Sudan University of Science & Technology

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Enhancement of ATM Withdrawal Scenario using QR-Code Technology in Sudanese Banks

تحسين خدمة السحب النقدي بالصرافات الآليه بإستخدام تقنية الـ QR-Code في البنوك السودانية

A Thesis Submitted In Partial Fulfillment Of The Requirements Of M.Sc. In Computer Science

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الآية

أعوذ بالله من الشيطان الرجيم

وَوَصَّيْنَا الْإِنسَانَ بِوَالِدَيْهِ إِحْسَانًا ۖ حَمَلَتْهُ أُمُّهُ كُرْهًا وَوَضَعَتْهُ كُرْهًا ۖ وَحَمْلُهُ وَفِصَالُهُ ثَلَاثُونَ شَهْرًا ۚ حَتَّىٰ إِذَا بَلَغَ أَشُدَّهُ وَبَلَغَ أَرْبَعِينَ سَنَةً قَالَ رَبِّ أَوْزِعْنِي أَنْ أَشْكُرَ نِعْمَتَكَ الَّتِي أَنْعَمْتَ عَلَيَّ وَعَلَىٰ وَالِدَيَّ وَأَنْ أَعْمَلَ صَالِحًا تَرْضَاهُ وَأَصْلِحْ لِي فِي ذُرِّيَّتِي ۖ إِنِّي تُبْتُ إِلَيْكَ وَإِنِّي مِنَ الْمُسْلِمِينَ

صدق الله العظيم

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Abstract

Background: Recently, with the lack of filling all the ATMs with sufficient amounts of money, the need has led to the emergence of a state of waiting for people in front of the ATMs to withdraw cash, and there are other factors that have increased the number of people, including the weak technical experience, which led to the slow process of withdrawing cash from the teller. Automated, the problem formed from the user interface responding to people who were called to find solutions to speed up the process of withdrawing cash from the ATM and reduce the number of people waiting. The subject was taken as a research problem for the study, this study was taken to solve the problem by increasing the speed of withdrawing cash from the ATM.

The method: The QR code technology was chosen and the bank card that required the presence of the person inside the ATM was chosen to deal with the mobile banking, a number of steps that took most of the time were shortened and implemented in the mobile banking while waiting at the queue, it required finding a new algorithm with time complexity Line and create a new table in the database for the joint interaction between the mobile banking, the ATM, and the third party organizing the financial process, so that the mobile reads the data within the QR Code pattern that appears on the ATM's welcome screen and uses it in the withdrawal process.

Results: A set of attempts were made as samples, which are attempts to withdrawal the money from the ATM, and it was analyzed and the average times required for the withdrawal process were calculated, A simulator was made consisting of an ATM simulator, a mobile application, and databases to simulate the algorithm that was designed, After testing the algorithm in the simulator, the result was an increase in the speed of the cash withdrawal process from the ATM four times than it was previously.

المستخلص

خلفية: في الأونة الأخيرة ومع قلة تغزية الصـــرافات الالية جميها بمبالغ مالية تكفي حاجة الناس ظهرت حالة من إصطفاف الناس امام الصرافات الالية وذلك للقيام بعملية سحب النقود كما أن هنالك عوامل اخري زادة من عدد صفوف الناس منها الخبرة التقنية المتواضـــعة التي أدت للبطئ في عملية ســـحب النقود من الصـــراف الالي هذه المشـــكلة واجهة العديد من الاشـخاص الامر الذي اسـتدعي ايجاد حلول للتسـريع من حركة سـحب النقود من الصـراف الالي و المسـاهمة في تقليل عدد صفوف الإنتظر . بالتالي تم اخذ الموضـوع كمشـكلة بحثية للدراسـة، خلال هذه الدراسـة تم الاخذ في الاعتبار حل المشكلة من خلال زيادة سرعة سحب النقود من الصاف الالي.

الطريقة: تم إختيار تقنية ال QR code و استبدال البطاقة المصرفية التي تطلب تواجد الشخص داخل الصراف الالي للتعامل بالموبايل المصـــرفي ،تم اختصـــار عدد من الخطوات التي كانت تاخذ معظم الوقت و تنفيذها بالجوال المصـــرفي اثناء الانتظار في الصـف، تطلب الامر يجاد خوارزمية جديدة ذات تعقيد زمني خطي و انشـاء جدول جديد في قاعدة البيانات للتعامل المشـــترك بين الجوال المصـــرفي و الصـــراف الالي و الطرف الثالث المنظم للعملية المالية، بحيث يقوم الجوال بقراة البيانات الموجودة داخل نمط ال QR Code الذي يظهر في الشاشة الترحيبية للصراف الالي و الاستفاده منها في عملية السحب.

النتائج: تم عمل مجموعة من المحاولات كعينات وهي محاولات لحسب النقود من الصراف الالي وتم تحليلها و حساب متوسط الأزمان الازمة لعملية الســـحب, تم عمل محاكي يتالف من محاكي لماكينة الصـــراف الالي و تطبيق للجوال و قواعد البيانات لمحاكاة الخوارزمية التي تم تصميمها, بعد إختبار الخوارزمية في جهاز المحاكاة كانت النتيجة زيادة سرعة عمل الصراف الالي اربع مرات من ما كان عليه سابقا.

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CHAPTER ONE INTRODUCTION

1.1 Background

Before few years ago to withdrawal the money should visit the banks and waiting for our turn in long queue also you should fill the required form that to complete the withdrawal process and get the cash. It was a big issue to withdrawal cash from Bank account at the peak time because a lot of time needed. Technology went ahead and a machine for withdrawing money was invented. This machine was called an ATM which gives cash from particular account using a smart card, then banks started to install ATM machines, which gives you cash from your account within few minutes without filling any form. You can even find ATM machine everywhere. But still sometimes you have to wait in the queue of ATM machine.

When performing the process of withdrawing money from the ATM, a set of steps are passed. These steps depend on its work in the ATM card that consumes time. With the increase in time, the size of the queue of people increases, As a result of the process of entering the ATM card and going through the required steps, until the money is withdrawn, usually five steps are (inserting the card - choosing the language - writing the password - choosing the type of account - choosing the amount or writing the amount and the notification and confirmation option).

These steps are about taking them right and by experienced people consuming between 40 seconds to one minute, As for when they are done by inexperienced people they consume between 90 seconds to 120 seconds and in the worst cases when they are done in the wrong way you need to re-insert the card and Going through the steps again and this consumes 3 to 4 minutes. Which leads to the slow performance of the ATM and the discontent of people which leads to the slow performance of the ATM and the discontent of people.

So all this symptom at the ***Figure 1****-1-1* bottom let issues at ATM card usage like forgot password, many option need select before withdraw that let to increase the waiting time, ATM card socket issues, customers less experience need more time, more attempt of same card let the ATM to be out of service for security reason, balance not know, lock the card and etc.

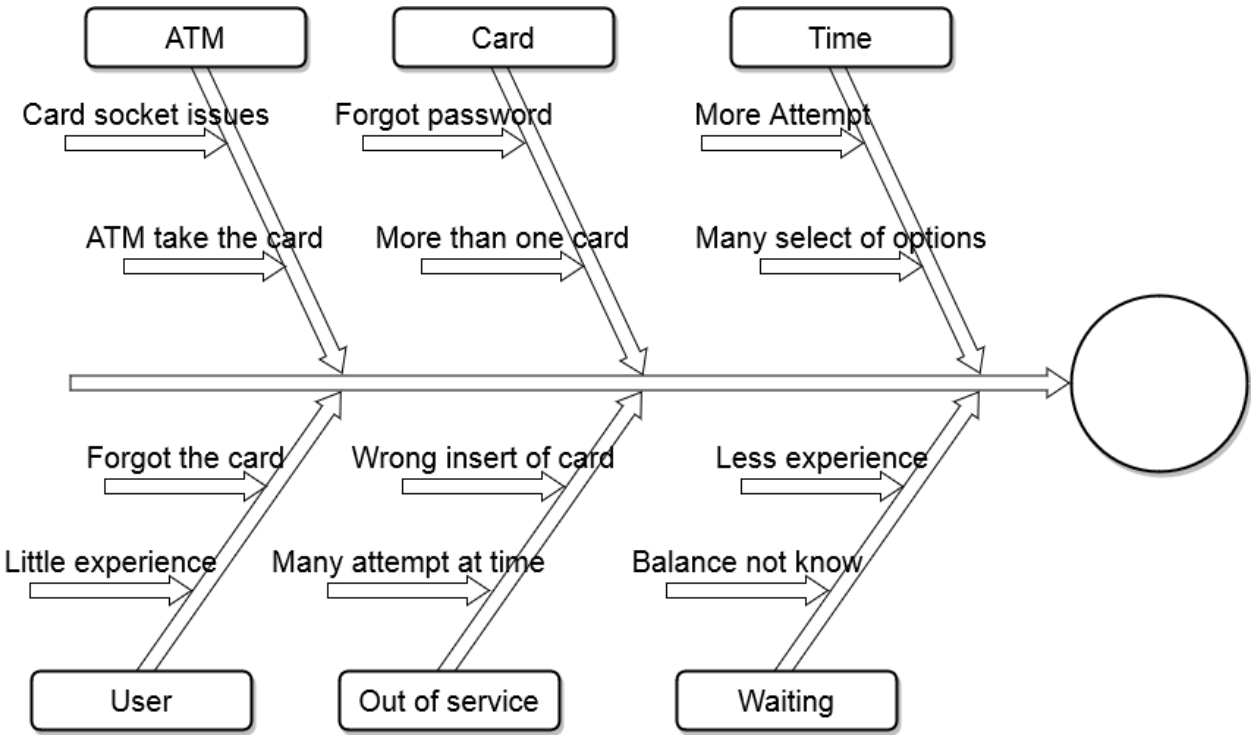

Figure 1-1-1 Fish backbone analysis for get the main issues from the symptoms

1.1.1 Automated Teller Machine (ATM)

Automated teller machines helped to reduce banking movement on bank branches through the ATM card, and with the continuous expansion and increase in the number of bank customers and bank accounts and the movement of money withdrawals, automated teller machines became a need for improvement, with the emergence of mobile banking systems generated a better opportunity for improvement and to absorb financial movements Between bank accounts, and with the increase in the demand for withdrawing money, the ATMs need to be further improved in order to perform their work better through the technologies that have emerged recently such as OTP and QR code.

An automated teller machine (ATM) is an electronic banking outlet that allows customers to complete basic transactions without the aid of a branch representative or teller. Anyone with a credit card or debit card can access cash at most ATMs. There are two primary types of ATMs. Basic units only allow customers to withdraw cash and receive updated account balances. The more complex machines accept deposits, facilitate line-of-credit payments and transfers, and access account information.

Figure 1-2 ATM Machine

Although the design of each ATM is different, they all contain the same basic parts Figure *1-2* ATM Machine

Card reader: This part reads the chip on the front of the card or the magnetic stripe on the back of the card.

Keypad: The keypad is used by the customer to input information, including personal identification number (PIN), the type of transaction required, and the amount of the transaction.

Cash dispenser: Bills are dispensed through a slot in the machine, which is connected to a safe at the bottom of the machine.

Printer: If required, consumers can request receipts that are printed here. The receipt records the type of transaction, the amount, and the account balance.

Screen: The ATM issues prompts that guide the consumer through the process of executing the transaction. Information is also transmitted on the screen, such as account information and balances (Cooharojananone, Taohai and Phimoltares, 2010).

1.1.2 ATM Card

Payment card or dedicated payment card that issued by a financial institution which enables a customer to access automated teller machines (ATMs). ATM cards are payment card size and style plastic cards with a magnetic stripe or a plastic smart card with a chip that contains a unique card number and some security information such as an expiration date ATM cards are known by a variety of names such as bank card, look at Figure 1-3 ATM Card.

Figure 1-3 ATM *Card*

1.1.3 One-Time Password (OTP)

A generated password that is used one time only valid for specific time also is randomly generated and cannot be used more than one time (Bansal and Singla, 2016).

1.1.4 Mobile Banking

A service provided by a bank or other financial institution that allows its customers to conduct financial transactions remotely using a mobile device such as a smartphone or tablet. Unlike the related internet banking it uses software, usually called an app, provided by the financial institution for the purpose. Mobile banking is dependent on the availability of an internet or data connection

to the mobile device. Transactions through mobile banking depend on the features of the mobile banking app provided and typically includes obtaining account balances and lists of latest transactions, electronic bill payments, remote check deposits, P2P payments, and funds transfers between a customer's or another's accounts (Bansal and Singla, 2016). Mobile banking in Sudan can found in many bank with different name, some of this like FAWARY from Faisal Islamic Bank, BANKAK from Bank of Khartoum, O-CASH from Omdurman National Bank and PayChat.

1.1.5 Mobile Banking PIN

Password required to start the Mobile banking application, before starting the process of cash withdrawal (Bansal and Singla, 2016).

1.1.6 Electronic Banking Services (EBS)

EBS Cooperates a centrally managed an integrated E. Payment network, under the control of the Central Bank of Sudan. Furthermore, it owns an integrated infrastructure that allow business opportunities to both public and private banking sectors, besides, offering projects and proposals which are keeping pace with the latest E. Payment solutions.

1.1.7 Quick Response Code (QR-code)

A type of matrix barcode, QR codes often contain data for a locator, identifier, or tracker that points to a website or application. A QR code uses four standardized encoding modes (numeric, alphanumeric, byte/binary, and kanji) to store data efficiently; extensions may also be used look at Figure *1-4* QR-Code.

Figure 1-4 QR-Code

The Quick Response system became popular outside the automotive industry due to its fast readability and greater storage capacity compared to standard UPC barcodes. Applications include product tracking, item identification, time tracking, document management, and general marketing. QR code is applied in different application streams related to marketing, security, academics etc. and gain popularity at a really high pace. Day by day more people are getting aware of this technology and use it accordingly. The popularity of QR code grows rapidly with the growth of smartphone users and thus the QR code is rapidly arriving at high levels of acceptance worldwide (Tiwari, 2017).

1.2 Statement of the Problem

Reducing the time taken in the process of withdrawing money from the ATM to solve the problem of people overcrowding at ATMs.

1.3 Objectives of the Research

The main objective of this research is to enhance the performance of the ATM system, the sub objective of this research can be highlights as follow.

1. Enhancement & simplify withdrawal process.
2. Avoiding misuse of card by using mobile banking.
3. Improvement the level of security.

1.4 Scope of the Research

This research can be applied to the following scope:

This study was applied within a geographical boundary that does not go beyond the country of Sudan also can applied at financial institutions like Bank of Sudan and All banks that has integrated system with EBS and ATM machine that has Mobile Banking applications, And all Sudanese ATM Machine Company as general.

The temporal scope of this study are from date of study until the emergence of a better new technology.

1.5 Significance of the Research

This study expect to speed up the cash withdrawal process, reduce the number of people queues at ATMs, and increase the level of safety. Also expect to be introduction of new technology on automated teller systems.

1.6 Research methodology

In this study can a verity task that can grouped into five basic steps:

The first step: Collect all required data then studying it and extracting the important points such as (how the ATM works? and the programming libraries that can be included in the study).

The second step: Utilizing the obtained data to analyze the general idea of whether this study can applicable or not.

The third step: Develop the algorithm required to reduce the time taken for the process of withdrawing money from the ATM and devising a way to shorten the current many steps to withdrawal money through the ATM card.

Fourth step: Make a simulation of an automated teller machine that simulates the algorithm.

The last step: testing the algorithm and obtaining the results and comparing them with the previous results in the withdrawal via the bank card.

1.7 Structure of the Thesis

The organization of my research it will be according to the following

Chapter 1: Present introduction about the topic and background also explain the problem statement and the objective of the research and provide proposal solution to this problem and determine the scope of study and expected contributed from this research.

Chapter 2: Content the details of background and discuss the related work that was exposed to.

Chapter 3: Discuss methodology and approaches that was adopted.

Chapter 4: Explains the case study of research.

Chapter 5: Content the findings in this research.

Chapter 6: Content the conclusion and future recommendations.

CHAPTER TWO Literature Review

2.1 Introduction

This chapter mention the previous studies related to the process of withdrawing money from ATMs, and present a set of comparisons and tables between these related studies. Also mention the most important features between each of them.

2.2 Related work

Study 1: Bansal Nischal & Singla Nepali proposed to improve the service of ATM cash withdrawal in less time with more level of security. Their research is to combine the ATM & Mobile banking to reduce the time of withdrawal money from ATM with increasing level of security by adding a new feature in the Mobile banking. There is no change required to the existing system but some addition required, which makes no impact on existing system. This research, which will increase the speed of cash withdrawal almost 3 times fast; could have positive impact on the customer's satisfaction, if proper functioning is ensured by the banks. The research can be used by banks to improve the services of ATM and can enhance the overall satisfaction of their customers & save cost for new ATMs. The study success to save customer time at front of the ATM and to increase the accuracy and to make system more secure by adding OTP technology, three level of security PIN and OTP and ATM Card, also not needed ATM Card PIN. But still cash withdraw is complexity and ATM Card is required if you forget? It's cannot get cash withdraw, also the time to enter OTP calculated in mind. (Bansal and Singla, 2016)

Study 2: Raid Mohsen Alhazmi proposed payment method through the mobile application without need of using the ATM bank card or credit card directly with POS he propose at his research to design a POS Debt System that is to return the complete or partial of the remaining funds from the businesses POS System to the customer's mobile phone account. The POS debt system scans the account on the customer's phone that displays a QR that is produced by a Telecom Company,

which then returns the balance. The customer gets an SMS that has a One-Time Password to verify that there is a debt from the business store via POS system. The customer then inserts the One-Time Password to the POS system to complete the return debt. Once the correct password is given, the POS system directly returns the balance to the customer's account. Lastly, the customers will receive a verification SMS to his/her mobile phone account to complete the process on their account. The good point at this study is used mobile application and explain the importance of the mobile application and the speed of its growth, also using QR Code technology to communicate data between customer and POS debit also increase the security by OTP technology, also he success avoid using ATM Card But he did not mention the queues for the payment process, as the payment process is somewhat complicated Therefore, it's not believe that it is a practical method at the present time and needs more research. (Alhazmi, 2020)

Study 3: Al Imran proposed model for Card less transaction and withdraw which use Bank PIN and One Time Password technology to verify the transaction, when need to do transaction at ATM first must press card less transaction then press withdrawal then enter amount at this point more process will done to verify OTP and dispense cash. This method is good because it is simple and does not require an ATM card, but it needs many changes to the ATM system, in addition to the way it is rebuilt on payment network methodology. (Imran, 2019)

Study 4: Munadi & Irawan and Romiadi proposed to use an encrypted smart card as an access card and dynamic PIN in the form of One- Time Passcode (OTP). This OTP PIN can only be used once in the PIN authentication process in this method the customer will receive the OTP in the Mobile banking. The disadvantage of this system is that it increases the time of executing operations. (Munadi, Irawan and Romiadi, 2019)

Study 5: Patil Rahul & Salunke Sagar & Lomte Rajesh and Kalbhor Madhura proposed system combining the ATM and mobile banking and minimizes the time of withdrawing cash from ATM. This will increase the speed of transaction almost three times fast; could have excellent impact on

customer's satisfaction. With the help of QR code information get encrypted so it also increases security, Proposed System will consist android application and QR code scanner in the ATM system. (Patil, 2019)

Study 5: Wang, Y. et al. (2018) proposed to enhance the security of QR code data by explicit graphic QR code and embedded the implicit QR code using infrared watermarking, the implicit QR code still can be successfully decoded under infrared detection. This solution is useful in this research to increase security level.

Study 6: Chen, C. T. C. (2012) proposed solution to increase security level in transaction process in mobile banking throw OTP, this OTP generated after any transaction by server side to confirm the process, the researcher not proposed solution for delaying time at OTP, to take advantages of this proposed solution can embedded the account ID, OTP and all information at the QR code graph. In addition to embedded information at QR code graph can avoid the delay of OTP process between the two side mobile banking and server side.

Study 7: Soares, J. and Gaikwad, A. N. (2016) & Banerjee, I. et al. (2019) proposed system to the security level by use finger print and iris recognition with OTP, the researcher in this study focus in security only and does not take the delay time or the cost of add the new machine part to the ATM, so this study is hard to applied in Sudan because more expensive.

Study 8: Abraham, A. and Poly, A. (2017) proposed Secure PIN Authentication using QR code and ensures the security of ATM transactions by making use of a three-level verification. Since is based on one-time PIN. The study not discuss withdrawal process but its success to process simply and fast.

Researchers	Technologies	Good point	Bad point
(Bansal and Singla, 2016)	– Mobile Banking – OTP – Mobile PIN	• Don't need ATM card PIN. • Save customer time at front of the ATM. • Three level of security. • Decrease waiting queue. • Transaction expiry. • OTP Attempt.	• Complexity. • ATM Card is required. • Time to OTP Attempt is adding to time for waiting queue.
(Alhazmi, 2020)	– Mobile Application – OTP – QR Code – SMS	• Payment details by SMS. • Using QR Code to encode customer account. • ATM Card less.	• Complexity. • More time needed than ATM Card.
(Imran, 2019)	– OTP – Bank PIN – PIN – SMS – Payment network	• Card less transaction. • Avoid using biometrics. • Easy and convenient process.	• More waiting time to receiving SMS message and to enter OTP. • Need major changing at ATM System software. • Depend on payment network
(Munadi, Irawan and Romiadi, 2019)	– OTP – PIN – Smart Card. – CSPRNG-SHA1-MWC algorithm. – Mobile Banking. – Amazon Web Services (AWS) services.	• Increase the security level.	• Increase the process complexity. • More time needed to receive OTP in Mobile Banking. • CSPRNG-SHA1-MWC algorithm increase the process time.
Patil Rahul & Salunke Sagar & Lomte Rajesh and Kalbhor Madhura in (Patil, 2019)	– QR code. – Mobile Application. – ATM PIN.	• Minimizes cash withdrawal time. • Security Enhancement.	• QR code. Scanner need to be installed in the ATM machine. • ATM Card number is required.
Chen, C. T. C. (2012)	– OTP – Mobile Banking	• Increase the security level.	• Not solve the delay issue at using OTP.

Soares, J. and Gaikwad, A. N. (2016)	– Finger print – Iris recognition – GSM – OTP	• Increase the security level by using the bio metrics. • Avoid using ATM card.	• Has delay time at transaction process. • Has delay time to receive OTP in the mobile. • More expensive.
Abraham, A. and Poly, A. (2017)	– QR code – PIN – Mobile Banking	• Simplify • Can applied at Sudan	• The time delay to send the PIN. • Not discuss withdrawal process.

Table 2.1 Discuss of related work

2.3 Summary of Related Work

Through the analysis of previous studies, it was found that the studies (1, 2, and 4) cannot be used to reduce the time of the money withdrawal process because it contains a complexity rate, unlike the method used. Also, it is not possible to benefit from the study (3, 5) because it did not care about the withdrawal time, and adding other operations led to an increasing in the withdrawal time. The studies (6 and 7) discuss the security issues but in hard to applied at Sudan because expensive and not solved the delaying time at withdrawal process. The study (8) the best way to applied at Sudan ATMs because simplify and cheaper than other and not need change at ATM structure. Look at Table *2.2* Summary of related work

According to the related researches in the past, only the QR-code technology can used because its simplicity and speed at using in data transfer and OTP in allocating a unique code for each withdrawal process and mobile banking technology in connecting all components.

The study	Simplified?	Required ATM structure change?	Security levels?	Expensive?	Save the time?	Can applied at Sudan ATM's
1	No	No	Four levels	No	No	Yes
2	No	No	Five levels	No	No	Yes
2	No	Yes	Five levels	Yes	No	No
3	No	No	Five levels	No	No	Yes
4	Yes	Yes	Four levels	Yes	Yes	No
5	Yes	No	Three levels	No	No	Yes
7	Yes	Yes	Four levels	Yes	No	No
8	Yes	No	Three levels	No	No	Yes

Table 2.2 Summary of related work

CHAPTER THREE Research Methodology

3.1 Introduction

This chapter discuss the research methodology which involve the QR code technology and explain the components that connected together also explain the instrumentation needed to the research and the assumptions & Limitations of the research finally discuss the withdrawal scenario.

3.2 QR Code Alternative to OTP

This research use QR code alternative to OTP and take advantages & features of QR code in validation to transfer the data between the two devices (ATM & Mobile banking application). Also adopted of security verification at mobile banking application so much. With QR code no need to use ATM card so can prevent ATM card cons like card lost at the ATM, forget the password, card expiration and scratch or damage to the card.

In mobile banking application the user must login and authorized, from list of service he select cash withdrawal after that enter the amount need to cash out the application shall open the camera to scan the QR code at ATM, At another ATM main screen has QR code content all information needed to compete transaction between EBS system and bank system, when user scan the QR code at ATM the process in ATM will start to decrement customer balance and cash out. To do that needed many component run together as one system, this component most communicating fast to reach the required speed level to reduce the time taken to withdraw money as possible.

3.3 Transaction & the synchronization

Transfer refers to the process of transferring money from one account to another. When the customer withdraws an amount from his account, the amount is deducted from the core bank database and transferred to the host's database or what is called an ATM controller. An ATM code

is sent to ensure that the operation was completed from during the relevant ATM; the ATM deducts the amount from the host's database and then withdraws the money. These operations take place simultaneously between the bank's database, the host and the ATM, so that if the transfer fails at one of the parties, a back-to-back process is carried out and canceled the operation.

3.4 ATM Machine

The automated teller machines that are currently operating belong to NCR Company, and this company provides the necessary technical support to the national entities dealing with it, so ATM machine is a hardware and such aspects of programming falls under embedded system programming, The coding used in ATMC is Pro*C. Banks maintains a modules called ATMC (ATM Controller) as server for responding to requests sent by the ATM, The Pro*C/C++ programming tool enables you to embed Structured Query Language (SQL) statements in a C or C++ program, the Pro*C/C++ precompile translates these statements into standard Oracle runtime library calls, then generates a modified source program that you can compile, link, and run in the usual way. Unfortunately ATM machine don't require any data structure to dispatch money or to swipe a card, it's just like a web page for front end where you have to provide some information as password and some other information to get your work done .System will verify your card information by connecting to their server. The ATM machine is like desktop computers its run with Windows 7 embedded or Windows 10 IoT Older ATMS use XP embedded.

3.5 NCR Company

NCR Corporation, previously known as National Cash Register, is an American software, managed and professional services, consulting and Technology Company that also makes self-service kiosks, point-of-sale terminals, automated teller machines, check processing systems, and barcode scanners, NCR is the world leader in the production and supply of ATMs. NCR's solutions for ATM networks and self-service systems provide our customers with competitive advantages in various areas of their business. It is considered a leading company in banking and commerce solutions and ATM.

3.6 ATM SDK

It is the operational and programming environment for the automated teller components that contains all the environment, software libraries, user interfaces and a special ATM emulator, each ATM Company has its own SDK. The SDK programs that work for the NCR Company operating in Sudan are programmed in the C language and come fully integrated.

3.7 ATM controller/host

Is a system used in financial institutions to route financial transactions between ATMs, core banking systems and other banks, An ATM controller is key infrastructure in an interbank network.

3.8 How ATM work

When a cardholder wants to do an ATM transaction, he or she provides the necessary information by means of the card reader and keypad. The ATM forwards this information to the host processor, which routes the transaction request to the cardholder's bank or the institution that issued the card. If the cardholder is requesting cash, the host processor causes an electronic funds transfer to take place from the customer's bank account to the host processor's account. Once the funds are transferred to the host processor's bank account, the processor sends an approval code to the ATM authorizing the machine to dispense the cash.

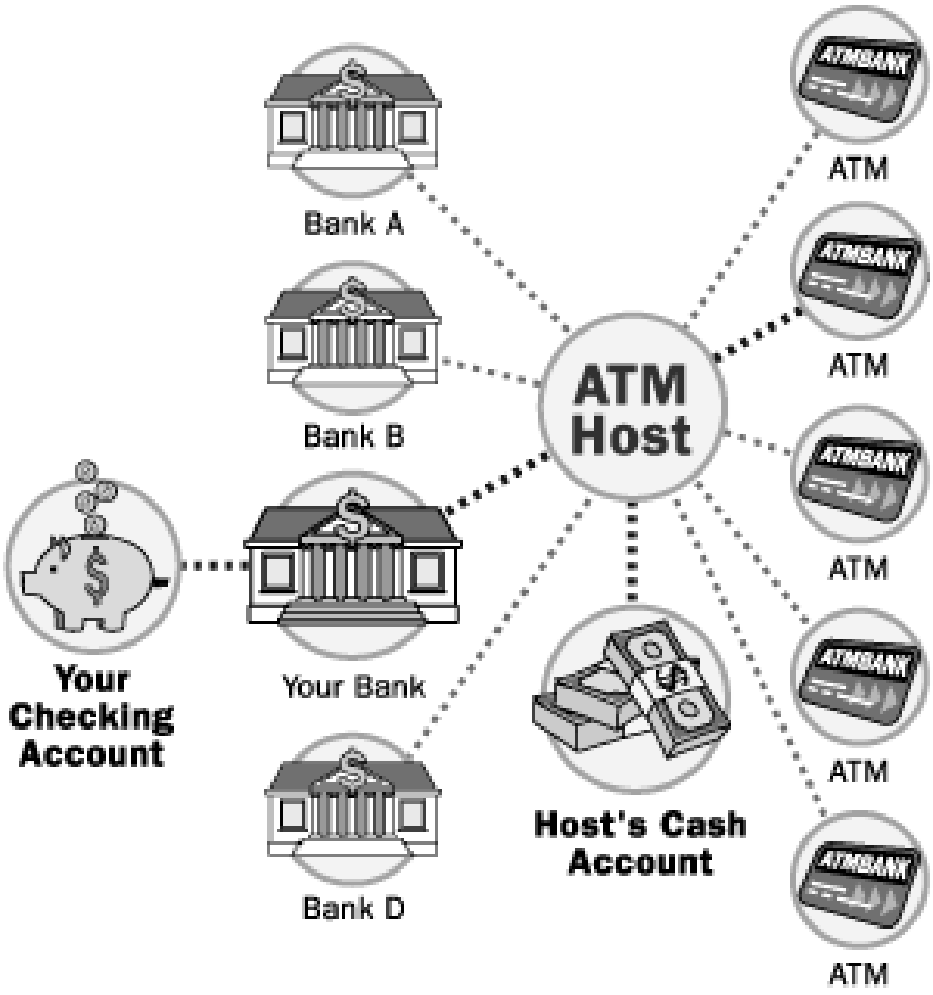

Figure 3-1 How ATM work

3.9 Mobile Application

On the mobile side, there must be a bank application that can be done within this process, and an option must be added to withdraw money to appear to the customer in the application. This option needs an API in the bank's server to complete the process through it; the QR code reader will be dealt with through a library it is called (ZXing) it says by reading the QR code from the phone's camera. The library also decodes the QR code and extracts the number of the exchange process in the database.

3.10 QR code Library (ZXing)

ZXing is an android library projects, this research used me.dm7.barcodescanner:zxing:1.9.13 library under ZXing that provides easy to use and extensible Barcode Scanner views to read the QR code, this library supported by Google, must add camera permission to be able to use the library, it as advance feature to use it with fragments. This library support 16 format.

Format name	**Description**
EAN8	International Article Number 8 digit
UPCE	The Universal Product Code 6 numeric digits
ISBN10	The International Standard Book Number 10 digit
UPCA	The Universal Product Code 12 numeric digits
EAN13	The International Article Number 13 digit
ISBN13	The International Standard Book Number 13 digit
I25	Interleaved 2 of 5 with check digits
DATABAR	Include the Omnidirectional and Expanded codes 14 digit
CODABAR	8 digit
CODE39	Symbology is also alphanumeric, numeric and character
PDF417	Contain the same number of data code words
QR_CODE	Quick Response content all varchar
CODE93	Symbology designed 10 digits and 7 special characters
CODE128	It is used for alphanumeric or numeric-only barcodes. It can encode all 128 characters of ASCII

Table 3.1 ZXing supported formats

3.11 Instrumentation

The devices required in this research consist of

1. Smart phone
2. A personal computer to carry out the development process
3. ATM machine
4. ATM host or the so-called ATM controller
5. A host for the core bank database

As for the case that these devices are not available, these five devices can be simulated

1. Smart phone
2. Personal computer for development
3. Simulator for cashier inside a personal computer
4. An emulator for a ATM host or what is called a ATM controller
5. A host for the core bank database

3.12 Tools

A simulator will be created to fully simulate the scenario, the tool that was used in programming the simulator for the ATM is the programming language VB.NET. As for the mobile banking application, it was programmed through the Android Studio tool by JAVA programming language. Apache was used to run the API that links the previous components together. The API was also programmed using the PHP language. Below is a detailed table of the versions of the tools that were used. Look at *Table 3.2 Tools*

Tool	**Version**	**Used For?**
VB.NET	2015	Simulator
Android Studio	2.1.2	Mobile Banking Application
PHP	5.6.3	API
MySQL	5.0.11	Core bank & Mobile Bank database
Apache	2.4.10	To run the API

Table 3.2 Tools

3.13 The Withdrawal Scenario

In the automated teller machine, before entering the person, the screen is been ready. In this situation, a new record is created in the ATM Host database. This record contains the transaction code, bank number, ATM number, and the QR-Code generated from a function within the ATM program. It also contains the creation date and a field to check the status of the transaction, whether it is completed or not? Look at Figure *6-3* ATM Simulator - Welcome Screen with QR-Code

When opening the mobile banking application, the bank account number and password are entered on the login page look at Figure *6-6* Mobile Banking - Login Screen. You will be transferred to the main page that contains the account statement and a new option (withdrawal money). When press the option (withdrawal money) look at Figure *6-7* Mobile Banking - Main Page Screen, a screen appears containing a field to write the amount to be withdrawn. The API communicates with the bank's database and finds out whether the account contains this amount or not? After that, the application opens the camera and is ready to scan the QR-Code, which contains all the necessary data such as the transaction number, the process code, the expiry date, etc. After scanning the code and taking the data, the application updates the previous active record that was generated by the ATM in the ATM Host database, and the values to be added are the account number, amount, and withdrawal date look at Figure *6-9* Mobile Banking - Withdrawal Amount.

After that, the ATM reads the new values from the same active record, and then obtains the required amount to be withdrawn and the account number from which the debit is to be taken. The teller sends the data to the API that deducts the amount from the customer's account, then the ATM extracts the money and updates the status of the active record in the database from (incomplete) to (complete) look at Figure *6-5* ATM Simulator - Withdrawal Process is done.

Finally, the application shows a notification that the withdrawal process has been completed successfully, as well as the ATM look at Figure *6-11* Mobile Banking - Withdrawal Process is done

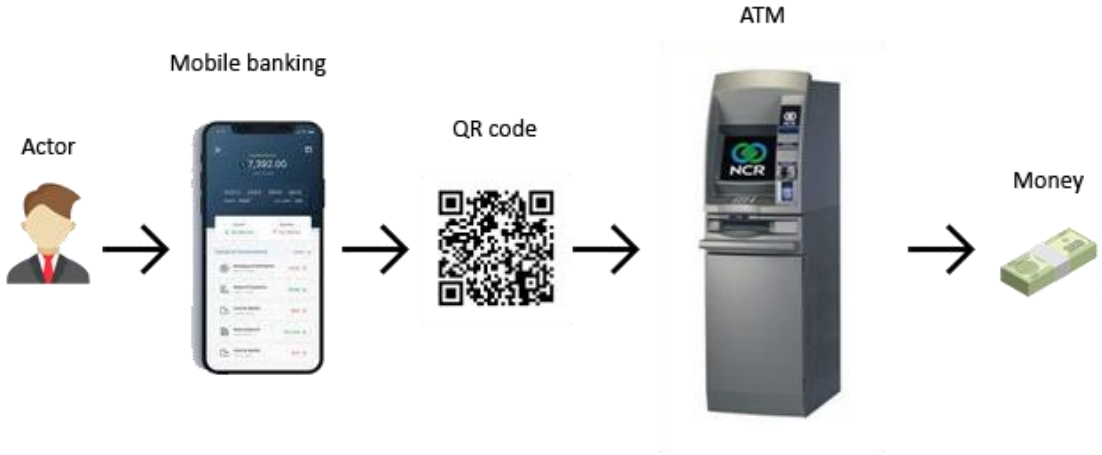

Figure 3-2 the scenario of withdrawal process

3.14 Security levels

According to this research mythology can category the security into three levels, each level content technic work overlapping with other levels to produces degree of protection can be reliable. Look Figure *3-3* Three level of security

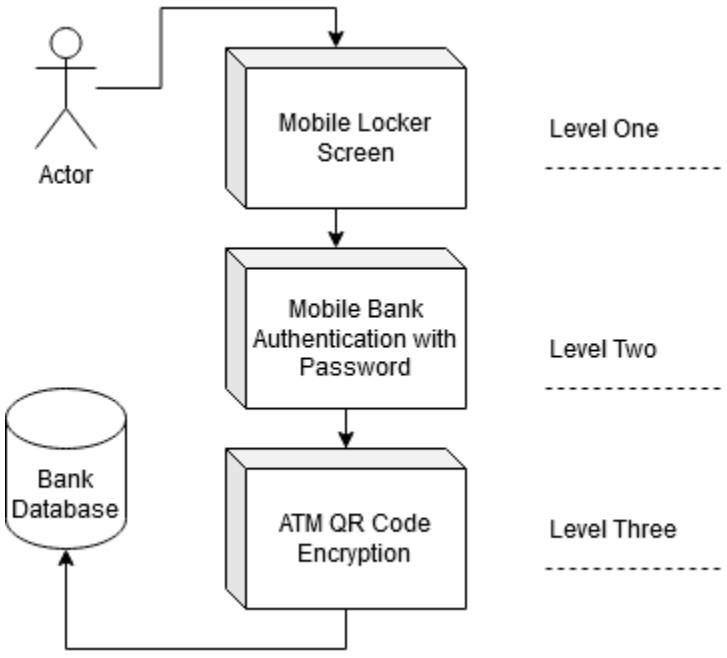

Figure 3-3 Three level of security

3.14.1 Mobile level

This level include mobile lock screen & biometric authentication (finger print or face recognition) and application locker example (AppLock & Norton App Lock & LOCKit and Privacy Knight), also new smart mobile support finger print and face recognition for more security. This level depends on parson awareness.

3.14.2 Mobile bank level

This level include mobile bank authentication which involve bank account ID and password and IEMI of mobile frame also each transaction to complete depends on the password. According to study proposed by Nosrati, L. (2015) should use channel manager which is middle-ware software to integrate Internet Banking, and Mobile Banking to core banking solution has been selected. Channel Manager provides an API in form of web services to handle transactions or queries expected from Internet Banking, and Mobile Banking. Requests. In this research use channel manager or API to separate the mobile database process from core banking process to avoid DDOS attack and increase the security level, the API simulated at APACHE tool developed by PHP language. Also there is absolutely no need to carry the ATM card for authentication. Once connected to the network, the user can login to the app using his username and the password generated. Upon successful login, he can scan the QR code generated on the ATM screen. Abraham, A. and Poly, A. (2017)

3.14.3 ATM level

This level include the QR code encryption which involve OTP & ATM ID & Expired date, also the protected level of encrypted graph can increased by mirage watermark graph and logo and QR code together but cannot use colored graph because the color increase the capacity Taveerad, N. (2015). Also QR code can protected from Brute force attach Kurita, S. (2012)

3.15 Assumptions and Limitations

In conducting this study the following assumptions were made. It was assumed that:

1. The technology that was used will elicit a response from the banking community
2. The technology involved in the research will be bank customer
3. The theoretical study of the research is accurate and identical to the actual reality, and the results are limited to the accuracy of this theoretical study
4. The methodology is suitable for the problem under study because it includes a business process analysis and a time complexity analysis of the algorithm
5. The simulation process is very suitable for the expensive and difficult to obtain banking devices

The following limitations are facing in research:

1. The implementation of this research is restricted to financial institutions, banks, and government agencies
2. It requires stable internet networks to function better
3. QR code technology is not popular in use in this country, it requires people well-educated in it to maintain it
4. The implementation of this study needs to provide devices that individuals cannot own
5. The implementation of this study needs a supportive banking side

3.16 SWOT Analysis

The analyze of strengths, weaknesses, opportunities, risks, and outputs as follows

STRENGTHS	**WEAKNESSES**
The strengths of this research are: 1. Facilitates the process of withdrawing money 2. Reducing the queues in front of the ATM 3. gain time 4. The introduction of a new technology on the automated teller system 5. Reducing the problems of bank cards such as losing the password, losing the card, withdrawing the card by the cashier and others	The weaknesses of this research are: 1. The implementation of this research is restricted to financial institutions, banks, and government agencies 2. It requires stable internet networks to function better 3. QR code technology is not popular in use in this country, it requires people well-educated in it to maintain it 4. The implementation of this study needs to provide devices that individuals cannot own 5. The implementation of this study needs a supportive banking side 6. Requires education level and good technical education
OPPORTUNITIES	**THREATS**
The opportunities of this research are: 1. Developing and increasing the users of bank financial mobile applications 2. Dealing with newer technologies 3. Improving banks' financial technologies 4. Contribute to the development of society technically	The threats of this research are: 1. Loss of the network when completely relying on the mobile app instead of the card 2. Poor mobile app security may lead to bank breaches 3. Poor application of the research and misuse of it by the customer may reflect a bad idea about the technology

Table 3.3 SWOT Analysis

CHAPTER FOUR ANALYSIS AND DESIGN

4.1 Introduction

This chapter discuss the research modeling which involve the research design and procedure of business process and suggested solutions and how they work.

4.2 Modeling

The Figure *4-1* Components Diagram below explain the four components (Mobile Application, ATM Host, EBS Host and Core bank) and communication between them. Also see Appendix (A).

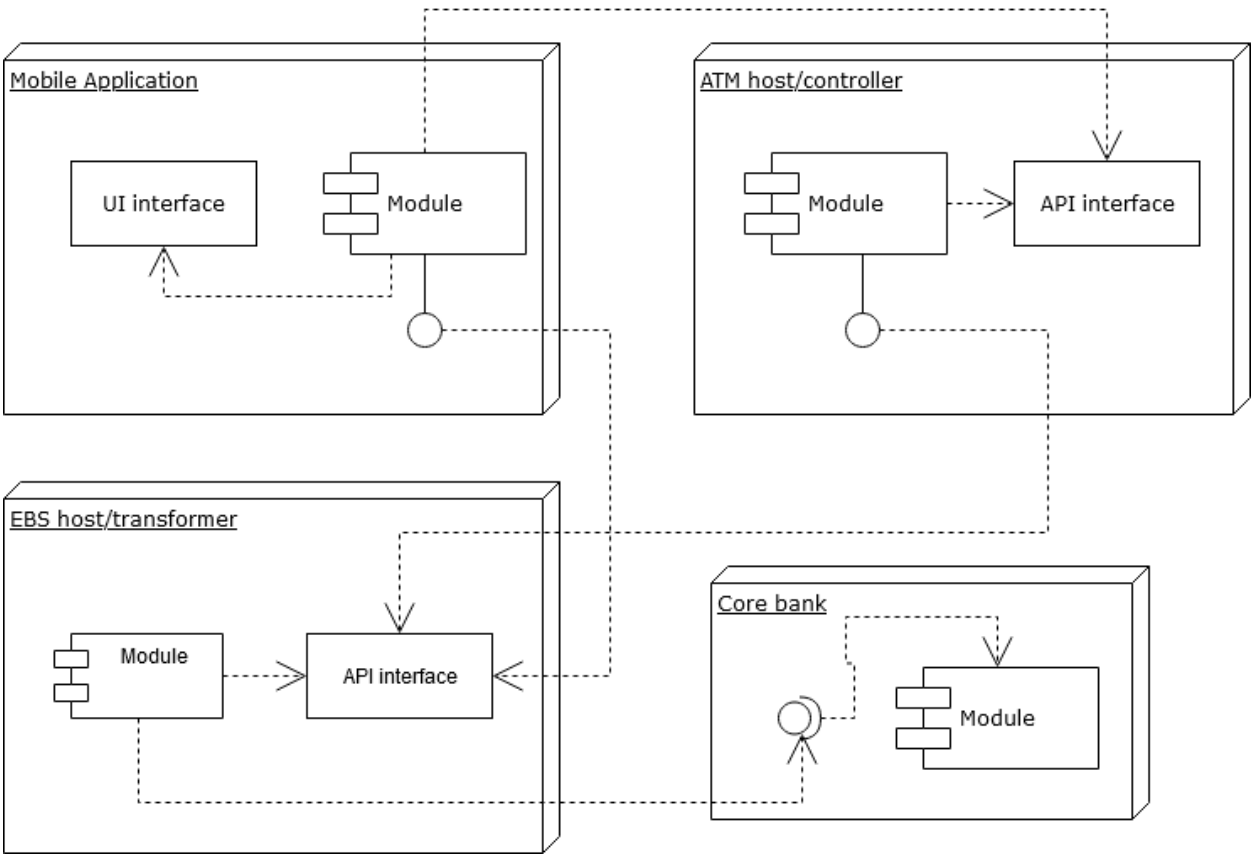

Figure 4-1 Components Diagram

4.3 Algorithm Design

This algorithm focus on decrease the time and make the process more simple. Also see *Appendix (B) and (C).*

1- Open mobile bank and login and enter authorization information.
2- If the customer not authorized go to step 1 else continue.
3- At mobile bank select option withdraw money from list of service.
4- Enter the amount that you want to get it.
5- Check the balance in account if has enough print a message (balance not enough) and go to step 4 else continue.
6- Scan the QR code by mobile camera at ATM machine.
7- Check the timestamp expired of request that generated by mobile bank when the customer do it at step 3, if expired print a message (timestamp of request was expired) and go to step 3 else continue.
8- At ATM machine the process of cash out will start and the customer get the cash from cash port.
9- Print a receipt amount and total balance at customer account.

4.3.2 The analysis of algorithm

At best case

T (n) = 4n **=>** ***O(n)*** linear function so not need more time is the best possible time complexity.

Where ***4*** is compression number, ***n*** input size.

At this research can avoid worse case by decrease of attempt withdrawal from ATM by ATMs card while waiting at queue.

$T(n) = \sum_{n=1}^{n} 4n$ => $4*1 + 4*2 + \ldots + 4*n$ => $c.n\ 4n$ => $\Omega(n)$ also linear function.

Where ***c*** constant

4.4 Business Process

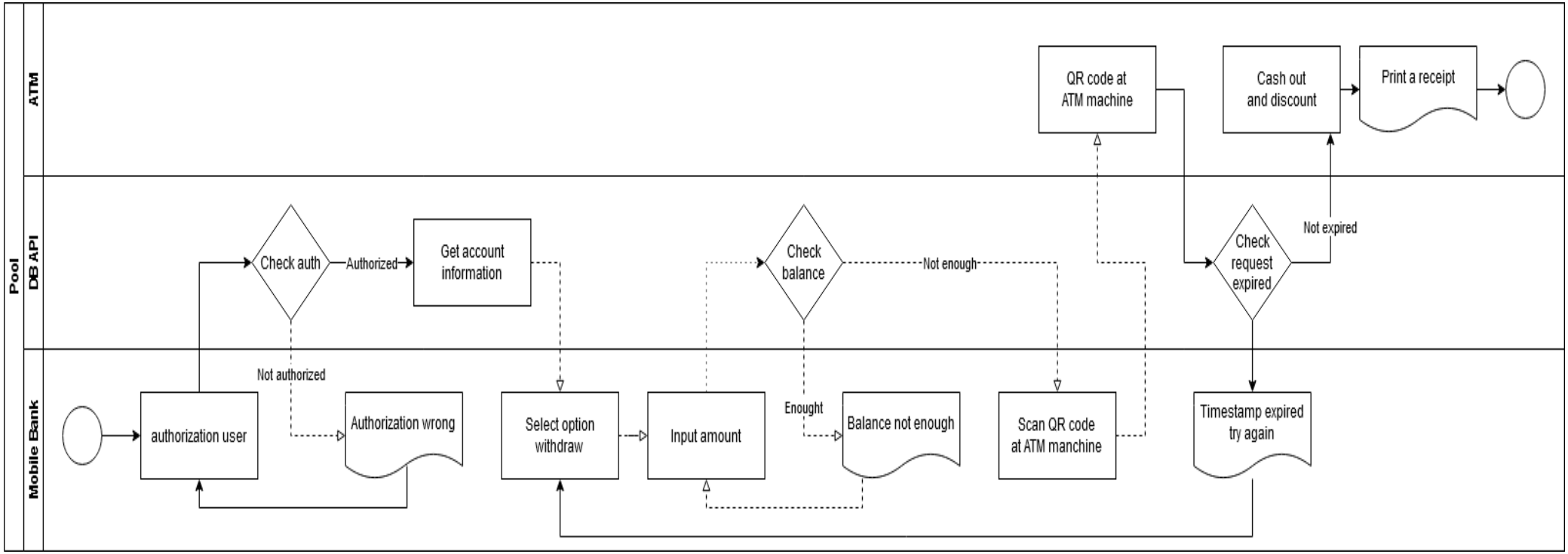

Figure 4-2 business process Swim lanes within Pool

4.5 ATM QR Code Generation

Here required to add function to generate row in database host this row content the basic information to ATM transaction like (withdraw identifier, account identifier, amount, created time stamp, ATM identifier, state, time expired, active, withdraw time stamp, mobile IMEI, mobile account identifier) this row must generate by ATM controller or ATM host when the ATM at ready state, this row reading by mobile application look at Figure *4-3* QR code generate process.

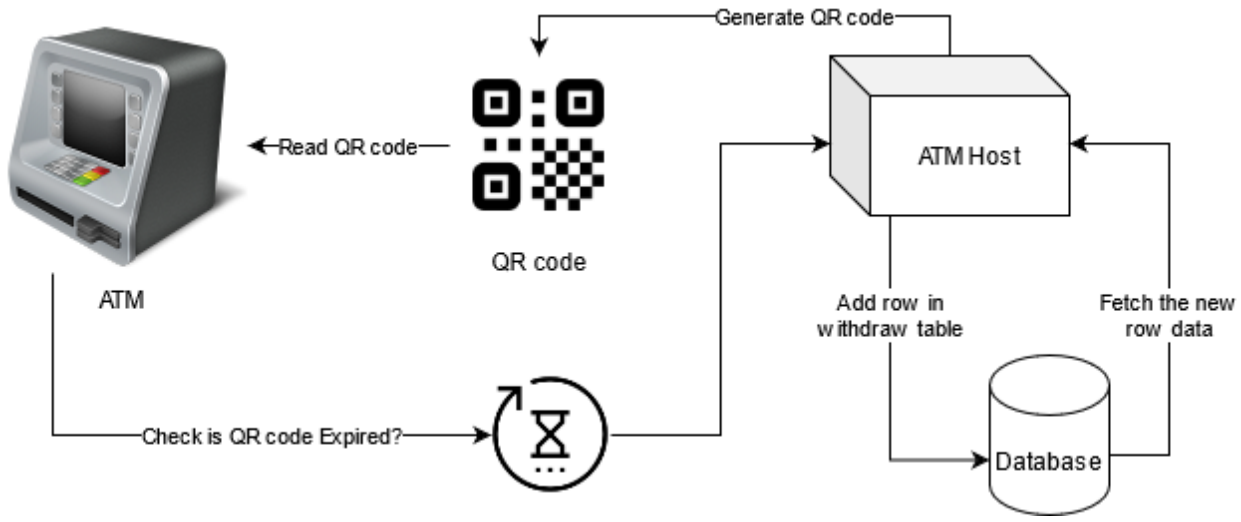

Figure 4-3 QR code generate process

4.6 QR Code Customization

When ATM at ready state and withdraw row generate by ATM controller or ATM host another function required to generate QR code pattern this QR code content encrypted data to withdraw identifier and ATM identifier that needed from mobile application to complete the process, the QR code generate will appear at ATM welcome screen and waiting to read it by the camera of mobile application.

So required more customize QR code shape to distinguish that this shape belongs to a financial institution or to an ATM machine, this customize can be like Eye Frame Shape, Eye Ball Shape, Body Shape, Foreground Color, Background Color, Logo. This design of QR code graph can increase the security by distinguish that this shape Tiwari, S. (2017). and also this method like proposed solution from Wang, Y. et al. (2018) to enhancing the security throw include watermark graphic in QR code graph, look at Figure *4-4* QR code after customization.

Figure 4-4 QR code after customization

4.7 At Mobile Application

At mobile application required add simple process or option to withdraw this process content session time expired to ending the session, when the customer select and fill all the parameters next stage comes the scanning of the QR code, after scanning the QR code the necessary data is obtained like (withdraw transaction identifier, ATM identifier). And also required adding function in mobile application API to complete the process by update withdraw table this update must add mobile account identifier, withdraw time stamp and change the state to complete. After that the amount is deducted from the ATM host's account.

4.8 Process Between The Four Parts

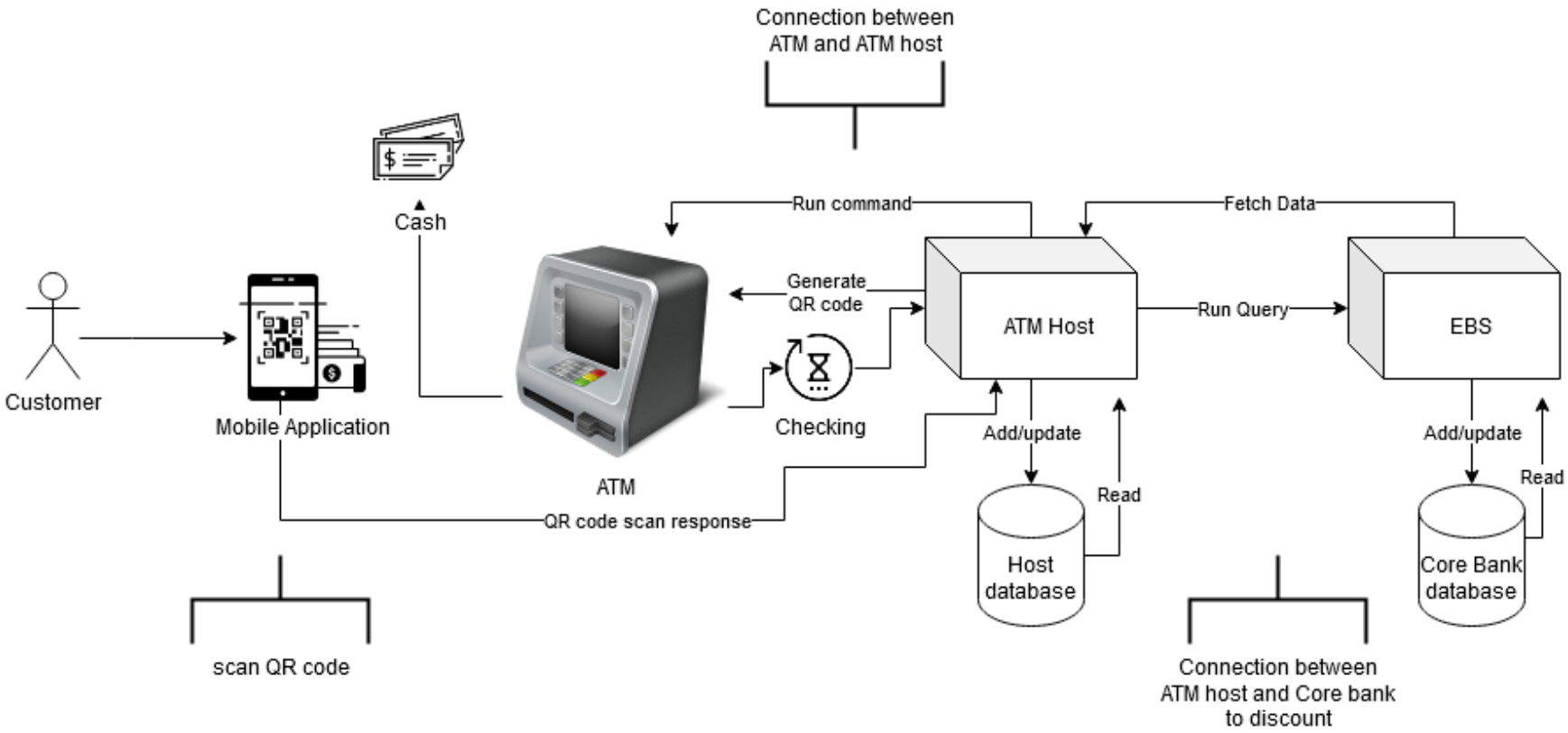

Figure 4-5 Process Betwee The Four Parts

CHAPTER FIVE Result

Introduction

This chapter explain the findings that obtained it from the research.

Results

A group of 20 samples were taken for the time spent withdrawing money through an ATM card from the ATMs machines of Faisal Islamic Bank, located next to the main branch in Khartoum. Samples were randomized to test four objects:

First: the time of executing the withdrawal process - the time was calculated from the timer hour from the person entering the cashier to the receipt of the money.

Second: cause of the problem in the event of the inability to withdraw - the problems were identified through the message displayed by the ATM system on the user's screen.

Third: level of the subjects' technical knowledge - technical knowledge was assessed by age and behavioral observation.

Fourth: times of attempt to do the cash disbursement process - the attempt times were calculated by eye observation. The result summarized at Table *6.1* group of samples at *Appendix (M).*

Also, through practical experience, it was found that the average time of the withdrawal process only, without the input options **(7 seconds)**. As for the time spent in each entry or selection is **(2-3 seconds)**. Also the number of times the selection or input required is (**7 times)**. There is also an important factor, which is the currency denomination of 100 pounds, 200 pounds, or 500 pounds. Calculating 10 cards of 100 pounds is not like counting two cards of 500 pounds.

By analyzing the search algorithm in Chapter Four, it was found that the algorithm Figure *6-2* Withdrawal Algorithm Had linear time complexity that did not take long, and also based on the methodology of reducing the amount of input while standing inside the ATM, the average time **(30 to 40 seconds)** was wasted in the card. Banking.

Based on reference number (Bansal and Singla, 2016), it is possible to estimate the reading time of the QR code shape and decode it in a time estimated of **(1 to 3 seconds)**. Based on previous results and estimates, that the time for withdrawing money from the ATM under this study will be about **(10 seconds)**. **(7 seconds)** for withdrawal process and **(3 seconds)** for reading QR code and process it. The result is that increased the speed of cash withdrawal from the ATM by **four times**, and this reduces congestion queues in front of ATMs.

CHAPTER SIX CONCLUSION

Introduction

This chapter content the conclusion, recommendations and the suggestions for future work and scientific references that quoted.

Conclusion

In this research collected 20 samples for withdrawal process by card ATM, this samples taken randomly from varies ATM, The samples proved that the withdrawal of money via the card needs to be improved and the introduction of a new technology that says that the withdrawal process is fast, An algorithm was developed using QR-Code technology & mobile banking that improved the speed of withdrawing money from the ATM. The algorithm increase the time of withdrawal from the ATM four times than using ATM card, this will reduce the waiting queues in front of the ATMs.

Recommendation

The most important point to recommend in research is to do more improvement in QR code technology in terms of speed, safety, improvement and simplification of the algorithm, and also:

1. More research is being done to increase the speed of communication between components
2. Apply the study at reality and benefit from it
3. Taking into account customer opinions about their technology experience and trying to improve it based on it
4. Do more accurate measurements in time
5. Convincing the financial authorities and banks of the importance of research in solving the problem of people queues at front of ATMs

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Appendices

Appendix (A)

The Figure *6-1* below explain the sequence processes activity to withdrawal from customer until rich core bank and discount the balance

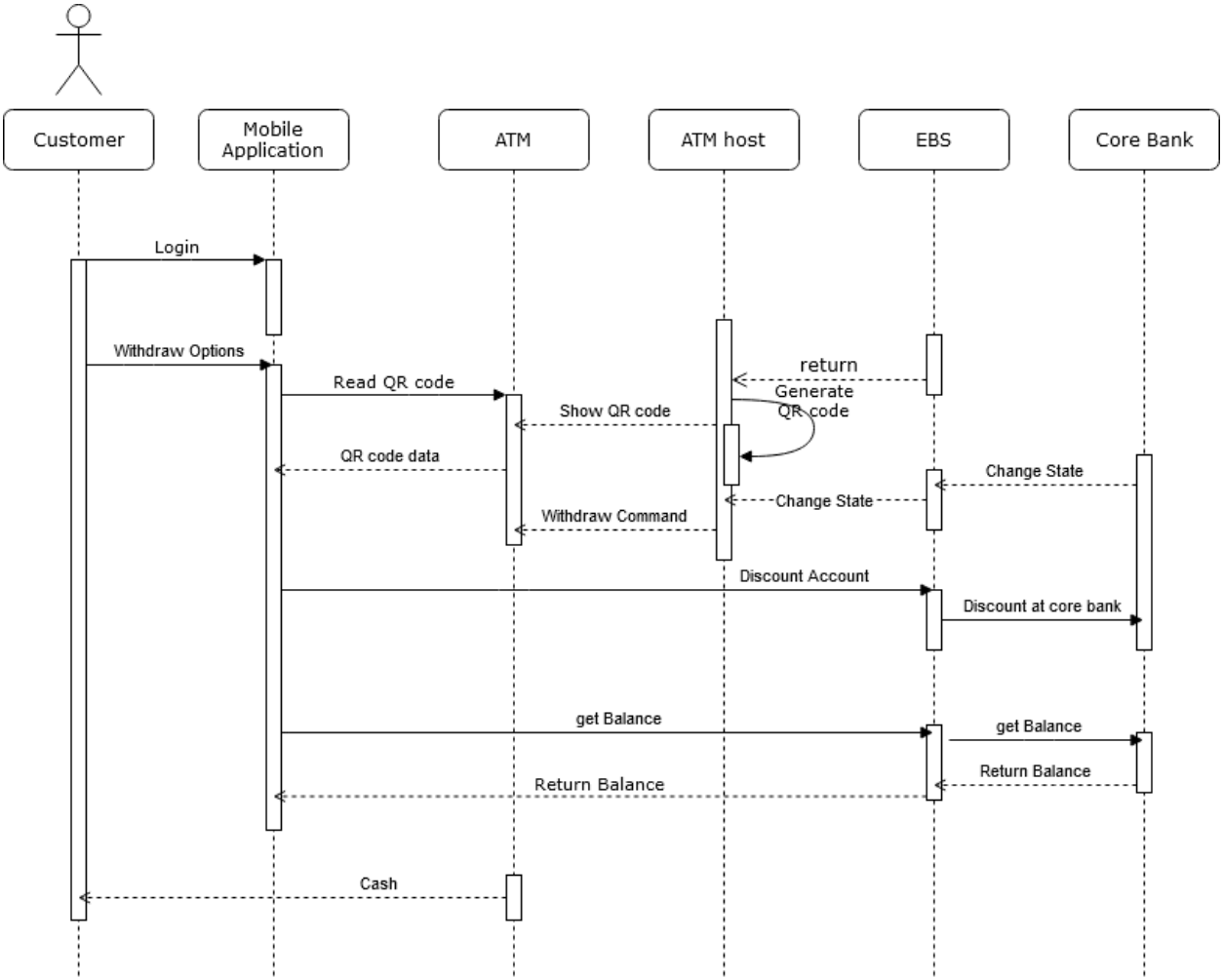

Figure 6-1 Sequence Diagram

Appendix (B)

Algorithm Pseudo code

```
Amount = 0
If authorization (username, password) then
        If select withdraw then
                Input (amount)
                If get Balance () > amount then
                        QRcode = getQRcodeScan ()
                        If request timestamp not expired then
                                Withdraw (amount)
                                Print (receipt)
                          Else
                                Message (timestamp of request was expired)
                        End if
                End if
        End if
Else
        Message (username or password not wrong)
```

Appendix (C)

Algorithm diagram

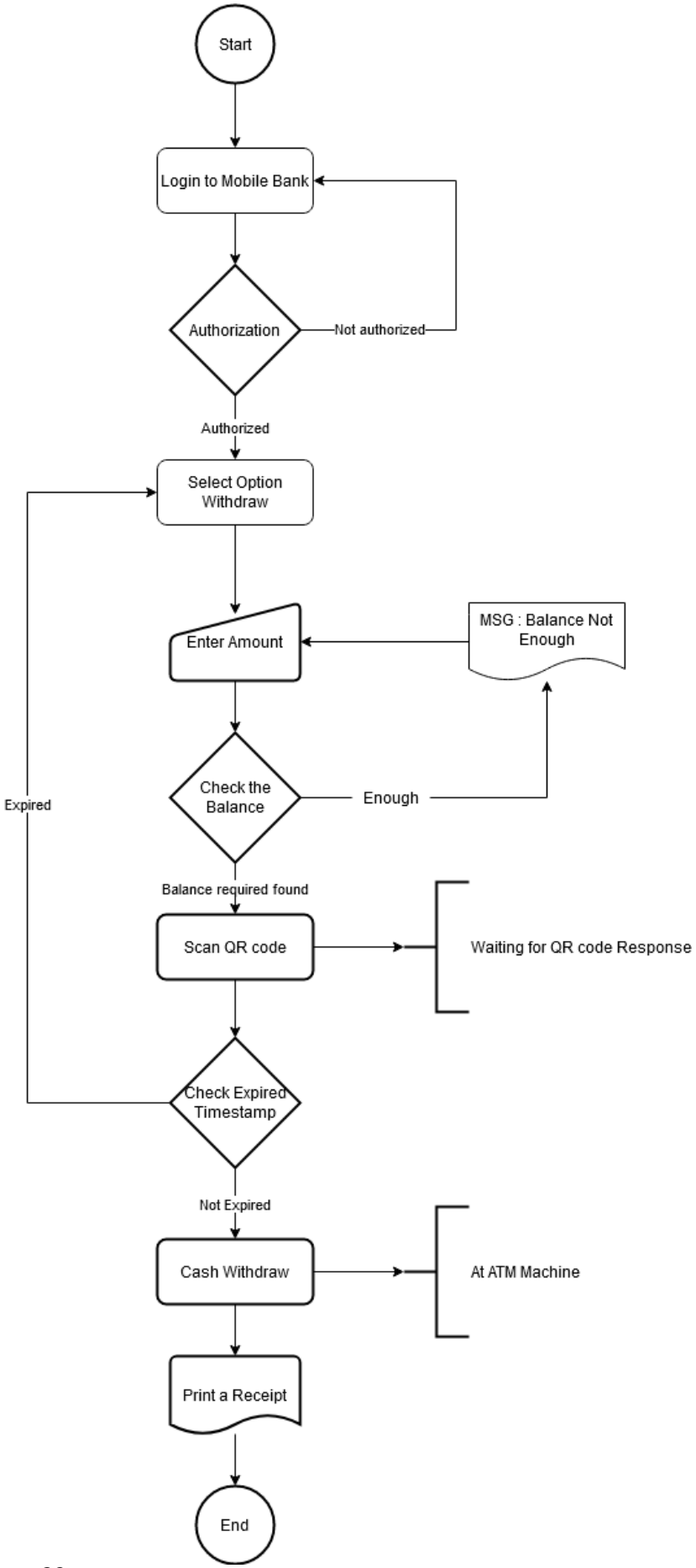

Figure 6-2 Withdrawal Algorithm

Appendix (D)

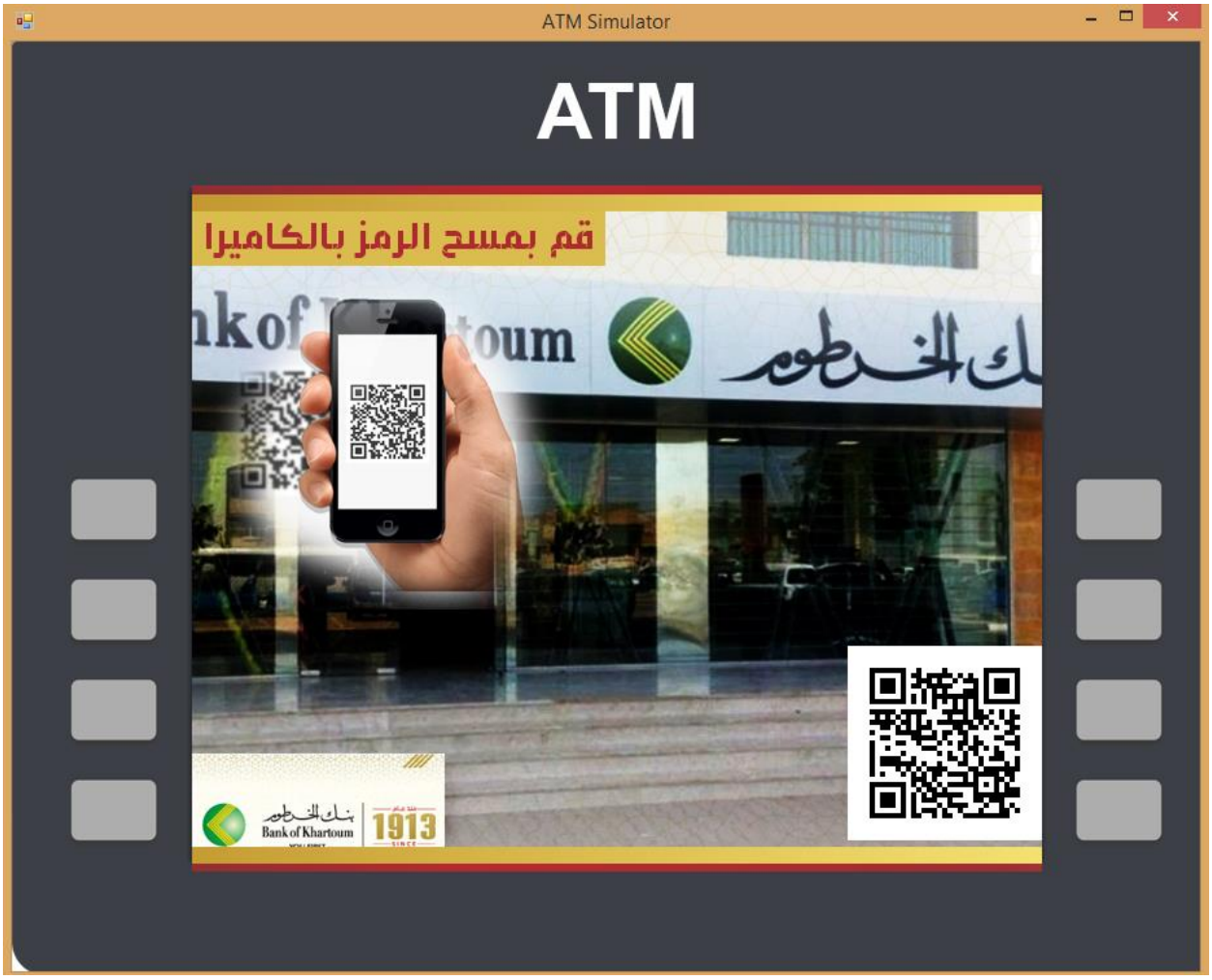

Figure 6-3 ATM Simulator - Welcome Screen with QR-Code

Appendix (E)

Figure 6-4 ATM Simulator - Under Process

Appendix (F)

Figure 6-5 ATM Simulator - Withdrawal Process is done

Appendix (G)

Figure 6-6 Mobile Banking - Login Screen

Appendix (H)

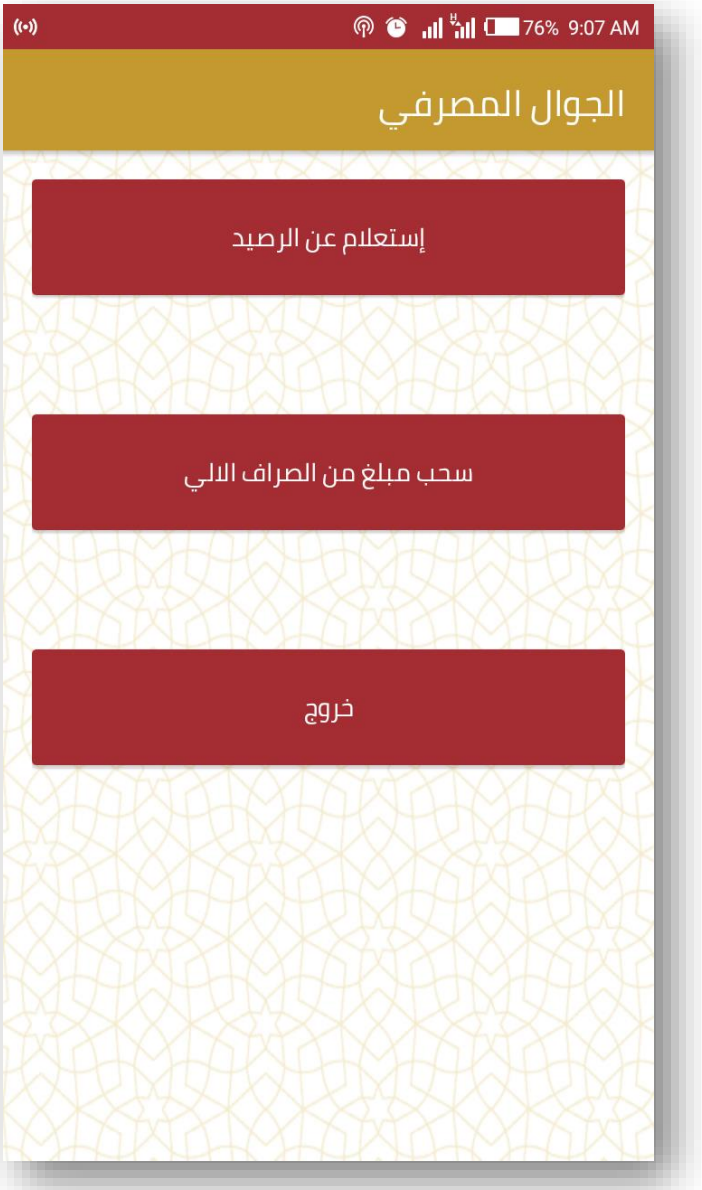

Figure 6-7 Mobile Banking - Main Page Screen

Appendix (I)

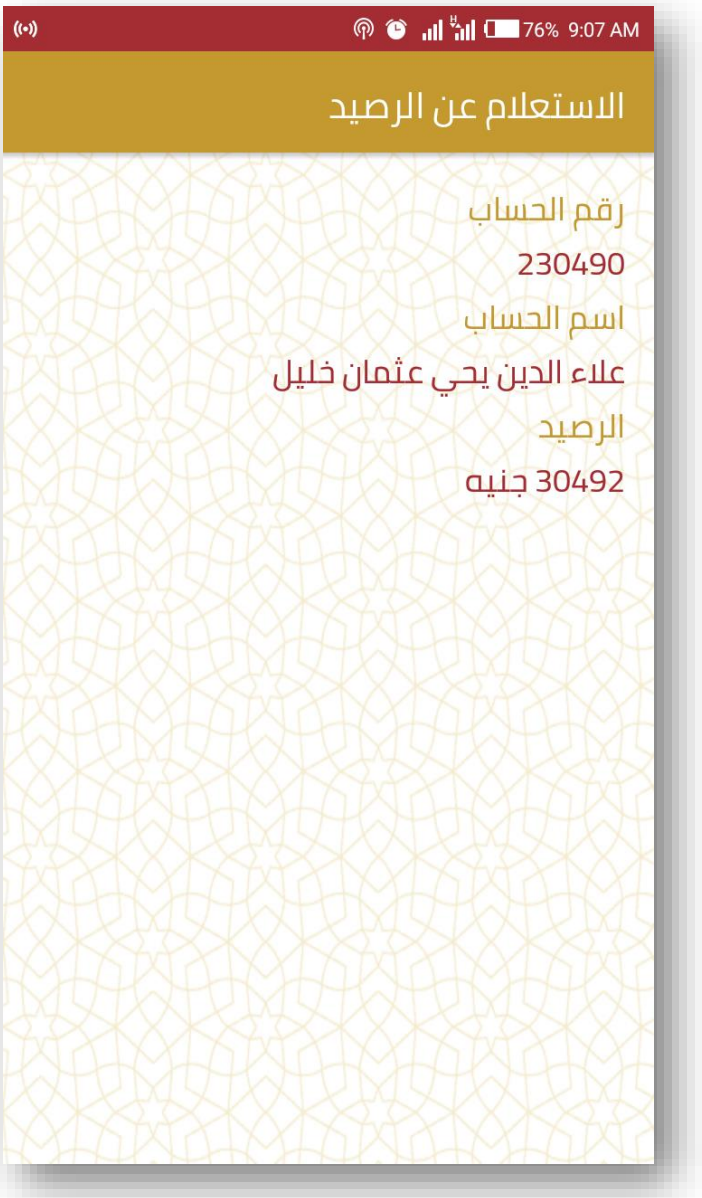

Figure 6-8 Mobile Banking - Account statement

Appendix (J)

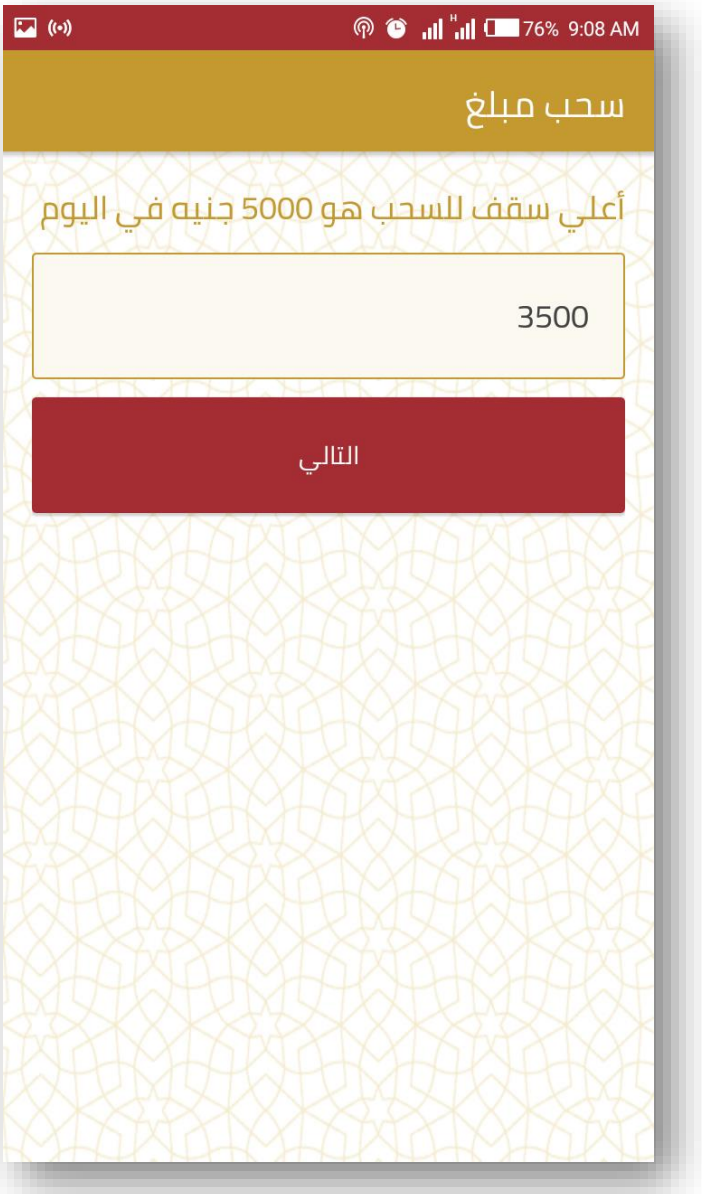

Figure 6-9 Mobile Banking - Withdrawal Amount

Appendix (K)

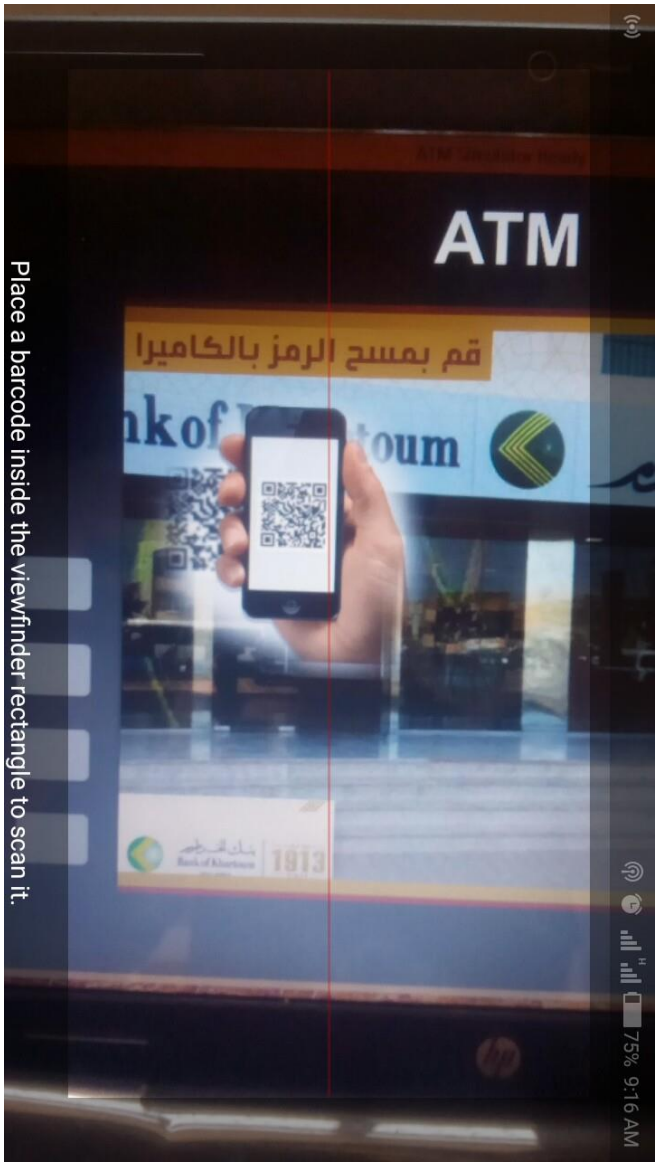

Figure 6-10 Mobile Banking - Scanning the QR-Code

Appendix (L)

Figure 6-11 Mobile Banking - Withdrawal Process is done

Appendix (M)

Samples Number	First Object Time Taken (Second)	Second Object Problem	Third Object Knowledge	Fourth Object Attempt
1.	50	Wrong entry	Medium	1
2.	00:53	Technical fault	Medium	1
3.	00:38	Balance not enough	Height	1
4.	00:21	Canceled	Height	1
5.	00:40	Technical fault	Height	1
6.	00:49	Technical fault	Medium	1
7.	00:43	No problem	Medium	1
8.	00:38	No problem	Height	1
9.	00:39	No problem	Height	1
10.	00:56	Technical fault	Low	1
11.	00:50	Wrong entry	Medium	2
12.	01:02	Unknown	Medium	1
13.	01:50	Unknown	Low	2
14.	01:00	No problem	medium	1
15.	00:41	No problem	Medium	1
16.	00:57	Account statement	Low	1
17.	00:52	Technical fault	Medium	1

18.	00:23	Account statement	Height	1
19.	04:13	No problem	Medium	3
20.	01:30	Wrong entry	Low	2
21.	00:34	No problem	Height	1
22.	00:39	Technical fault	Height	2
23.	00:30	No problem	Height	1
24.	01:00	Recharge phone balance	Height	1
25.	00:38	Balance not enough	Height	1
26.	00:50	No problem	Medium	1
27.	00:37	No problem	Height	1
28.	01:00	No problem	Low	1
29.	00:57	No problem	Low	1
30.	00:32	Wrong entry	Height	1
31.	00:23	No problem	Medium	1
32.	00:49	No problem	Medium	1
33.	00:53	No problem	Medium	1
34.	00:39	No problem	Height	1
35.	00:09	Wrong entry	Low	1
36.	00:15	Technical fault	Low	1
37.	00:48	No problem	Medium	1
38.	01:00	Technical fault	Low	1

39.	01:10	Unknown	Medium	1
40.	01:18	No problem	Low	1
41.	00:55	Canceled	Medium	1
42.	00:51	No problem	Low	1
43.	00:50	N	Low	1

Table 6.1 group of samples