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

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Abstract: E-banking cardless technologies, enable to withdraw cash from ATM without virtual or any physical card. It increases enhanced utilization of ATM banking services and improve flexibility of services to customers. The purpose of this research was to develop cardless e-banking services. The study used design Science research methodology. The study uses requirement elicitation method to identify and analyze existing system challenges then to design E-banking cardless transaction services framework. Based on the proposed framework, the software was developed that allows customer to withdraw cash from ATM machine using their mobile phone. Based on the study result, card expiration, captured, dispute and forgotten were the main challenges to the exiting ATM based banking services. All of the respondents were used Mobile and ATM services. Domain experts were evaluated both the framework and the prototype, acceptable result was found from the evaluation. The integration of ATM and Mobile banking services and the ECTS framework development can enhance utilization of E-banking services.

Introduction

Electronic banking (E-banking) is a form of banking services which is delivered through digital devices to increase flexibility in service delivery. It includes different electronic channels and E-banking services like Telephone, ATM, Mobile, Internet, Agent, etc. (Sekhon and Yap, 2010). This study predominantly focused on Mobile and ATM banking services to properly utilize E-banking services. On the existing card system, customers' information like customer account number and PIN is integrated in the ATM card using magnetic strip. This information 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. According to the report of global ATM market and forecasts to 2021, there are 4 million ATMs' around the globe even if the use of Electronic Automated Teller Machine (EATM) services has declined in recent years (atmmarketplace, 2021). In order to overcome the problem, most banks' in Ethiopia allocated more amount of currency to acquire effective E-banking. However, the existing carding system security has a lot of problems. 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 et al, 2016). The above problems can be solved by using E-banking cardless transaction services which integrates ATM and Mobile banking applications. Currently, 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). Hegde and Sharath (2016), Iyabode, Nureni, et al. (2015) and Kinsman (2019) conducted empirical researches on card based E-banking service and they found problems of ATM card expiration, lost, cloned, damaged, skimmed, captured and disputed, forgetting wallet at home, account debited without paying and long reconciliation time issues. Ahmad and Rifen (2016) proposed special biometric features (finger print and face recognition) on ATM to do cardless transaction. Development of ATM having such special features is not cost effective. This study proposed cardless cash withdrawal from normal ATM using mobile phone authentication method.

Literature Review

EATM Cardless Withdrawal: EATM is an electronic banking outlet that permits 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.

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.

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 is critical that banks should provide quality services to stay competitive through cardless ATMs'.

One Time Password (OTP) It 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.

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 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
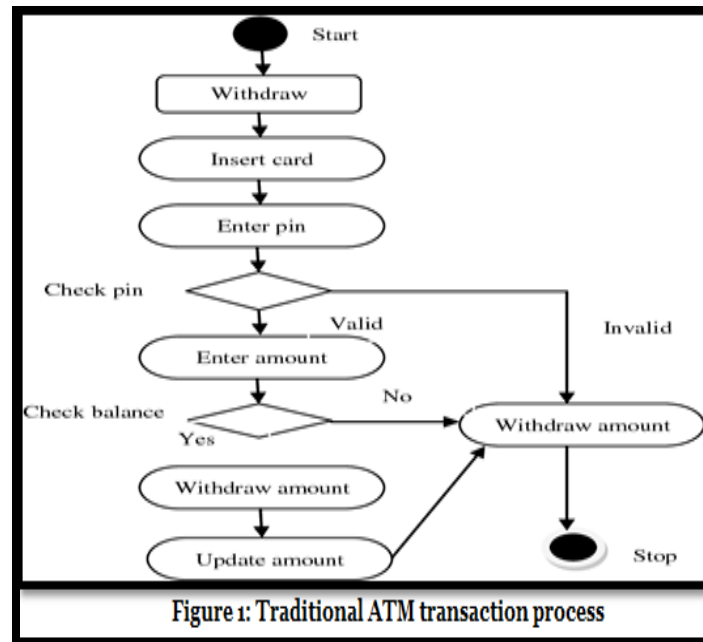
Methodology

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.

Research Approach: In this study, Design Science research approach was applied. Interview, observation and document analysis data were used for data to identify, the existing E-banking card system related problems. Additionally, Design Science research is a method used to create and evaluate new artifacts.

Research method: In order to design the proposed theoretical E-banking cardless transaction services framework, Design Science (DS) research method was used to develop the artifact. According to Hevner, et al. (2004), DS research method 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. Design uses theoretical knowledge from the knowledge base and creates new innovative artifacts which did not exist before. DS research in IT often addresses problems associated with some aspect of the design of a system. Constructing a design instantiation that automates a process demonstrates that the method can be automated (Hevner, March, et.al., 2004).

The study used the DS research process which was developed by Offermann (2009). The design process is relevant to achieve the general and specific objectives of this research and to design the required E-banking cardless transaction services framework. It has three main stages namely problem identification, solution design and evaluation. 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 card system. Therefore, to resolve all the problems related to the card system, the researcher designed and proposed E-banking cradles transaction services framework which is relevant to enhance utilization of E-banking services. Finally, the proposed framework was evaluated using different evaluation parameters. Based on the evaluation checklist (see Appendix 2 and 3), E-banking and IT experts evaluated the framework and the developed software.

Figure 2: DS research process model
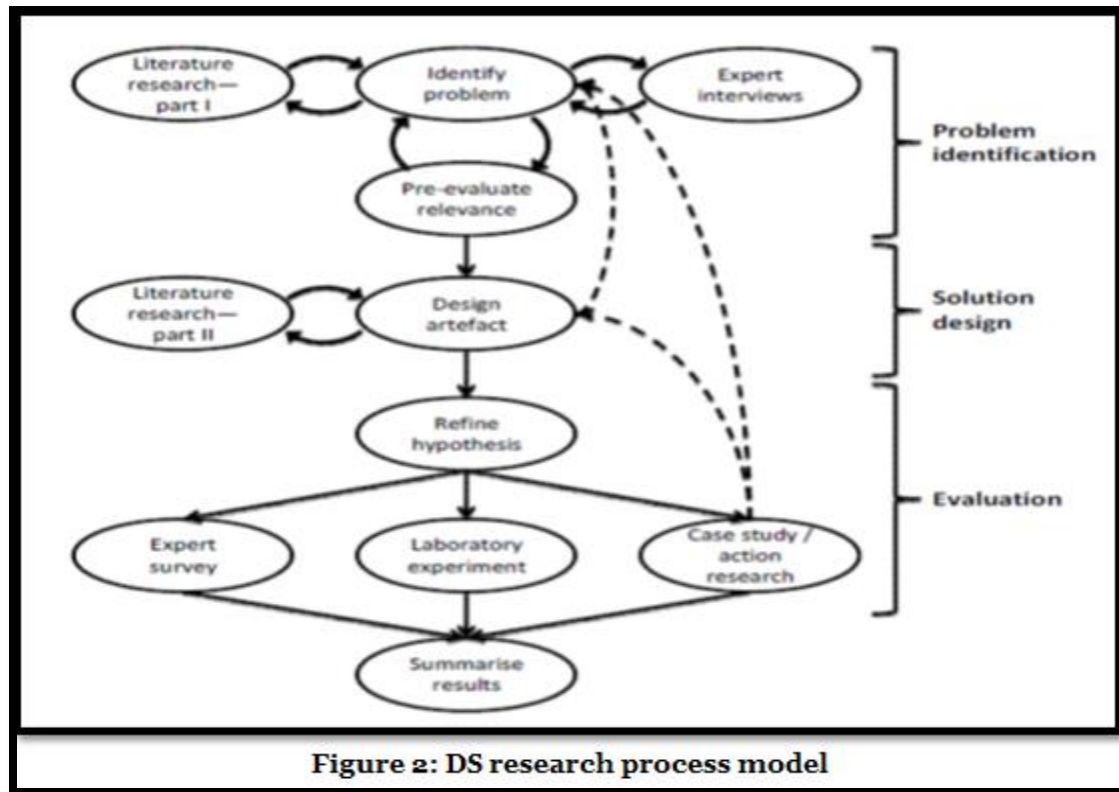
In relation to DS research process model indicated above on Figure 5, identified problems were challenges stated on statement of the problem which were related to the existing carding system. The DS research methodology mainly focused on problem identification, solution design and evaluation. The design 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.

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:

No	Respondents	Count
1	E-banking experts	5
2	IT experts	3

3	Managers	3
4	Accountants	4
5	Cashiers	3
6	Tellers	2
7	Other external Customers	3
GrandTotal		23
Table 1: Respondents' data distribution		

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.

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 should be performed to check whether if the new artifact achieves artifact development objectives. 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. 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.

Data 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 Microsoft Excel 2016 and then imported to QDA Miner lite software for analysis. The bar graph shown below in Figure 3, 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.

Figure 3: Distribution of Interview Keywords
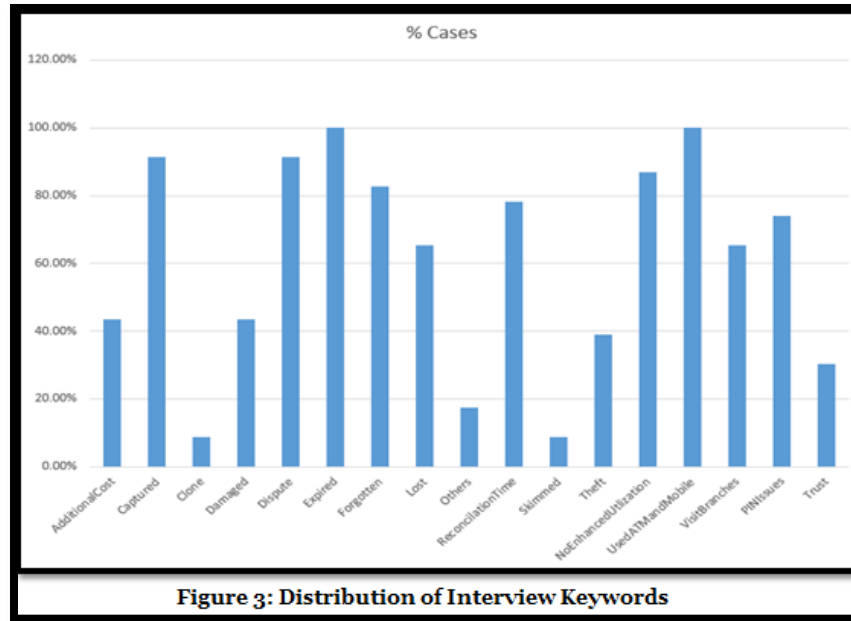
Findings: Based on the analysis, discussion and the result got from QDA Miner as shown above on the bar graph, the following were the major findings and can be summarized as stated below:

- 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.

E-banking Cardless Prototype Development

This section discusses proposed E-banking cardless framework and evaluation of the proposed framework 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.

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 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 and SMS notification for the beneficiary.

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, and Scalability, maintainability and availability of the system.

Proposed System Mobile Banking Workflow: In order to design the actual ECTS framework it is better to know how ECTS works and Figure 4 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.
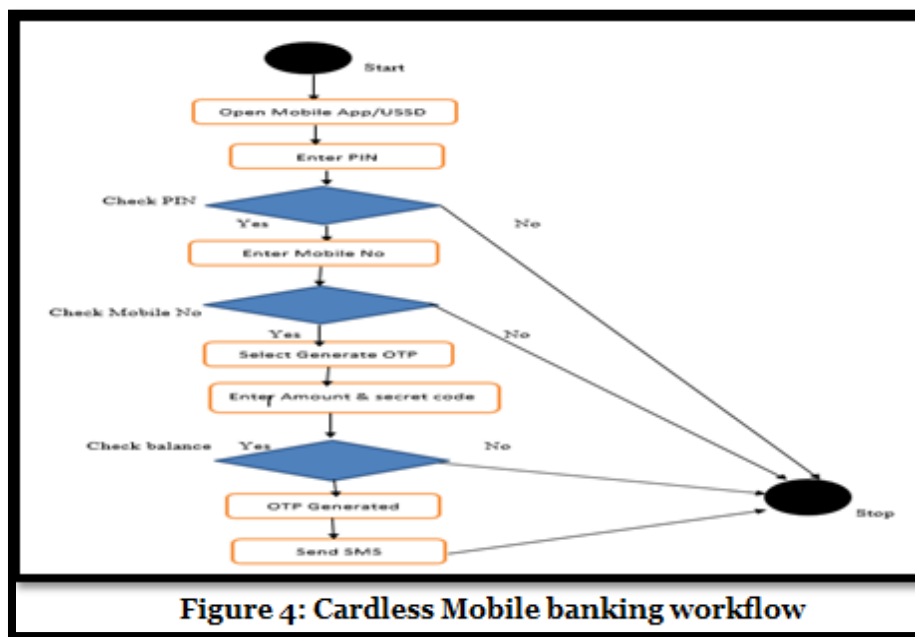

Figure 4: Cardless Mobile banking workflow

From the Mobile banking process side as indicated above on Figure 4, 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.

Proposed System ATM Banking Workflow: Similar to the steps on Mobile banking module, the following are the steps from ATM side as indicated on Figure 5. 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".
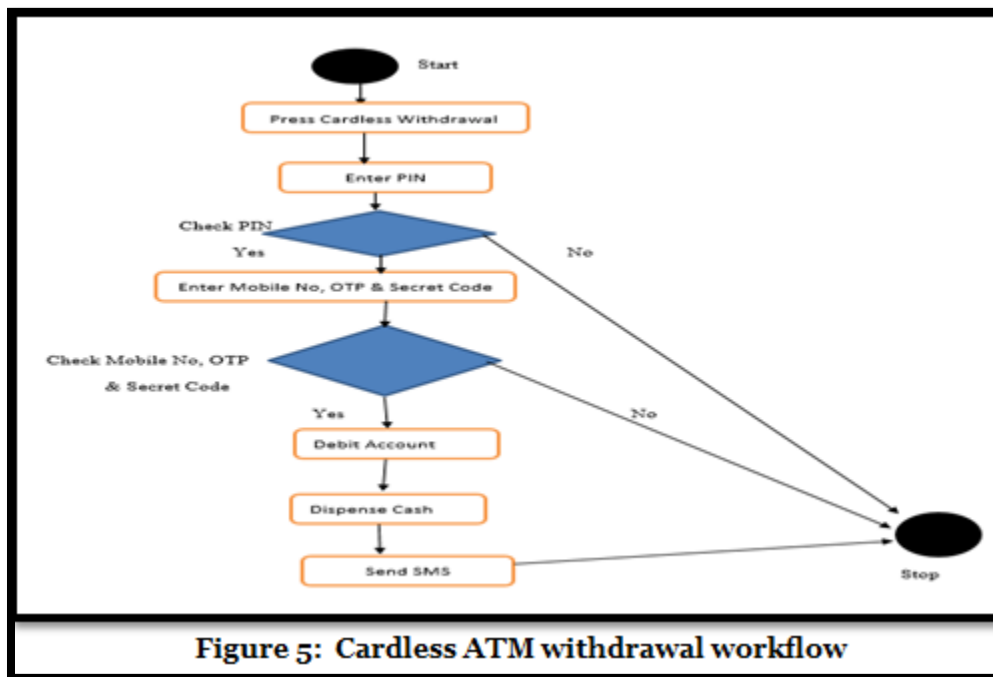

Figure 5: Cardless ATM withdrawal workflow

Proposed System 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 6).

Figure 6: Proposed ECTS Framework
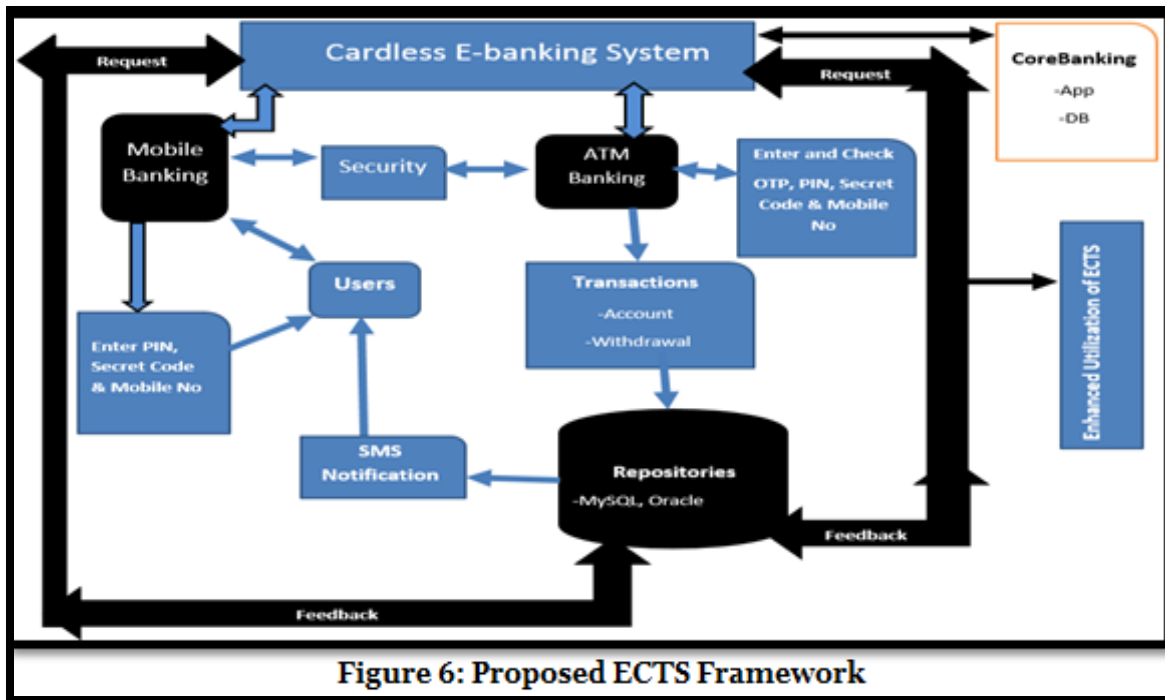
Prototyping for ECTS System: As stated by Houde (1997), prototypes are widely recognized to be a core means of exploring and expressing designs for interactive system relevant to deliver an artifact. In order to know the right framework was developed prototyping is important. The proposed prototype sample screen shots and codes from the designed sample software on Mobile and ATM banking modules are discussed in the following section.

Mobile Banking Module Screens: If the user entered valid and registered mobile number, the screen shown below on Figure 7, will be displayed.


Figure 7: 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.

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. Based on Figure 8 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.

Figure 8: Enter OTP screen on ATM
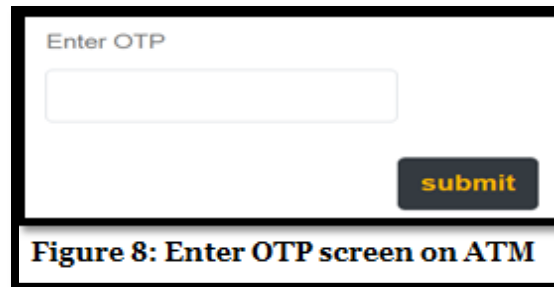
Due to security reason, the developer did not want to send the Secret code information through SMS and the simple Secret code resides on the mind of the sender. As a result, the beneficiary need to communicate the sender in order to get the right secret code that the sender already used for confirmation. As shown below on Figure 9, the system requested to enter the correct 4-digit Secret code and then press submit button.

Figure 9: Secret Code screen on ATM
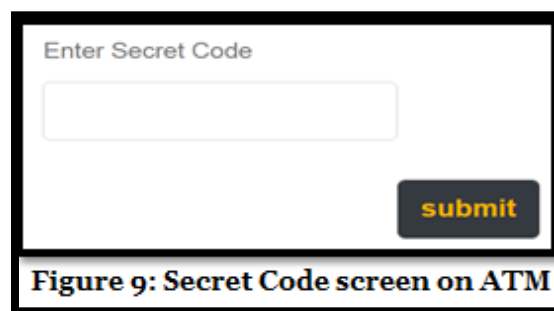
In order to complete the whole process, the user should enter valid and resisted beneficiary's Mobile number.

SMS Notifications Sample SMS: Figure 10 shown below, shows the sample SMS send to the beneficiary using the developed cardless E-banking services system.

Figure 10: Sample SMS
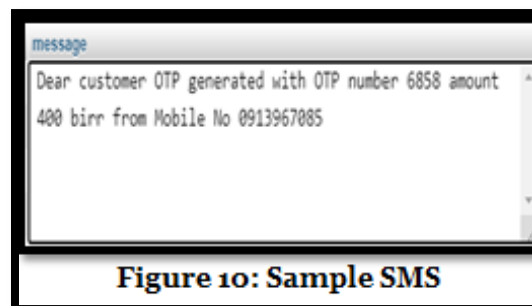
Moreover, the sample SMS code (Appendix 4) used to send SMS notification to the beneficiaries' Mobile number when OTP would be generated for the customer and when the customer account debited based on the system user request.

Framework and Prototype Evaluation: 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, ease of use and security. To evaluate the framework and prototype, interview checklist was 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, then the researcher converted the result to average percentage.

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

Conclusion

Based on the current study 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. 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 service system. The cardless E-banking system allows withdrawing cash from ATM without using 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. The main functionality of the proposed prototype is to accept registered Mobile number, PIN, OTP and Secret Code, checking 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. The system was also designed to be user friendly by having graphic interface, feedback for wrong entry, scalability, availability, maintainability and performance of application. 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.

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