mobile that the user entered and successfully terminate the whole process.

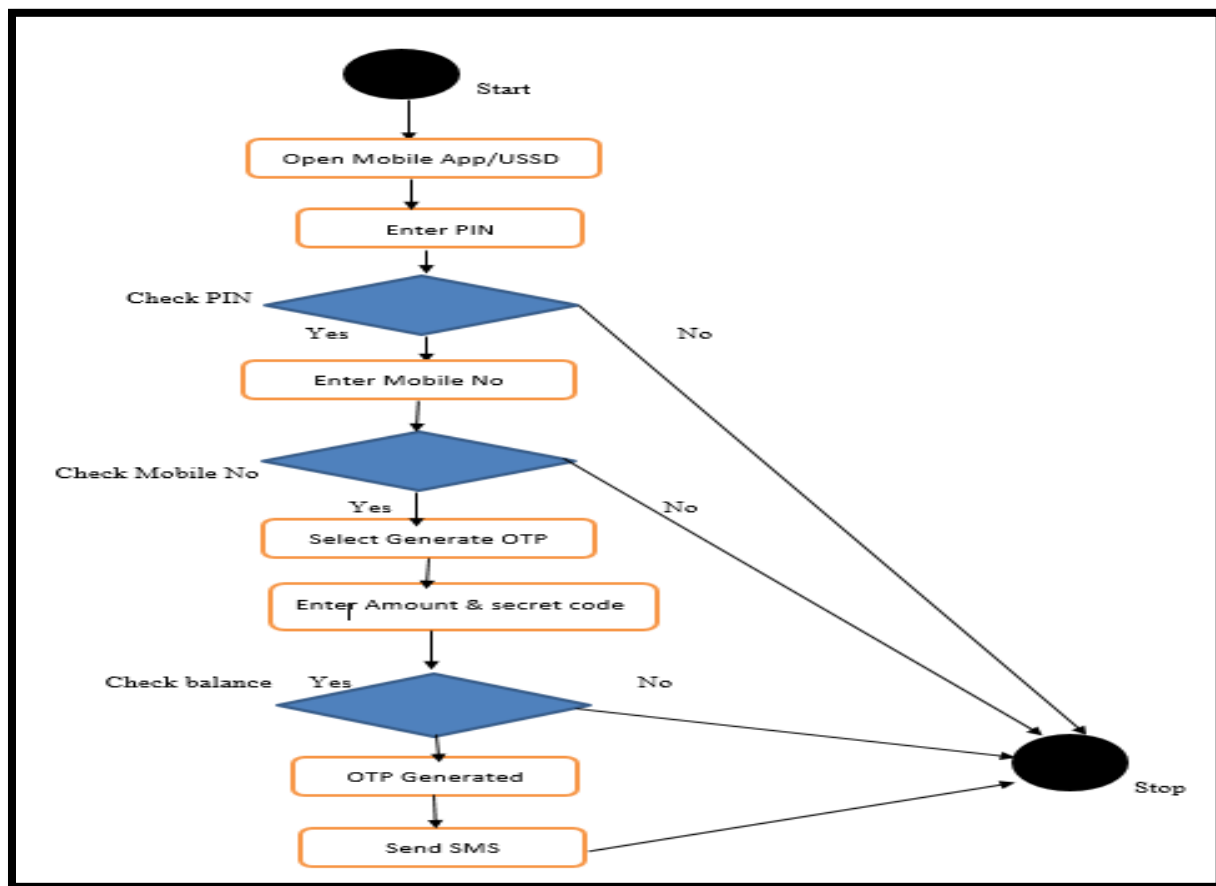


Figure 12: Cardless Mobile banking workflow

From the Mobile banking process side as indicated above on Figure 12, the user expected to enter valid 4 digit registered PIN code and Mobile number, amount and any 4-digit secret code. Then, the system checks PIN, Mobile number and amount. If all the user inputs were correct then the system automatically generate the OTP number send a message to the registered Mobile number. The message looks like “Dear customer OTP generated with OTP number ***, amount *** birr from Mobile No 09***”. OTP number can be generated with two options (self, other customers). For security reason “Secret Code” could not be sent automatically to the beneficiary so that, phone call or SMS is required to get the “Secret Code” from the sender. Only OTP number and amount information will be sent to the beneficiary and to get the cardless withdrawal services, the customer expected to visit the nearest bank’s ATM.

5.3.2.2. ATM Banking Workflow

Similar to the steps on Mobile banking module, the following are the steps from ATM side as indicated on Figure 13. User “Press Cardless Withdrawal” button from ATM then “Enter PIN”, here the system checks whether the PIN is correct or not, if it is wrong the system stops the amount withdrawal process. If the PIN is correct, move to “Enter Mobile No, OTP and Secret Code”, here system check the validity of Mobile number, OTP and Secret code and if one of these would be wrong, the system terminate the amount withdrawal process. If all of these issues becomes correct, system made withdrawal transaction then debit the customer account and dispenses cash from ATM. Finally, the system sends SMS notification to the account holder mobile number to notify the customer as the account was debited based on the OTP request.

Moreover, the customer expected to enter registered and valid PIN code and Mobile number from ATM side. Since the beneficiary already got SMS from the sender, OTP information also visible for the beneficiary from the SMS text. In the same way, the beneficiary customer should get the “Secret Code” from the sender using phone call. After entering all the necessary parameters, the system did the withdrawal transaction by debiting the customer account and the ATM immediately dispenses the cash to the beneficiary. Finally, the system automatically sends SMS to the account holder and the message looks like “Dear customer your account '*****' debited with amount '*****' ETB birr”.

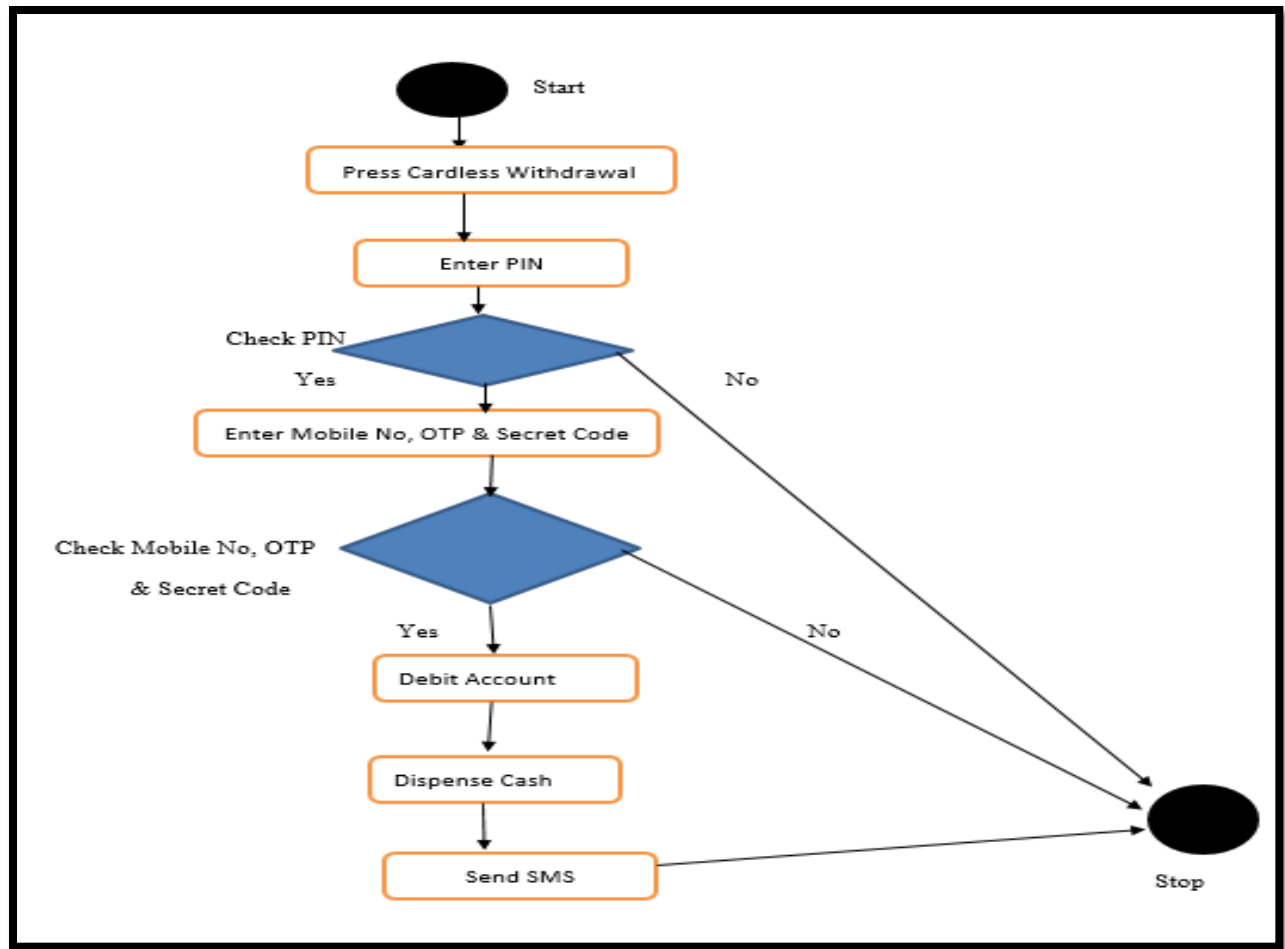


Figure 13: Cardless ATM withdrawal workflow

5.4. Proposed system Database Design ERD

The following Figure indicated on Figure 14, shows the ERD that the researcher designed and exported from the MySQL database designer to show the database tables and attributed during the prototyping process. This ERD is used for the frontend interface design and coding the system.

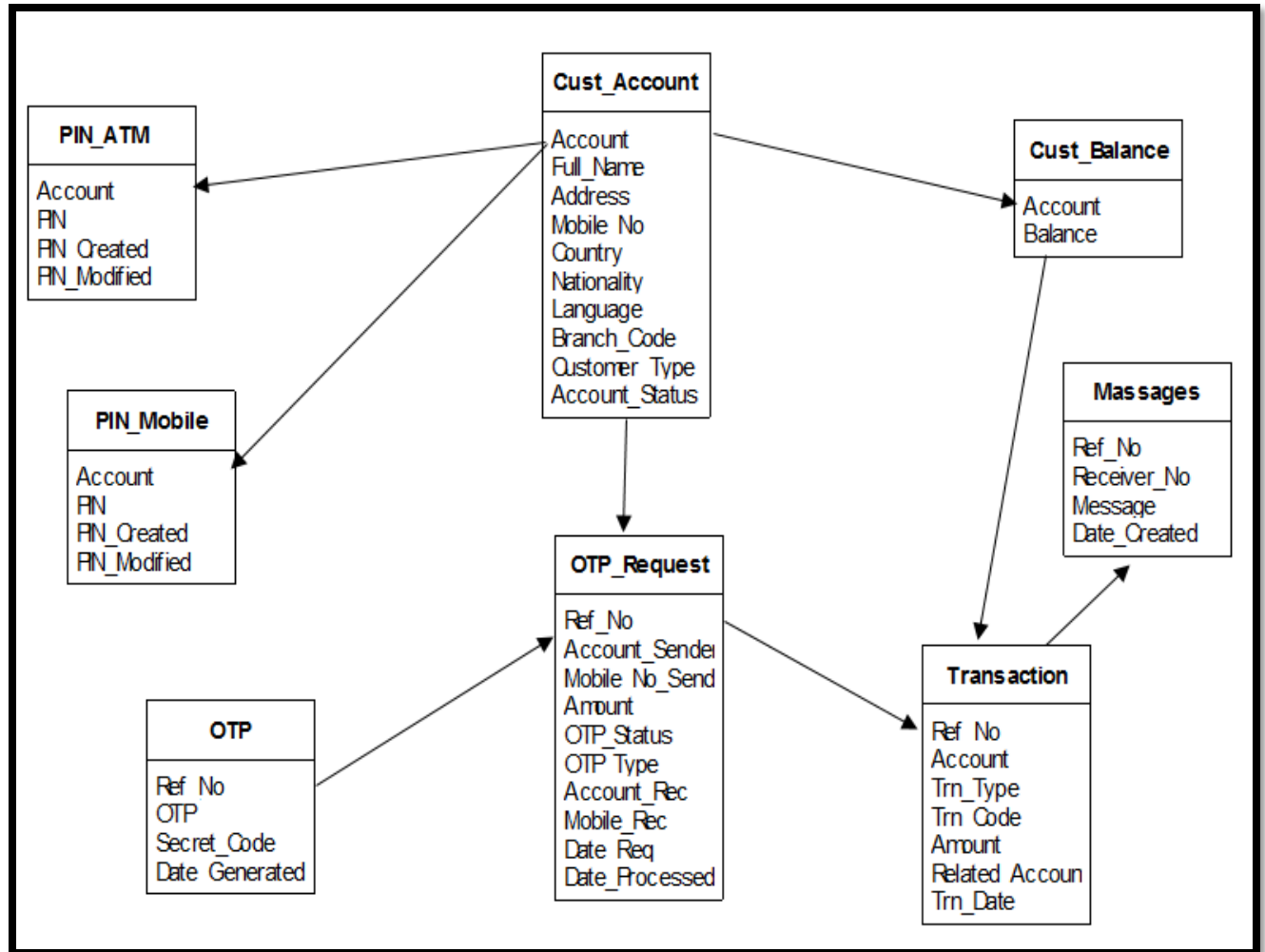


Figure 14: Cardless system ERD

5.5. Proposed System Physical Architecture

Figure 15, shown below represents the physical layout of the system and subcomponents of the system included to design and develop cardless E-banking transaction services system.

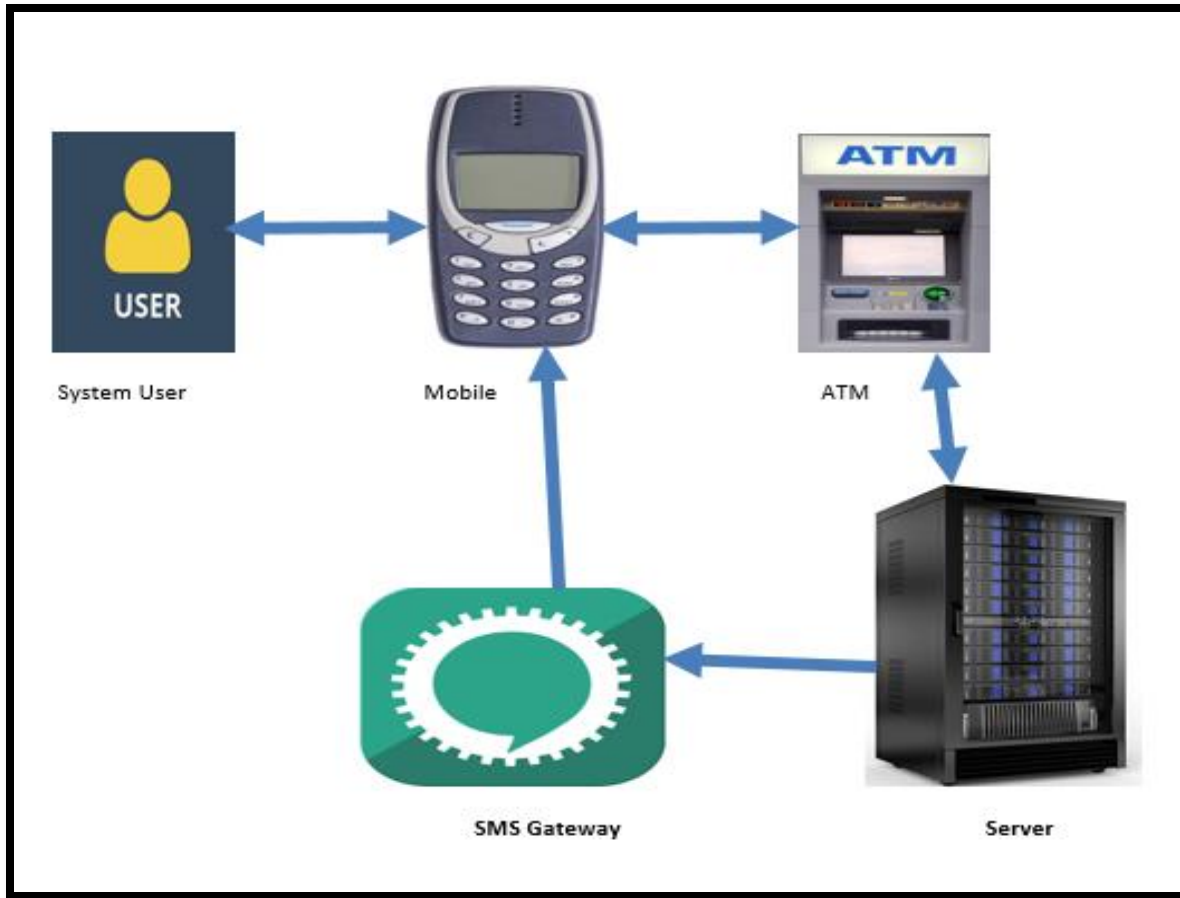


Figure 15: Proposed system physical architecture

5.6. Proposed ECTS Framework

Framework provide guidance about all facets of the study relevant to assessing the general philosophical ideas behind the inquiry, follow detailed data collection and analysis procedures and situate plans in ideas that are well-grounded in the literature (Creswell, 2003). Therefore, the ECTS framework relevant to design and implementation of cardless E-banking services system for Abay bank is shown below (Figure 16).

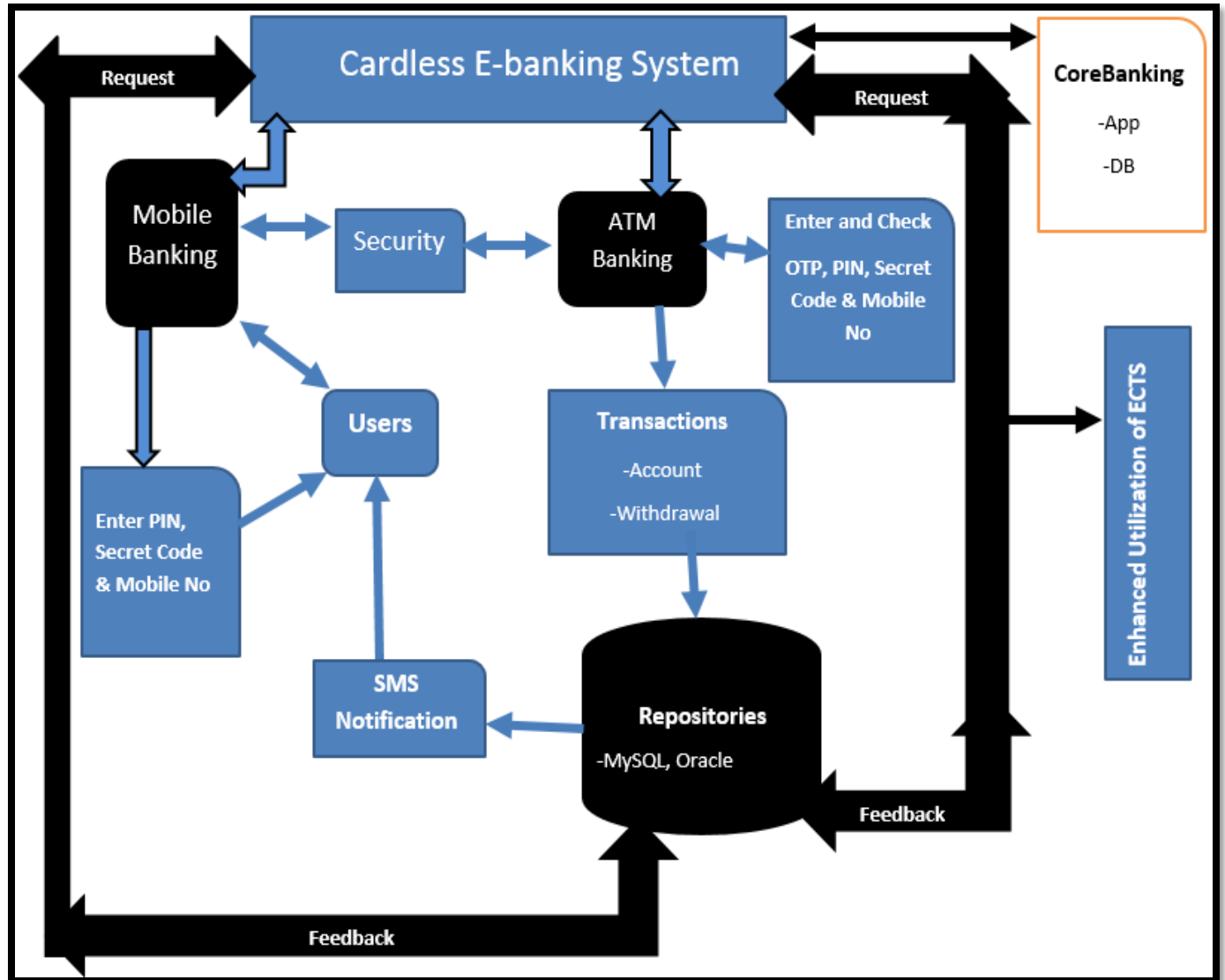


Figure 16: Proposed Framework

5.7. Design Science Research Solution Design

As stated by Houde (1997), prototypes are widely recognized to be a core means of exploring and expressing designs for interactive system relevant to deliver an artifact. In order to know the right framework was developed prototyping is important. The proposed prototype sample screen shots and codes from the designed sample software on Mobile and ATM banking modules are discussed in the following section.

5.7.1. Mobile Banking Module Screens

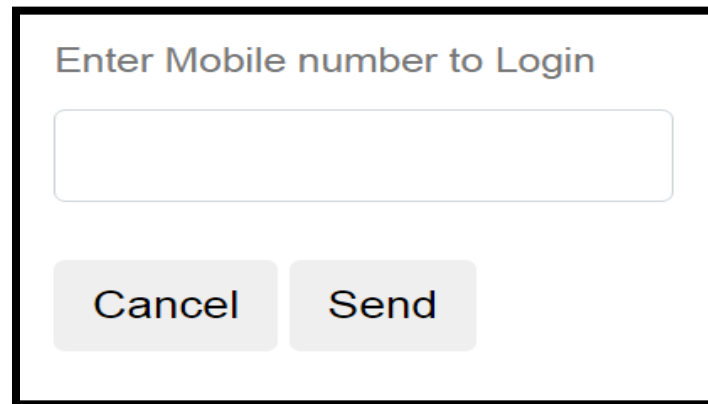
A screenshot of a mobile banking login screen. It features a title "Enter Mobile number to Login" at the top. Below the title is a single-line text input field. At the bottom, there are two buttons: "Cancel" on the left and "Send" on the right, both with a light gray background and black text.

Figure 17: Mobile banking login screen

As shown above on Figure 17, in order to start cardless withdrawal transaction using Mobile and ATM E-banking application, the customer need to enter valid and registered mobile number then need to click “Send “button. If the mobile number was not correct, the system requested the user to enter again valid mobile number. If the user entered valid and registered mobile number, the screen shown below on Figure 18, will be displayed.

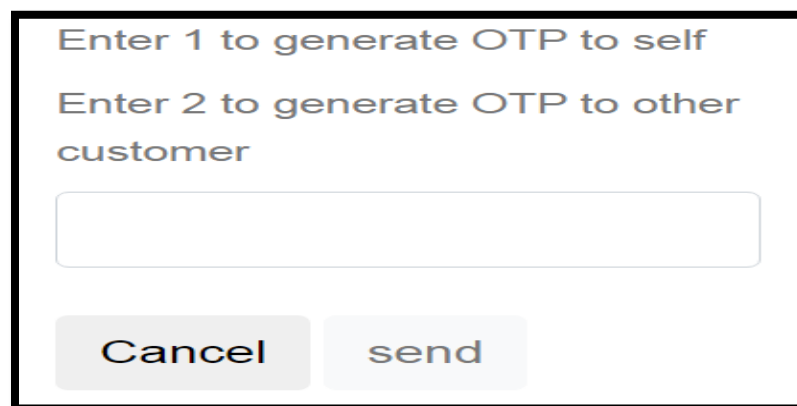
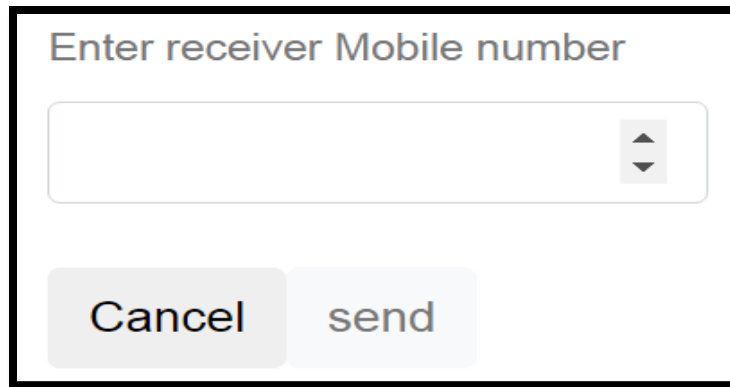
A screenshot of an OTP selection screen. It displays two options: "Enter 1 to generate OTP to self" and "Enter 2 to generate OTP to other customer". Below these options is a single-line text input field. At the bottom, there are two buttons: "Cancel" on the left and "send" on the right, both with a light gray background and black text.

Figure 18: OTP selection screen

Based on the screen shown above on Figure 18, the user expected to enter 1 to generate OTP request to self and need to enter 2 to generate OTP cardless withdrawal request for other beneficiary. If the user entered any other numbers, the system displayed a message to enter only 1 or 2.



Enter receiver Mobile number

Cancel send

Figure 19: Screen to enter receiver's mobile

When the user entered 2, then the screen indicated above on Figure 19, displayed and the user expected to enter valid and registered receiver's Mobile number too to proceed to the next process.

5.7.2. ATM Banking Module Screens

Existing system ATM services were, cash withdrawal, balance inquiry, short statement, fund transfer, money send, top up and bill payment but the new system enables E-banking services to be done without card and added one service called "Cardless" services. As shown below on Figure 20, the user expected to press "CARDLESS" button from ATM machine.

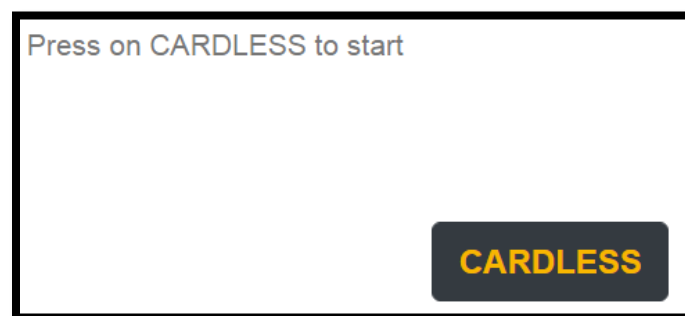


Figure 20: Press CARDLESS button on ATM

Based on Figure 21 shown below, the user should enter active and valid OTP which already sent to the beneficiary's Mobile number through SMS. So that the system user expected to enter such OTP number and click submit button to proceed to the next step.

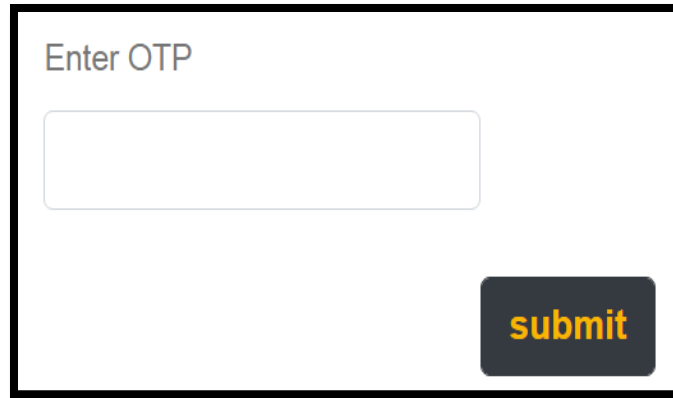
A screenshot of an ATM screen with a black border. At the top left, the text "Enter OTP" is displayed in a grey font. Below it is a large, empty rectangular input field with a thin grey border. In the bottom right corner, there is a dark grey rectangular button with the word "submit" written in a bold, orange font.

Figure 21: Enter OTP screen on ATM

Due to security reason, the developer did not want to send the Secret code information through SMS and the simple Secret code resides on the mind of the sender. As a result, the beneficiary need to communicate the sender in order to get the right secret code that the sender already used for confirmation. As shown below on Figure 22, the system requested to enter the correct 4-digit Secret code and then press submit button.

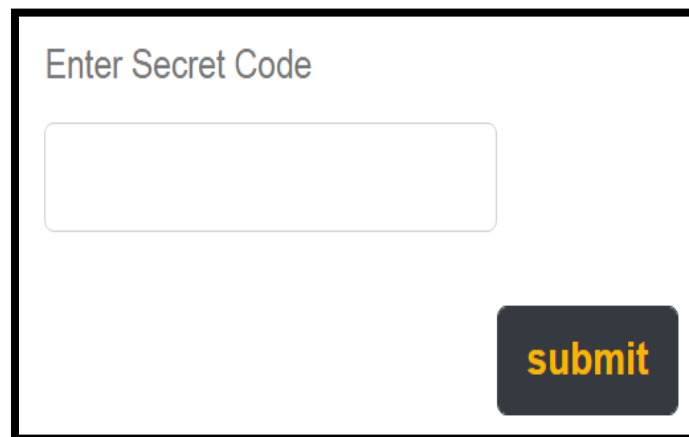
A screenshot of an ATM screen with a black border. At the top left, the text "Enter Secret Code" is displayed in a grey font. Below it is a large, empty rectangular input field with a thin grey border. In the bottom right corner, there is a dark grey rectangular button with the word "submit" written in a bold, orange font.

Figure 22: Enter Secret Code screen on ATM

In order to complete the whole process, the user should enter valid and resisted beneficiary's Mobile number. When the user entered the Mobile number and press submit button as shown below on Figure 23, the process would be completed.

Figure 23: Enter Mobile Number screen on ATM

5.7.3. Prototype Sample Codes

5.7.3.1. Mobile Banking Sample Codes

The following script checks whether the user entered valid registered Mobile number and PIN code. Both the Mobile number and PIN code are already exist in the database so, the system compare the input value with existing data.

```
public function checkPhone($data){
    $this->db->query("SELECT * FROM `cust_account` WHERE `mobile_no` = :mobile_no");

    $this->db->bind(':mobile_no',$data['pno']);

    $row = $this->db->single();

    if($this->db->rowCount() > 0){
        $phonedata=[
            "status"=>true,
            "account"=>$row->account,
        ];
        return $phonedata;
    } else {
```

```

$phonedata=[
    "status"=>false,
    "account"=>"",
];
return $phonedata;
}    }

public function check_pin($data){
    $this->db->query("SELECT * FROM `pin_mobile` WHERE `account` = :account");
    $this->db->bind(':account',$data['account']);
    //$this->db->bind(':AccountStatus', "Enabled");
    $row = $this->db->single();
    if($this->db->rowCount() > 0){
        $hashed_password = $row->pin;
        if(password_verify($data['pin'], $hashed_password)){
            $pindata=[
                "status"=>true,
            ];
            return $pindata;
        } else {
            return false;
        }
    } else {
        return false; }    }

```

5.7.3.2. ATM Banking Sample Codes

Similar to the Mobile banking, the following is sample function taken from ATM banking module used to check the withdrawal process is completed:

```
public function complete_process($data){

    $this->db->query("SELECT * FROM `cust_balance` WHERE `account` = :account");

    $this->db->bind(':account',$data['account_sender']);

    //$this->db->bind(':AccountStatus', "Enabled");

    $row = $this->db->single();

    $current_bal=$row->balance-$data['amount'];

    $this->db->query("UPDATE `otp_request` SET `otp_status`=:otp_status WHERE `ref_no`=:ref_no");

    // Bind Values

    $this->db->bind(':otp_status', 'C');

    $this->db->bind(':ref_no', $data['ref_no']);

    //$this->db->bind(':AccountStatus', "Enabled");

    if($this->db->execute()){

        $this->db->query("UPDATE `cust_balance` SET `balance`=:balance WHERE `account`=:account");

        $this->db->bind(':balance', $current_bal);

        $this->db->bind(':account', $data['account_sender']);

        if($this->db->execute()){

            $this->db->query('INSERT INTO `transaction`(`ref_no`,`account`,`trn_type`,`trn_code`,`amount`,`related_account`)

                VALUES (:ref_no,:account,:trn_type,:trn_code,:amount,:related_account)');

            // Bind Values

            $this->db->bind(':ref_no', $data['ref_no']);

            $this->db->bind(':account', $data['account_sender']);

            $this->db->bind(':trn_type', 'OTP');
```

```

if($data['otp_type']=='OTH'){

    $this->db->bind(':trn_code', 'OTP-OTH');

    $this->db->bind(':related_account', $data['account_rec']);

} else{

    $this->db->bind(':trn_code', 'OTP-SEL');

    $this->db->bind(':related_account',''); }

$this->db->bind(':amount', $data['amount']);

//$this->db->bind(':AccountStatus', "Enabled");

if($this->db->execute()){

    $PNO=$data['mobile_no_sender'];

    $msg="Dear customer ". $data['amount']." birr is deducted from your account";

    $this->sender->send($PNO,$msg);

$this->db->query('INSERT INTO `messges`(`ref_no`, `receiver_no`, `message`)

    VALUES (:ref_no,:receiver_no,:messages)');

    // Bind Values

    $this->db->bind(':ref_no', $data['ref_no']);

    $this->db->bind(':receiver_no', $PNO);

    $this->db->bind(':messages', $msg);

    if($this->db->execute()){

        return true; }

    else{ return false; } }

    else{return false;

}} else{ }

} else { return false; } }

```

5.7.3.3. SMS Notifications Sample SMS

Figure 24 shown below, shows the sample SMS send to the beneficiary using the developed cardless E-banking services system.

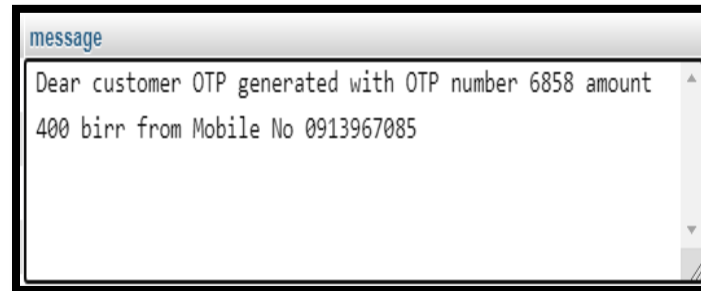


Figure 24: Sample SMS

Moreover, the sample SMS code (Appendix 4) used to send SMS notification to the beneficiaries' Mobile number when OTP would be generated for the customer and when the customer account debited based on the system user request.

5.8. System Configuration and Setup Procedures

The whole developed frontend and backend cardless E-banking services system applications were uploaded on free website (<https://files.fm/>). So that, in order to configure and setup the cardless E-banking transaction services system to any new machine in the future, system user can follow the following procedures:

- ✓ Prepare any server or desktop computer to deploy the cardless system on it
- ✓ Install vcxist_x64 software before installing Xampp software
- ✓ Install xampp-windows-x64-8.0.3-0-VS16-installer on the computer
- ✓ The developed applications were kept under free website so that, download the application files from <https://files.fm/u/gvqs4qabn> link.
- ✓ Create MySQL database and import the file cardless_banking.sql to the database using Xampp Control Panel
- ✓ Develop frontend applications and interfaces using PHP, HTML and cascading style sheets (CSS) or use the current developed software by downloading from the site.
- ✓ Configure database and application ports if required or use the default ports. Use the default port number 3306 for MySQL database and add the port number 8002 to access Mobile

banking application from <http://127.0.0.1:8002/> and add 8003 to access ATM banking application from <http://127.0.0.1:8003/> sites.

- ✓ Restart Apache and MySQL services using Xampp Control Panel
- ✓ Put the developed frontend applications folders (ATMBanking and CardBanking) under C:\xampp\htdocs folder
- ✓ Copy and paste httpd-vhosts.conf to C:\xampp\apache\conf\extra\ httpd-vhosts.conf
- ✓ Copy and paste php.ini file to C:\xampp\php\ php.ini file in order to turnoff PHP warnings.
- ✓ To configure the SMS app, user need to install “SMS Gateway API_v4.1.1_apkpure.com.apk” on the Mobile to get device identification and create account on <https://msgateway.me/> using email address and password then sign in to get token identification.

5.9. Framework and Prototype Evaluation

5.9.1. Evaluation of the Framework

As stated by Petter and Khazanchi (2010), DS based framework can be evaluated using different evaluation criterions’ which includes plausibility, effectiveness, feasibility, predictively, reliability, comprehensiveness, scalability and ease of use. To evaluate the framework interview checklist were prepared based on these criterions, then IT and E-banking experts were evaluated the proposed framework. Moreover, to evaluate the framework using the evaluation criterions, “Yes” and “No” options were presented for the respondents. If the framework satisfies the criteria, the respondent tick (✓) for Yes and (X) for No (see Appendix 2), then the researcher converted the result to average percentage (Table 4).

Table 4: Framework evaluation criteria

No.	Evaluation Criteria	Description of Criteria	Of Total Respondents (%)
1.	Plausibility	Considering the current understanding of the domain	100
2.	Effectiveness	Described and understandable the root causes of the problem are identified and addressed by the recommended solutions	100
3.	Feasibility	Can be operationalized or implemented as described.	100
4.	Predictively	Produces the expected result or produces a result in the intended direction	87.5
5.	Reliability	Produces similar results regardless of the implementer or technique	100
6.	Comprehensiveness	Does the framework includes all components of the system	87.5
7.	Scalability	Shows the framework can be scaled in size, modified or not when required	100
8.	Ease of use	Describe how easily users can use the framework	100
9.	Security	Indicates the state of being free from any threat	100
Average			97.2%

According to the study of Mugisha, Nankabirwa, et.al (2019), if the average evaluation checklist value $\geq 80\%$, the system is the most usable. The average percentage of the evaluation checklist of the respondents was 97.2% which shows that the right framework was designed and proposed for cardless E-banking services (Table 4).

5.9.2. Evaluation of the Prototype

According to the study of Giakoumakis and Xylomenos (1996), a software should be evaluated and some of the evaluation criteria of the prototype shown below (Table 5). To evaluate the prototype, interview evaluation checklists were prepared and E-banking and IT experts evaluated it. The evaluation criteria and the total respondents' percentage indicated on Table 5 below. Moreover, to evaluate the prototype using the evaluation criteria, "Yes" and "No" options were presented for the respondents. If the framework satisfies the criteria, the respondent tick (✓) for

Yes and (X) for No (see Appendix 3), then the researcher converted the result to average percentage (Table 5).

Table 5: Prototype evaluation criteria

No.	Evaluation Criteria	Description of Criteria	Of Total respondents (%)
1.	Functionality	The tasks that the system must do and why the system need to be developed	100
2.	Ease of use	Describe how easily users can use the framework	100
3.	Completeness	Does the system included important modules	87.5
4.	Consistency	How much the system has uniformity and do not contradict with other systems	87.5
5.	Scalability	Shows the framework can be scaled in size, modified or not when required	100
6.	Reliability	Produces similar results regardless of the implementer or technique	100
7.	Integrity	Examines whether the system is part of a complete series of E-banking system, covering all development phases.	87.5
8.	Maintainability	Does the system can be easily modified when required	100
9.	Usability	The degree to which the system is able or fit to be used for E-banking services	100
10.	Security	Indicates the state of being free from any threat	87.5
11.	Performance	Does the system can do a task with in a given time	100
12.	Quality	How well it complies with a given design and code, based on functional requirements	100
13.	Business logic	Does business policies, procedures and rules incorporated	100
Average			96.2%

Similarly, based on the study of Mugisha, Nankabirwa, et.al (2019), if the average evaluation checklist value $\geq 80\%$, the designed software is strongly acceptable. The average percentage of the respondents on the criteria was 96.2 %. This shows that, the developed cardless E-banking services prototype was accurate and can be implemented in banking sectors (Table 5).

5.10. Discussion of Evaluation Result

According to the study of Mugisha, Nankabirwa, et.al (2019), if the average evaluation checklist value $\geq 80\%$, the system is the most usable. The average percentage value of the evaluation checklist of the respondents for the framework is 97.2% which shows that the right framework was designed and proposed for E-banking cardless services (Table 4). Similarly, the average percentage value of the respondents on the criteria for the prototype is 96.2 %. This shows that, the developed E-banking cardless services prototype was accurate and can be implemented in banking sectors (Table 5).

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

Based on the current study result and findings, the researcher can give the following major conclusions: In banking sectors, E-banking services plays a great role for the development of the bank by providing convenient, effective and efficient banking services. EATM reduces congestion of customers in bank hall. The existing carding system challenged by card expiration, lost, clone, damage, skimming, capture, dispute, additional cost of issuance and maintenance, forget wallet at home, theft, account debited without paying and long reconciliation time. From the listed challenges, card expiration, dispute, forgotten, reconciliation time, capture and PIN issues were the most critical challenges on existing ATM services.

Due to different challenges, there is very low utilization of EATM services even if huge investment were paid to acquire E-banking technologies. Therefore, to enhance utilization of EATM services, existing card based ATM services challenges were identified, analyzed and interpreted to propose and evaluate cardless E-banking services system. The cardless E-banking system allows to withdraw from ATM without the aid of any physical ATM card. It needs only the integration of Mobile and ATM banking system modules. Based on the study, the functional and nonfunctional requirements to develop E-banking cardless services framework were identified. Insert registered Mobile number, PIN, OTP and Secret Code, check the validity of registered Mobile number, PIN, OTP and Secret Code, check customer account balance, debit customer account and handle transactions and SMS notification for the beneficiary were functional requirements of the system whereas, security, ease of use, feedback for wrong entry, scalability, availability, maintainability and performance of application were nonfunctional requirements of the system.

Security also the most critical challenge on existing E-banking carding system because authentication of the customer done by only PIN but the new system uses registered Mobile number, OTP and secret code as additional security mechanisms. From Mobile banking module, OTP will be generated and SMS will be sent to the beneficiary. Similarly, on the ATM module,

user requested to enter OTP number, Secret code and Mobile number, then when the transaction become successful, account debited is notified through SMS to the account holder.

Based on the result of the framework evaluation checklist, the proposed framework fulfills plausibility, effectiveness, feasibility, predictively, reliability, comprehensiveness, scalability, ease of use and security parameters. Moreover, the developed prototype software also realized functionality, ease of use, completeness, consistency, scalability, reliability, integration, maintainability, usability, security, performance, quality and business logic metrics as prototype evaluation checklist result stated.

6.2. Recommendations

Based on the study findings, the researcher wants to recommend the following major points in relation to E-banking services:

This study identified that card based ATM E-banking services faces a lot of challenges and security issues such as ATM card damaged, expired, lost, disputed, additional cost of issuance and maintenance, customer account accessed by third parties, long reconciliation time, etc. All of these and related challenges can be overcome through the use of E-banking cardless transaction services framework proposed by the author of this research work. The researcher has given a framework for E-banking cardless transaction services that uses OTP, registered Mobile, number, PIN and secret code to make the system more secured and for access control. Due to the above challenges there is no enhanced and proper utilization of ATM services in the bank so that the researcher recommends to implement the proposed framework.

The existing carding systems seems complex and is not user friendly, so that IT experts and E-banking experts should strive more to increase the ease of use of the E-banking system and more research should be carried out on how the system could be implemented and integrated with the existing E-banking system. The researcher already developed a prototype for E-banking cardless transaction services and the framework including the prototype was evaluated as well. Full system development should be evaluated by larger group of system developers and users.

This study will have enhanced utilization of ATM services in the bank if the system fully and properly implemented in the bank. It will increase customer satisfaction and productivity of the organization in general. In E-banking system the biggest issue throughout the world is security

issues, so that Abay bank E-banking system stakeholders including IT experts, E-banking experts, security and infrastructure departments professionals should work in collaboration and they should give high attention about security issues to give stable and effective E-banking services for the customers. The bank's security reputation will play a vital role to attract new customers in the bank.

6.3. Future Research Works

The current study mainly focused on identifying, analyzing and interpreting the existing E-banking carding system then designing and evaluation of ECTS framework for Abay bank to enhance utilization of E-banking services. Actual implementation of the designed ECTS framework will be the future research work. Moreover, this study was conducted only on Abay bank but other researchers can replicate this study for other banks to increase the validity and reliability of the proposed solution. In this study, the researcher used 4-digit number for OTP and Secret code but future researchers can use alphanumeric values for OTP and Secret code to make the system more secured. Future researchers also need to add any other framework and prototype evaluation parameters apart from the evaluation parameters stated on the evaluation checklists used in this research.

7. References

- Ahmad, N., Rifien, A.A.M. and Abd Wahab, M.H., 2016, November. AES cardless automatic teller machine (ATM) biometric security system design using FPGA implementation. In *IOP conference series: materials science and engineering* (Vol. 160, No. 1, p. 012113). IOP Publishing.
- Ajayi, L.B., 2014. Effect of cashless monetary policy on Nigerian banking industry: Issues, prospects and challenges. *International Journal of Finance and Business Management Research*, 2, pp.29-41.
- Al Kilani, M. and Kobziev, V., 2016. An Overview of Research Methodology in Information System (IS). *Open Access Library Journal*, 3(11), pp.1-9.
- Auta, E.M., 2010. E-Banking in developing economy: empirical evidence from Nigeria. *Journal of applied quantitative methods*, 5(2), pp. 1-11.
- Bahl, S., 2012. E-banking: Challenges & policy implications. *International Journal of Computing & Business Research*, Vol. 1, pp.229-6166.
- Basavegowda, R.A. and Seenappa, S.H., 2014. Secret code authentication using enhanced visual cryptography. In *Emerging Research in Electronics, Computer Science and Technology* (pp. 69-76). Springer, New Delhi
- Bhosale, S.T. and Sawant, B.S., 2012. Security in e-banking via cardless biometric ATMs. *International Journal of Advanced Technology & Engineering Research*, 2(4), pp.457-462.
- Braun, V., & Clarke, V. (2012). *Thematic analysis*. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), *APA handbooks in psychology®. APA handbook of research methods in psychology, Vol. 2. Research designs: Quantitative, qualitative, neuropsychological, and biological* (p. 57–71). American Psychological Association.
- Elshalom, E., 2016, Evaluating the Impact of Information Systems in Ethiopian Commercial Banks. Master's thesis, Addis Ababa University, School of Information Science.

Getnet, W., 2017, DATA CENTER VIRTUALIZATION FRAMEWORK IN BANKING SECTOR: THE CASE OF WEGAGEN BANK S.C. Master's thesis, Addis Ababa University, School of Information Science.

Giakoumakis, E.A. and Xylomenos, G., 1996. Evaluation and selection criteria for software requirements specification standards. *Software Engineering Journal*, 11(5), pp.307-307.

Goyal, V., Pandey, U.S. and Batra, S., 2012. Mobile banking in India: Practices, challenges and security issues. *International Journal of Advanced Trends in Computer Science and Engineering*, 1(2).

Hegde, and Sharath, 2016. Cardless ATM cash withdrawal: a simple and alternate approach. *International Journal of Computer Science and Information Technologies*, 7(1), pp.126-128.

Henos, D., 2018, Challenges and Prospects of Agent Banking in Ethiopia: the case of M-BIRR and CBE-BIRR. Master's thesis, Addis Ababa University, School of Information Science.

Hertzum, M., Jørgensen, N. and Nørgaard, M., 2004. Usable security and e-banking: Ease of use vis-a-vis security. *Australasian Journal of Information Systems*, 11(2).

Hevner, A. and Chatterjee, S., 2010. Design science research in information systems. In *Design research in information systems* (pp. 9-22). Springer, Boston, MA.

Hevner, A.R., March, S.T., Park, J. and Ram, S., 2004. Design science in information systems research. *MIS quarterly*, pp.75-105.

Houde, S. and Hill, C., 1997. What do prototypes prototype? In *Handbook of human-computer interaction* (pp. 367-381). North-Holland.

<https://ethswitch.com/> , <https://psseth.com/>, <https://www.abaybank.com.et/>,

<https://msgateway.me/>

Hu, K., Ling, S., Ma, S. and Venkataraman, S., 2020. The Cardless and Cashless Future: The Rise of Mobile Payment. *Available at SSRN 3543163*.

Istrate, C.M., 2014. Cardless withdrawal system for mobile banking applications. *Journal of mobile, embedded and distributed systems*, 6(1), pp.11-16.

Iyabode,Nureni, 2015. Cardless electronic automated teller machine (EATM) with biometric authentication. *International Journal of Engineering Trends and Technology (IJETT)*, 30(1).

Jatana, R. and Uppal, R.K. eds., 2007. *E-banking in India: challenges and opportunities*. New Century Publications.

Kayanja, 2019. The Impact of Electronic Banking on Customer Satisfaction towards the Financial Institutions in Uganda: Case Study of Customers of Centenary Bank and Baclays Bank at Victoria Mall, Entebbe (Doctoral dissertation, Makerere University).

Kinsman, J.E., 2019. Cardless banking in the Nelson Mandela Metropole: A means of financial inclusion for the excluded. *Journal of Economic and Financial Sciences*, 12(1), pp.1-11.

Manala, M.M., 2018. *Adoption of e-banking amongst small, micro and medium enterprises in the City of Tshwane Metropolitan Municipality* (Doctoral dissertation).

Mehmood, N., Shah, F., Azhar, M. and Rasheed, A., 2014. The factors effecting e-banking usage in Pakistan. *Journal of Management Information System and E-commerce*, 1(1), pp.57-94.

Mindahun, D., 2016. DESIGNING A KNOWLEDGE SHARING PLATFORM FOR INTER ORGANIZATIONS: THE CASE OF ETHIOPIAN CHAMBER OF COMMERCE AND SECTORAL ASSOCIATIONS. Master's thesis, Addis Ababa University, School of Information Science.

Mugisha, A., Nankabirwa, V., Tylleskär, T. and Babic, A., 2019. A usability design checklist for Mobile electronic data capturing forms: the validation process. *BMC medical informatics and decision making*, 19(1), pp.1-11.

Nidhi, K., 2016. E-Banking in India: Challenges and Opportunities. *International Journal of Science Technology and Management*, Volume, 5.

Nowell, L.S., Norris, J.M., White, D.E. and Moules, N.J., 2017. Thematic analysis: Striving to meet the trustworthiness criteria. *International journal of qualitative methods*, 16(1), p.1609.

Offermann, P., Levina, O., Schonherr, M., & Bub, U. (2009). Outline of a design science research process. *Proceedings of the 4th International Conference on Design Science Research in Information*.

Ohki, M., Urushihara, A., Furuya, J., Kitagawa, H. and Oosawa, T., Hitachi Ltd, 1999. *Depositing, withdrawal, balance check, exchange and transfer of electronic money in automatic cash handling machine*. U.S. Patent 5,952,639.

Onodugo, I.C., 2015. Overview of electronic banking in Nigeria. *International Journal of Multidisciplinary Research and Development*, 2(7), pp.336-342.

Petter, S., Khazanchi, D. and Murphy, J.D., 2010. A design science based evaluation framework for patterns. *ACM SIGMIS Database: the DATABASE for Advances in Information Systems*, 41(3), pp.9-26.

Rizzo, C.J., Hsu, P.R.R. and Sears, M.L., Citicorp Development Center Inc, 2011. *Method and system for performing a cash transaction with a self-service financial transaction terminal*. U.S. Patent 8,065,226.

Ryan, F., Coughlan, M. and Cronin, P., 2009. Interviewing in qualitative research: The one-to-one interview. *International Journal of Therapy and Rehabilitation*, 16(6), pp.309-314.

Sekhon, H., Yap, K.B., Wong, D.H., Loh, C. and Bak, R., 2010. Offline and online banking—where to draw the line when building trust in E-banking?. *International Journal of Bank Marketing*.

Teka, B.M., 2017. Assessment of the practices and challenges of electronic banking adoption in Ethiopia. *Int J Res IT Manag*, 7, pp.82-94.

Varadarajan, R., Computer Associates Think Inc, 2011. *Cardless atm transaction method and system*. U.S. Patent Application 13/048,096.

8. Appendices

8.1. Appendix 1: Interview Questions

In order to collect the survey research data from the respondents, the researcher will use the following open-ended semi structured interview questions.

I. Interview questions for all Respondents

1. Have you used both ATM and Mobile banking services and can you tell me the duration you were using such services?
2. Are you satisfied by the current carding system and do you think that you were utilizing the ATM E-banking services properly?
3. What are the main challenges of the customers' to use E-banking services preferably ATM and Mobile banking?
4. Does your ATM card was expired and how much time and what was the impact on your E-banking services usage?
5. While using ATM E-banking services, have you got a problem of your ATM card was captured?
6. Have you lost or forgotten your ATM card at home and what was the challenges you faced?
7. Does theft taken your ATM wallet and do you heard anyone whose ATM wallet was taken by theft?
8. Do you think that the additional cost of card issuance (money and time) is fair?
9. Have you got a problem of card dispute or debiting your account without paying cash and are you satisfied by the duration of the cash reconciliation time?
10. Does your ATM card was damaged and broken and have you got any difficulty to get ATM services?
11. Have you observed any security issues on the current carding system and do you have trust to freely use the E-banking services?
12. Have you visited branches to withdraw cash even if you have ATM card? Why?
13. Do you think that there is enhanced utilization of E-banking services? Why?
14. Do you have any additional issues you want to raise about E-banking services?

II. Interview questions for IT and E-banking experts only

15. What is the current system technical problems in the existing E-banking services?
16. What solutions do you propose to resolve the current carding system problems?
17. What do you know about "E-banking cardless transaction services" and do you think that it is relevant to enhance utilization of E-banking services?
18. Do you think that if you use your mobile and integrating it with ATM, does it will be easy to use?

8.2. Appendix 2: Framework Evaluation Checklist

To evaluate the framework using the evaluation criterions, "Yes" and "No" options were presented for the respondents. If the framework satisfies the criteria, the respondent tick (√) for Yes and (X) for No

Respondent#	Plausibility	Effectiveness	Feasibility	Predictively	Reliability	Comprehensive	Scalability	Ease of use	Security
1.	√	√	√	√	√	X	√	√	√
2.	√	√	√	√	√	√	√	√	√
3.	√	√	√	√	√	√	√	√	√
4.	√	√	√	√	√	√	√	√	√
5.	√	√	√	√	√	√	√	√	√
6.	√	√	√	√	√	√	√	√	√
7.	√	√	√	√	√	√	√	√	√
8.	√	√	√	X	√	√	√	√	√

8.3. Appendix 3: Prototype Evaluation Checklist

To evaluate the prototype using the evaluation criterions, “Yes” and “No” options were presented for the respondents. If the framework satisfies the criteria, the respondent tick (√) for Yes and (X) for No

Respondent#	Functionality	Ease of use	Completeness	Consistency	Scalability	Reliability	Integration	Maintainability	Usability	Security	Performance	Quality	Business logic
1.	√	√	√	√	√	√	X	√	√	X	√	√	√
2.	√	√	√	√	√	√	√	√	√	√	√	√	√
3.	√	√	√	√	√	√	√	√	√	√	√	√	√
4.	√	√	√	√	√	√	√	√	√	√	√	√	√
5.	√	√	X	√	√	√	√	√	√	√	√	√	√
6.	√	√	√	√	√	√	√	√	√	√	√	√	√
7.	√	√	√	√	√	√	√	√	√	√	√	√	√
8.	√	√	√	X	√	√	√	√	√	√	√	√	√

8.3. Appendix 4: AAU Letter

Date: March 19, 2021

Ref No. SIS/26/2021/13

To Whom It May Concern

Subject:- Student Abebaw Teshome Abebe

Dear Sir /Madam,

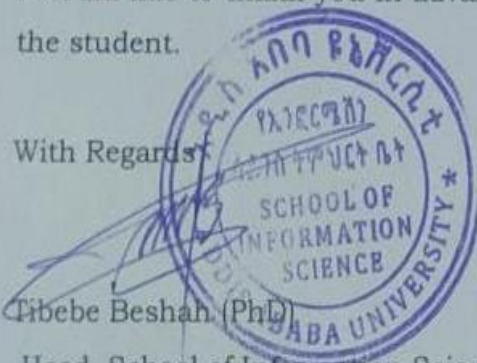
Student Abebaw Teshome Abebe (ID.No GSE/3493/11) is graduate student at the School of Information Science, Addis Ababa University. He is currently conducting a M.Sc. Thesis research under the title "Designing E-banking cradles transaction services framework for banking sectors in Ethiopia: The case of Abay Bank".

I would like to thank you in advance for all the assistance that you would provide to the student.

With Regards

Tibebe Beshah (PhD)

Head, School of Information Science



8.4. Appendix 4: SMS Gateway.me and Sample Code

```
<?php
    include "vendor/autoload.php";

    $clients = new SMSGatewayMe\Client\ClientProvider("your-token-
here");

    $sendMessageRequest = new
SMSGatewayMe\Client\Model\SendMessageRequest([
        'phoneNumber' => 'XXXXX', 'message' => 'hello world',
        'deviceId' => 1
    ]);

    $sentMessages = $clients->getMessageClient()-
>sendMessages([$sendMessageRequest]);
```

```
<?php

class sendSms{

    public function send($phone,$message){

        $clients = new
SMSGatewayMe\Client\ClientProvider("eyJ0eXAiOiJKV1QiLCJhbGciOiJIUzI1NiJ9.eyJpc3MiOiJhZG1pbilIsIm1hdCI6MTYxNzYyNTY5OSwiZXhwIjo0MTAyNDQ0ODAwLCJ1aWQiOjg4MDk4LCJyb2xlcyI6WyJST0xFX1VTRVIiXX0.l9eDxyIicyJ-APM-0XGrabxHu26Y4JgcK7LcErrNM2c");

        $sendMessageRequest = new SMSGatewayMe\Client\Model\SendMessageRequest([

            'phoneNumber' => $phone, 'message' => $message, 'deviceId' => 123930

        ]);

        $sentMessages = $clients->getMessageClient()->sendMessages([$sendMessageRequest]);

    }
}
```