Development of Electronic Bank Deposit and Withdrawal System Using Quick Response Code Technology

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ABSTRACT

The emergence of mobile devices and the automated teller machines has re-shaped banking operations in recent times. Several other attempts have been made to ensure a better service delivery in our banking institutions, especially using various technologies of the digital age. But such efforts have not fully paid off owing to obvious queues that continue to persist at the various teller points. Persisting customer queues within the banking halls despite the deployment of ATM machines and other technological innovations have proved the need for a more efficient system. The goal of this study is to develop an electronic deposit and withdrawal system using the Quick Response (QR) code technology for a more efficient service delivery in commercial banks. The system is intended to reduce the transaction time at each teller point by engaging the customers to generate a QR code using their mobile devices and this will speed up the process of cash withdrawal or deposit. To validate the customer, the Teller quickly scans the information (Customer Account Information) contained in the generated code within seconds. With such a system in place, a withdrawal/deposit transaction, which originally concludes within five to 10 minutes, will now take less than three minutes to complete. Furthermore, the system will permit multiple bank transactions to be carried out at once using a single QR code, and this can further speed up the transaction process. The new system was developed using the prototyping methodology, considered as best suited for this project for its iterative nature and user involvement. User experiences and expectations of efficient bank tellers for withdrawal and deposit were surveyed using the questionnaire as the major data gathering instrument. This data was used for initial requirement analysis for the proposed system. Result obtained from this study shows that the new QR code deposit and withdrawal system provides improved operational efficiency and better secured transaction than the traditional banking service delivery.

Keywords: Barcode, Bank transaction , Mobile technology, Operational efficiency, QR code

1.0. INTRODUCTION

1.1 Background Information

Globally, financial institutions, including government and non-governmental agencies are testing different implementation of the Quick Response code (QR code) technology to provide simple unified payment solutions. QR Code is the trademark for a type of matrix based barcode (or two-dimensional barcode), which was first designed for the automotive industry in Japan. Its fast readability and greater storage capacity has made it a popular technology alternative which is now being deployed outside the automotive industry. It consists of a black modules (square dots) arranged in a square grid on a white background capable of encoding four standardized types (modes) of data (numeric, alphanumeric, byte/binary, Kanji) or other supported extensions [6].

A proper implementation of the Quick Response Code technology can improve operational efficiency in the banking sector. Operational efficiency can be achieved with the right combination of people, processes and

technology to increase productivity and value of business operations while driving down the cost of routine operations to a desired level [3]. This is part of what this study seeks to achieve.

According to [3], operational efficiency in the banking sector is essential for a well-functioning economy. This is because commercial banks are critical financial intermediaries between savers and borrowers in any economy. Every other sector depends directly or indirectly on this sector for survival and growth; hence, achieving operational efficiency in the banking sector will translate into a more robust economy for any nation.

Unarguably, financial institutions have succeeded in reducing queues in the banking halls by the introduction of the Automated Teller Machines (ATM). But the queues have resurfaced outside the banking hall where bank customers now line up in endless queues waiting to use the ATM machine.

With the recent growth in technology especially in hardware and software, and the potential benefits of the quick response code technology, the new system being proposed will no doubt bring about positive changes in the way financial institutions operate their business.

Despite the widespread use of ATM, customers still flood banking halls, requesting for same services that the ATM is meant to offer them. Most times, bank customers are usually apprehensive of the security risk associated with the use of the automated teller machines. Because of this trend, bankers require an alternative cost effective solution aimed at helping bank tellers offer efficient services within the banking halls. There is therefore need to provide simple and unified payment solution for a more efficient banking operation in Nigeria and beyond.

In this research paper therefore, we will develop an electronic bank deposit and withdrawal system based on the Quick Response code technology to provide a fast payment solution and improved customer inclusiveness in the daily transaction process.

1.2 Aim and objectives of Study

This research paper aims at developing an electronic bank deposit and withdrawal system based on the Quick Response code technology to provide a faster transaction processing technique by our commercial banks.

The study will seek to achieve the following specific objectives:

i. Identify basic performance indicators for efficient teller systems based on user expectations and preferences.
ii. Evaluate strengths and weaknesses of existing teller systems based on identified performance indicators.
iii. Design a Quick Response Code teller system for cash withdrawal and deposit to run on Android Operating Systems.
iv. Make recommendations for a way forward.

2.0. LITERATURE REVIEW

2.1. Meaning and Historical Background of QR code Technology

The Quick Response (QR) code is a special type of barcodes. As was stated earlier, QR code's birth place is the automotive industry in Japan in 1994. It was first introduced by Denso Wave, a subsidiary of Toyota. Denso Wave developed the QR code in an attempt to improve the manufacturing process and tracking of vehicles and vehicular parts, and to allow for a high speed component scanning or decoding of manufacturing information [15].
However, QR codes owe their existence to the success and development of barcodes [16]. According to [16], existing barcodes can only hold 20 alphanumeric characters of information which helped cashiers in the 1960's to lighten their burden of manually keying in prices at discount stores and retail service lines. As time went on, there was need for barcodes that could hold more data and this need led to further research, resulting in the development of the Quick Response code in 1994. Since then, there have been several standards aimed at improving its data holding capacity and faster encoding of information.

2.1.1 Meaning

QR code is actually a matrix-type (or two dimensional) barcode trade mark, which are optical, machine readable labels attached to items that record information related to the item [6]. These machine-readable labels have the ability to store information both vertically and horizontally as opposed to conventional one-dimensional barcodes that could store information only in the horizontal plane [10].

According to [8], QR codes can contain data for a locator, identifier, or tracker that points to various data sources, such as a website, a URL, an application, text, or other types of data, which can be easily read by cameras of mobile devices.

Generally, a QR code is composed of black modules (Square dots) arranged in a square grid on a white background. It can encode four standardized types of data, which are numeric, alphanumeric, byte/binary, and kanji, or through supported extensions [6].

This information can then be read as an image by any imaging device such as a camera, and processed using Reed–Solomon error correction for proper and accurate interpretation as required.

According to [17], scanned QR codes can display text to the user, add a vCard contact to the user's device, open a Uniform Resource Identifier (URI), or connect to a wireless network, an email, or text message.

Today, QR code system is the most useful type of two dimensional barcode technologies. It is now being deployed outside the automotive industry for two reasons:

(i). Fast readability, and

(ii). Greater storage capacity.

These technologies are now used for commercial tracking applications and convenience-oriented applications that targets mobile phone users. Notable areas of QR deployment applications include product tracking, item identification, time tracking, document management, and general marketing.

2.2. Various Models of the Quick Response Code Technology

According to [16], there are various models of the Quick Response Code Technology implemented in various sectors. They include: QR code model 1, QR code model 2, Micro QR code, the iQR code, and the Secure Quick Response Code (SQR) Code. Some of these models are illustrated in figure 2.1, figure 2.2, figure 2.3, and figure 2.4.

Fig. 2.2. QR Code Model 1

Source: (QR Code.com, n.d)

The QR code model 1 is the original QR code. As shown in Figure 2.1, this code can contain as large as 14 (73 x 73) modules, capable of storing up to 1,167 numerals.

Fig. 2.2. QR Code Model 2

Source: (QR Code.com, n.d)

QR code model 2, as depicted in Figure 2.2 is an enhancement of model 1. It is capable of being read smoothly even if distorted in some way. It embeds an alignment pattern that enables its application on carved surfaces or surfaces whose reading images are distorted due to the reading angle. This code model can encode up to 7, 089 numerals with its maximum version being 40 (177 by 177) modules. QR code Model 2 is the most common or typical QR code ever deployed.

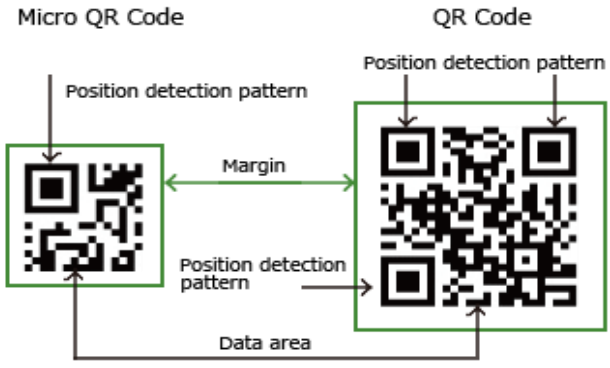

Fig. 2.3. Micro QR Code

Source: (QR Code.com, n.d)

A major feature of the Micro QR code model is the one position detection pattern when contrasted with the

regular (model 2) QR that uses three position detection symbols. The two-module wide margin of the micro edition allows its application on areas smaller than the regular edition. Data storage capacity is 35 numerals (max.), 21 alphanumeric or 15 byte of data (Lead Tools n.d), with four variants [9].

Fig. 2.4 Two variants of the iQR code

Source: (QR Code.com, n.d)

The iQR code model allows for a wide range of codes from codes smaller that Model 2 and Micro editions to large ones that can hold more data than they, and in two variants rectangular or traditional square. This code can be printed as rectangular, turned over, black and white inversion or dot pattern (direct part marking) codes thus allowing for large spectrum of application. An iQR code can hold 80% more data than previous editions of QR code of the same dimension. Thus it has a high rate of information packing, approximately 40,000 (422 x 422) modules.

On the other hand, the Secure Quick response codes are secure two dimensional barcodes with high data density with encryption capability which is extremely difficult to decode into plain text in the absence of the encryption cipher or key. Typical implementation involves creating a one-time use SQR code on a mobile phone screen to effectively use a one-time pad (an encryption technique that cannot be cracked but requires the use of a one-time pre-shared key, same size or longer than the message).

2.3. Empirical Study and Scholarly Views on Existing QR Code Systems and Implementations

[10] evaluated the impact of the Quick Response (QR) code technology on Customer Satisfaction in the online shopping context on the basis of perceived flow. They discovered that the implementation of QR code technology had a significant effect on perceived flow. According to the research, percieved flow significantly increased customers purchase intension and satisfaction. Their findings confirmed the significant effects of QR code systems on online community (retailing, marketing promotion, consumer behavior, advertisers and online shoppers). They further adduce that QR codes can influence customers to engage and share information with other customers in the online community, which will help to increase the volume of sales. This goes a long way to show that implementing QR codes in banks for deposits and withdrawals can significantly influcence customers satisfaction, usage intension and propensity to share their experience of ease-of-use and security advantages of the QR code-based system to other bank customers.

[14] outlined the various institutions that have adopted the use of two-dimensional bar codes, also known as QR codes for encoding information such as URLs which are easily read by smart phones, digital tablets and other electronic devices. Their report shows that these codes can serve as a vehicle to evoke a consumer response or some type of behavior, and further listed out some of the major benefit for users of smart phones.

Results from the survey study of college students' awareness and use of QR codes indicate that QR code usage rate has a positive relationship with electronic device ownership.

Finally, [6] proposed a system based on the QR code, which is used to admit students into their lecture halls. The system proposes the use of the mobile technology to efficiently maximise the school's assigned lecture time. In their view, precious lecture time is usually wasted by instructors taking class attendance, especially for very large classes. Thus the need to automate this process by engaing the students themselves to use their mobile devices to speed up the process. According to them, all that a students need to do is to qucikly scan the code to confirm his/her class attendance. The researchers further explained the high level implementation details of their system and show how the system verifies student identity and eliminated incidence of false registration.

3.0. METHODOLOGY ADOPTED AND USER REQUIREMENT ANALYSIS FOR THE NEW SYSTEM

Prototyping methodology was adopted for analysis and design of the proposed QR code-based electronic bank withdrawal and deposit system. This methodology allows for a quick design of a prototype system after an initial gathering of user requirement. The prototype is then subjected to test and user evaluation using appropriate test data. The purpose of the evaluation is to allow users to use the system with a view to discovering new user requirements or improve on existing ones. The testing and evaluation process continues until all user requirements are fully met and user is satisfied with the prototype. Thus a functional and acceptable prototype evolves which ultimately form the basis for creation of the final system.

Software prototyping model works best in situations where system requirement is not fully known at the onset. User involvement, especially the continuous interaction between system users and system developers make the prototyping model the most preferred for this type of project. Figure 3.1. shows the prototyping model.

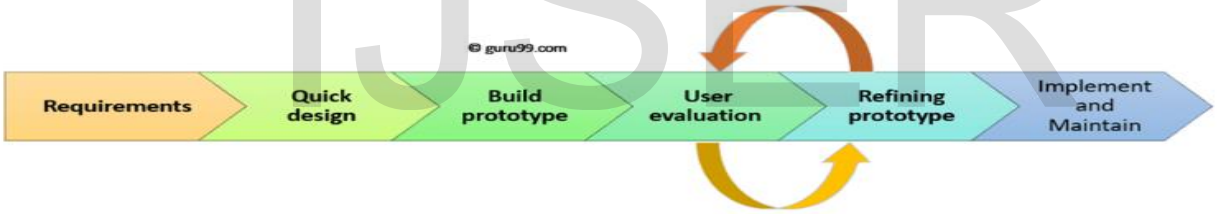

Fig. 3.1. Phases of the Prototyping Model

3.1. Data Gathering and Requirement Analysis

To generate requirements for development of our proposed system, a questionnaire was designed to gather information based on stated research questions. More than 300 copies of questionnaire were administered to commercial bank customers as well as bank operators and teller system users within Owerri city, east of Nigeria. In line with (Knatterud, Rockhold, George, and Barton, 2018), our goal was to ensure accurate and honest information gathering. Structured questions were posed to elicit information relating to:

i. Existing method of daily bank deposit and withdrawal transactions.
ii. Weaknesses of existing teller systems based on identified performance indicators.
iii. Expected performance enhancement based on user expectations and preferences.

From the information gathered at the data gathering stage, we were able to establish the following: Who initiates withdrawal and deposit transactions; how withdrawal and deposit transactions are performed; how often they are performed; how data is generated, processed and stored; what the media of storage are; and overall implementation of data flows within the system. Such information was gathered from bank directors, section mangers, supervisors, tellers and bank customers.

4.0. System Design, Result and Discussions

4.1. Architecture of the Proposed QR code System for Bank Withdrawal and Deposit

The proposed system follows a four-tier architecture and depicts a conceptual framework showing the various activities involved in the new system as shown in the figure 4.5.

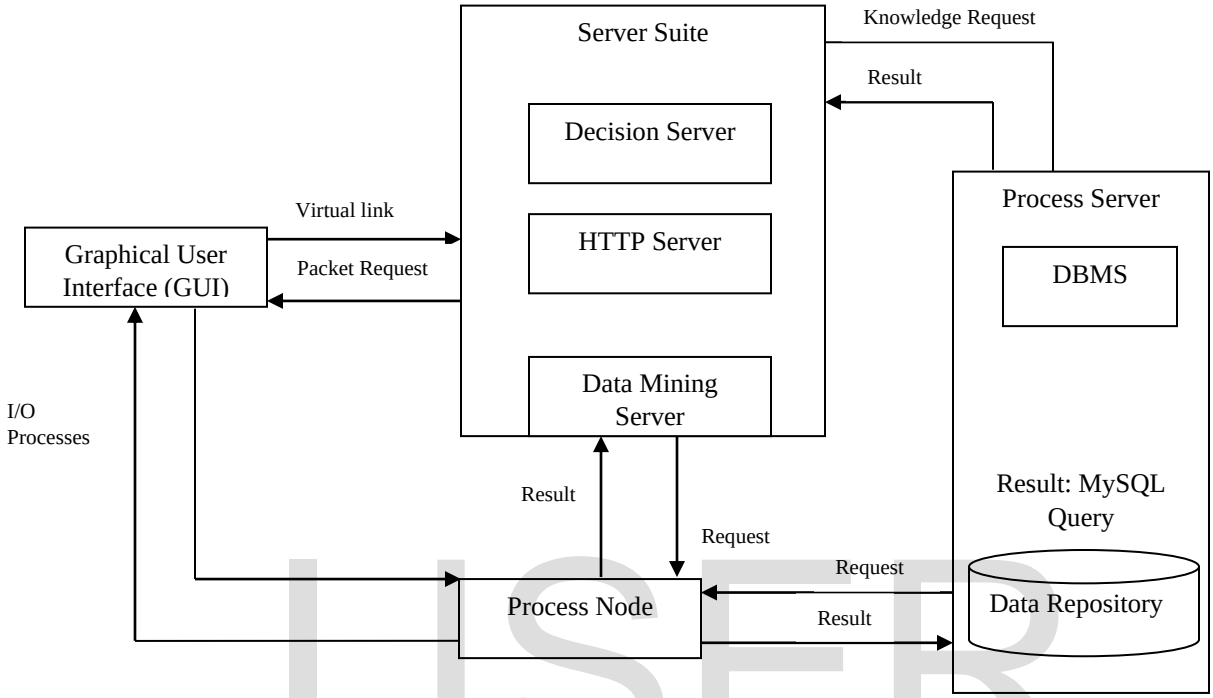

Figure 4.5: Architecture of the Proposed System with multiple-Server Technology

4.2. Program Flowchart for the New System

The program flowchart for the new QR code-based system is shown in figure 4.6.

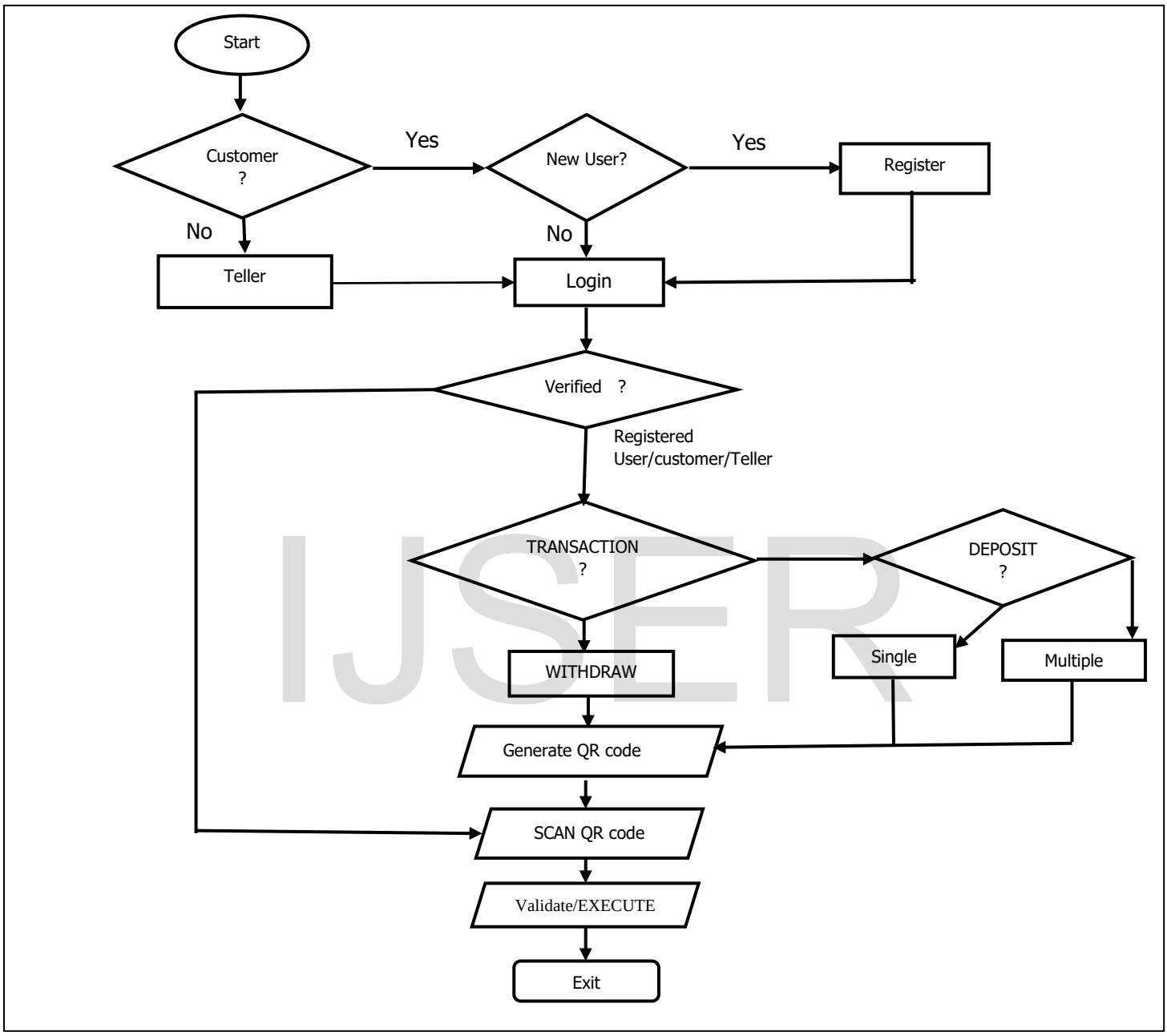

Figure 4.6: Program flowchart

4.3. Use Case Diagram

The use case diagram of the new system is as shown in figure 4.7.

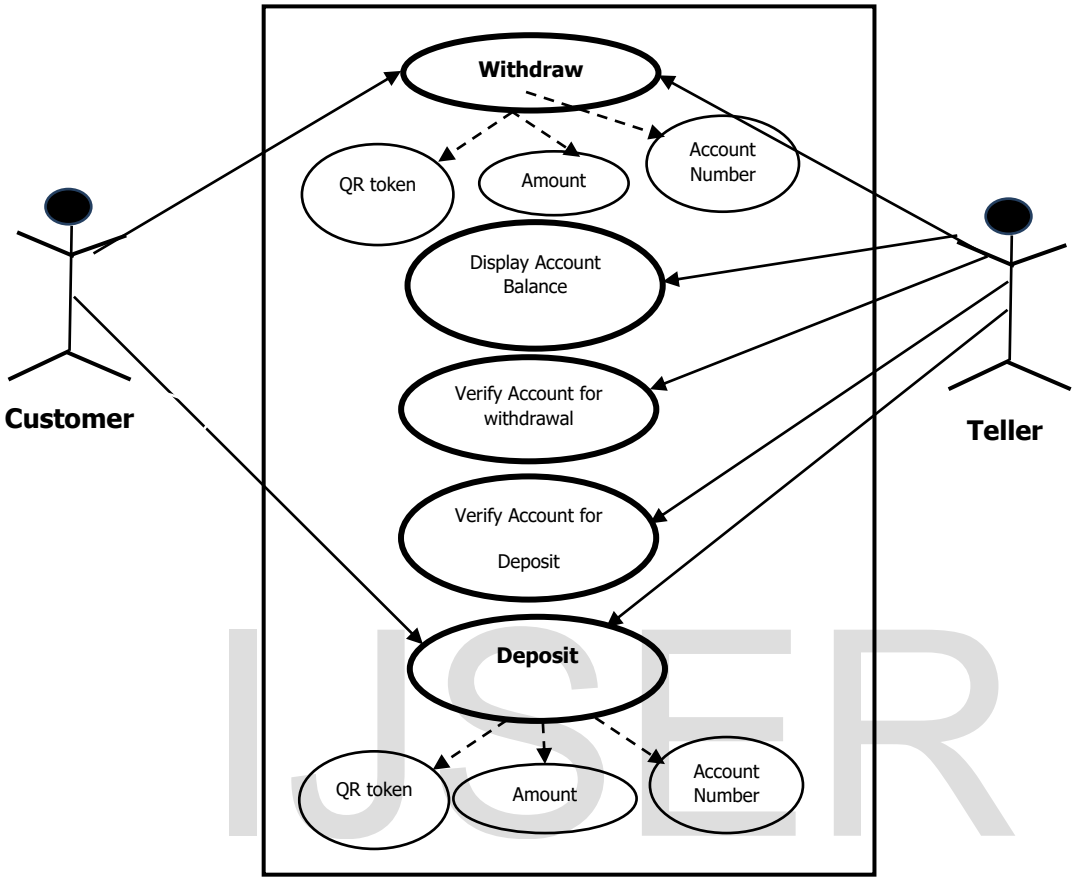

Figure 4.7. Use Case Diagram

4.4. Data Model for the Proposed System

4.4.1. Entity relationship diagram

Figure 4.8 shows the Entity Relationship Diagram for the new system.

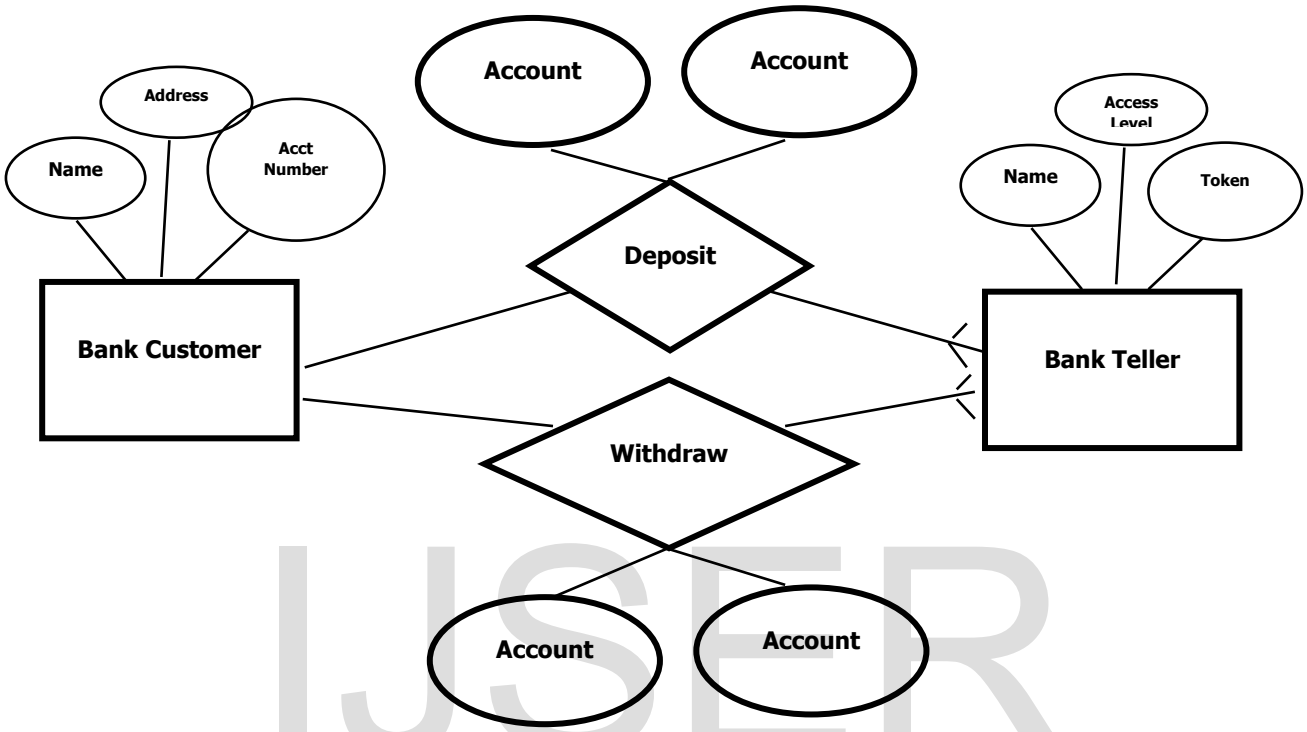

Figure 4.8. Entity relationship diagram of new system

4.4.2. Database Structure

A database is a group of related files which contains structured data and records with no duplication. It can therefore be referred to as a constructed, consistent and controlled pool of data. A good database must be common to all users and independent of the programs by which it is processed to generate output. For the new system under development, MySQL was used as the database management system.

4.4.2.1. Input Design

Table 4.1. Account Information Database File

S/N	FIELD NAME	DATA TYPE	SIZE
1	AccountHolderFirstname	Varchar	20
2	AccountHolderOtherNames	Varchar	40
3	Address	Varchar	40
4	Sex	Varchar	1

5	DateOfBirth	Date/Time	8
6	AccountNumber	Int	10
7	AccountType	Varchar	10
8	DateCreated	Date/Time	8
9	OpeningBalance	Decimal	20.2
10	CurrentBalance	Decimal	20.2
11	Email	Varchar	50
12	PhoneNumber	Int	11
13	ResidencialAddress	Varchar	50
13	ValidSignature	Img	20
14	NextOfKin	Varchar	50

4.5. System Implementation

The following sections of the new system were implemented using the under listed programming tools:

Image Server Application: PHP was used in creating the coding logic for listening to user requests. This application will equally receive captured images from mobile devices and send to the Database.

Mobile Application: HTML 5 markup language, CSS and JavaScript were used to develop the user interface from where users send requests to the image server over the internet.

Database: MySQL was used to develop a relational database to store images from mobile devices and stores customer account details.

The new system will provide a fast and easy way to carry out bank deposit and withdrawal transactions and ensure improved operational efficiency in the banking sector.

4.5.1. Results

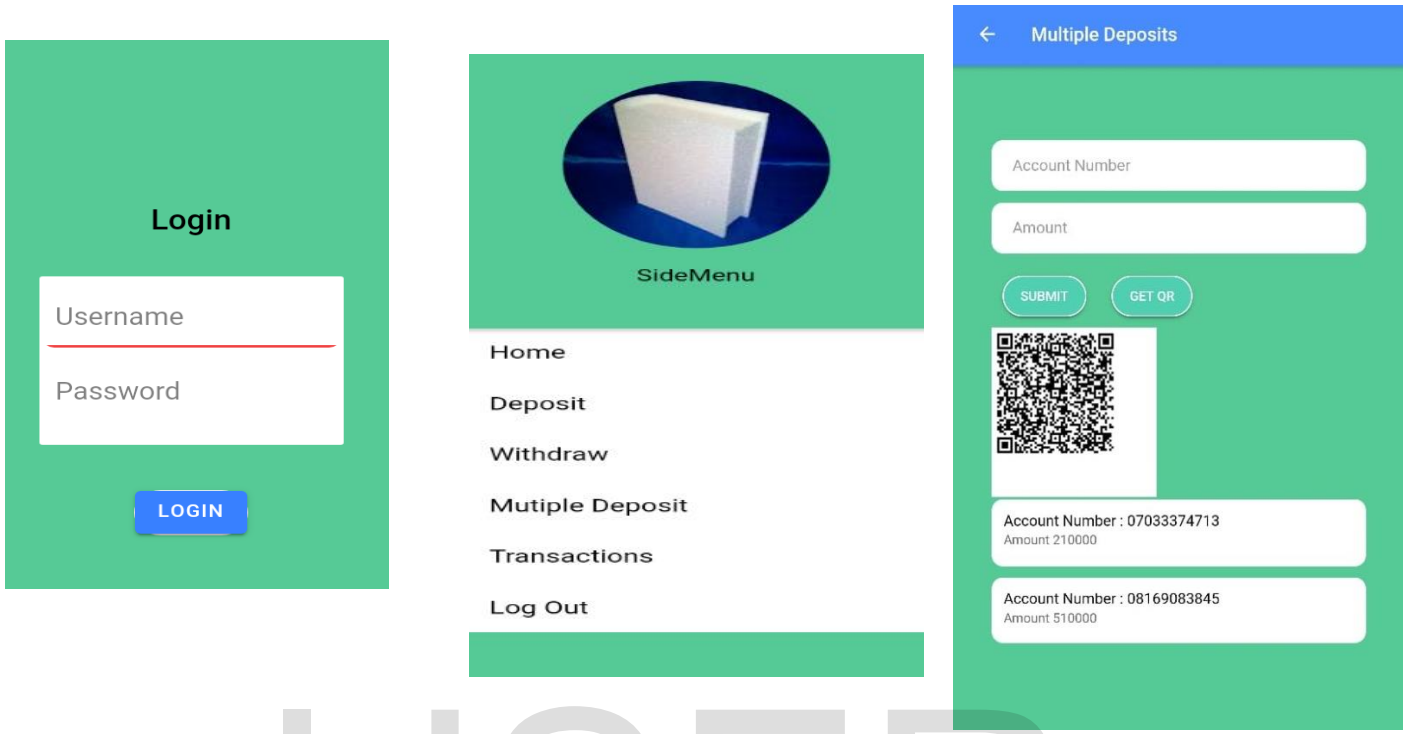

Figure 4.9. Some Output screen from the New System

4.6. Discussion and Interpretations of Major Components of the New System

Figure 4.5 shows the architecture of the new system. The framework follows a four-tier architecture showing the various activities involved in the new Electronic Bank Withdrawal and Deposit System based on the QR code technology. The major components of the framework include: Server suite, Android based Graphical User Interface, Process server, and the Process node.

The Server Suite:

The Server suite comprises of a three-layered Network Servers which is supposed to manage the entire network. Example, the HTTP server takes care of all HTTP requests in the system and controls all processes linking the system to other networks, while the Data Mining server processes complex data mining activities/procedures.

Process Server:
The Process server element comprises of two components: the Data repository, which stores actual data for the system, especially Customer Account Information, the DBMS (Database Management System), which is responsible for all database operations and maintenance including data retrieval, insertion, deletions, and so on. It also manages data sent to/from the system to other devices.

Process Node:
This module is responsible for channeling user requests to appropriate servers for effective and efficient responses.

User Interface: This is an Android based Graphical User Interface (GUI) component through which mobile device users launch the application. This module is responsible for all interactions and communications between the system and registered users. Users include: Bank Account holders, Bank tellers, and any other third party connected with the account.
Through this interface, users can carry out data input as required for system operations. From the interface, users can access a Login screen, Data forms, user profile, and so on. Major programming language tools used in developing this component include HTML, CSS and the JavaScript.

5.0. Conclusion and Recommendations

5.1. Conclusion

This study has developed an electronic deposit and withdrawal system using the Quick Response (QR) code technology for a more efficient service delivery in our commercial banks. Deployment of the system into the banking sector can reduce transaction time at each teller point by engaging the customers to generate a QR code via their mobile devices and speed up the process of cash withdrawal and deposit. To validate the customer, the Teller quickly scans the information (customer account information) contained in the generated code within seconds. With such a system in place, a withdrawal/deposit transaction, which originally concludes within five to 10 minutes, will now take less than three minutes to complete. Furthermore, the system can permit multiple bank transactions to be carried out at once using a single QR code, and this can further speed up the transaction process. The new system was developed using the prototyping methodology, considered as best suited for this project for its iterative nature and user involvement. User experiences and expectations of efficient bank tellers for withdrawal and deposit were surveyed using the questionnaire as the major data gathering instrument. A thorough Requirement Analysis was carried out to enable proper design of the prototype system. Result obtained from this study shows that the new QR code deposit and withdrawal system provides improved operational efficiency and better secured transaction than the traditional system.

5.2. Recommendations

We recommend an early implementation of the findings of this research paper. The novel system of electronic bank deposit and withdrawal based on the Quick Response code technology should be deployed into the Nigerian Banking sector for improved operational efficiency. There is need for a concerted effort by all stake holders, government, Bank operators, etc, to take advantage of the opportunities offered by the emergence of mobile devices and Information Technology to improve the sector.

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