An Innovative Framework for Integrated Loan Management with QR Code Enhancement

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Abstract - This research paper aims at design of an innovative framework scalable and integrated loan management with Quick Response Code enhancement, which will guarantee easy and better-secured loan validation and processing in microfinance banks and other lending institutions. As the number of microfinance bank customers in need of personal loans rises on a daily basis, especially in the post COVID-19 era, management is faced with the complex job of loan application verification in order to correctly determine eligibility for a loan. There is the challenge of coping with fraudulent customers who make false claims with their loan application documentations, sometimes seeking to access multiple loans from more than one microfinance banks and using single collateral security. There is need for a central regulatory agency that links up major lending institutions in a collaborative effort to forestall incidences of multiple loan access using single loan security. Our new model will also forestall activities of some fraudulent bank officials who go as far as granting credit facilities to their friends and family members without following due process and using their privileged positions to obtain unsecured loans for themselves and their relations, sometimes in excess of bank's statutory lending limits, and in total violation of the provisions of policy of microfinance banking sector. Our new model was designed using the Rapid Application Development (RAD) methodology following its high involvement and concentration on user's viewpoint as well as its ability to change system design on the go based on user demands. Implementation of the new system was done using such development tools as PHP, JavaScript, MySQL, and Visual Studio. Basic functionality testing was carried out on the system to make sure all the buttons on every screen works as desired, and to ascertain that the system could forestall incidences of "insider abuse" and that loan approvals are done according to internal and external regulations.
Keywords: Loan Scheme, Loan Security, Microfinance Bank, Management, QR Code

I. INTRODUCTION

A. General Overview

The number of people seeking for bank loans these days, especially in Nigeria has risen drastically. Salary Earners and Business Executives alike, have all been caught in the mad rush for loan, either to enable them solve some pressing personal/domestic needs, or to serve as initial capital for new business initiatives, or even to support an existing business venture. Sometime these Loan Seekers are willing even to cut corners or deceive the bank management in one way or the other in order just to have their way. The desperation of some of these Loan Seekers can easily be traceable to the poor living condition in Nigeria, and in most third world countries of the world. The poor economic situation in these countries seems to have affected both salary earners and business entrepreneurs who now see bank loan procurement as the only way to meet up with their individual and corporate financial obligations.

The COVID-19 pandemic has also fuelled the worsening economy and the living condition of most citizens. Unemployment rate has risen to its highest ebb. The desperation to survive in the land has given rise to many more individuals seeking loan opportunities from lenders, both banking and non-banking institutions. Some have even argued that without such loans, it will be quite difficult to achieve most of their economic set goals and aspirations. For Salary Earners, this can be attributed to poor remuneration, inconsistency in salary payments, inflations, as well as consistent and indiscriminate deductions in salaries, especially, those in the categories of government employees. Government workers now resort to formation of Cooperative Societies as a strong and dependable alternative to Workers' Welfare. Again, apart from assisting to meeting mutual needs of members, there is a strong belief that people can actually achieve more as a group or as members of a cooperative society. Cooperative societies have helped members in collective Estate Acquisition, accessing of soft loans from commercial banks as well as from Microfinance banks.

With an organized system, accessing of loans should be a simple and straightforward process, unlike what we see today, especially in the microfinance banking sector. The process of loan application processing should be as easy as bank management checking her client's eligibility for a loan, then approving or denying the loan request. Once approved, the customer should easily receive the funds without much delay. This is, however, not the case, especially when it comes to individual loan application processing by management of microfinance banks. These bankers often complain that some of the individual loan seekers are fraudulent deceivers and that there is need to take time to thoroughly verify their claims.

In some cases, for instances loan applicants can go as far as seeking to access multiple loans from more than one microfinance banks at the same time, using a single collateral security. Though this is against microfinance banking policy, it takes much effort and scrutiny to discover these abnormalities and sharp practices on the part of bank customers. This is obviously one the reasons for delay in loan application processing and procurement. Despite their resolve to forestall or identify these sharp practices no matter how long it takes, microfinance banks, most times still fall short of their responsibilities. There is basically no system in place to assist them in checkmating the excesses of fraudulent customers in this regard.

Apart from fraudulent bank customers, we also have fraudulent bank staff and corrupt managers to contend with. Activities of these bankers have hampered the performance of microfinance banks. This is called "insider abuse"[20]. According to [20], "insider abuse" in microfinance bank is made manifest in the granting of credit facilities. Some researchers has pointed out that a good number of Microfinance bank directors misuse their privileged positions to obtain unsecured loans for themselves and their relations, which, in some cases are in excess of their banks' statutory lending limits, and in violation of the provisions of policy of microfinance banks. Furthermore, they have been found to approve loans for their friends and relatives without proper documentation, and in most cases these loans turn out to increase cases of non-performing credit. These fraudulent activities continue to go unabated due to poor system of loan management, and lack of proper use of the digitized system.

In traditional lending systems, particularly in larger organizations, the process of loan application verification, processing, and monitoring, is often chaotic, and without an efficient verification system in place, the process of loan application processing and monitoring will continue to drag. If this is not properly addressed, instead of becoming a smooth experience, loan application processing will continue to be tedious and stressful on the part of both the lender and the borrower. Globally, several other sectors, especially the banking sectors are testing different implementations of the Quick Response (QR) code technology which seek to provide simple and unified payment solution as well as other solutions. QR Code is the trademark for a type of matrix-based barcode (or two-dimensional bar code) first designed for the automotive industry in Japan [10]. Its fast readability and greater storage capacity has made the QR code a popular technology alternative, which is now being deployed outside the automotive industry.

Research has shown that QR codes can easily be read by any smartphone camera, point of sale (POS) terminals, or other devices. Its use ranges from advertising and promotions to merchandise tracking and coupons, to accessing media on the Internet, downloading offers, locating product information, and many more. Several implementations of QR codes also exist in other fields. [8], for example, made use of the QR technology to secure and transmit patient-sensitive information from one level of the system of health care delivery to another. Getting a digital platform that incorporates the QR code technology is quite crucial for the survival of the lending business sector in this competitive market, especially with the increasing number of loan seekers across the country. The obvious challenges faced by both management and customers of microfinance banks in Nigeria leave very little to be desired [11], and as such, an effective Loan Management System is needed to streamline the process.

Despite the clear advantages of Information Technology over the manual process and its unlimited possibilities, very few microfinance banks have embraced the digital technology as a viable tool for accurate record keeping and verification. Similarly, it is no longer in doubt that the world is constantly undergoing an Information and Communication Technology (ICT) revolution. Information Technology is being deployed for more efficient goal attainment, flexibility, accurate record management, and transparency in transaction processing.

B. Aim and Objectives of Study

In this research paper, we aim at a developing a modular, scalable and integrated Loan Management system with Quick Response Code Enhancement for easyand better-secured loan processing in the microfinance banking sector and other lending institutions. Specific objectives include, to

1. Ascertain all User Requirements for efficient loan management based on customer expectations and management regulations.
2. Design a QR code-enabled digital platform that inhibits multiple loan access on single collateral security to reduce credit risk.
3. Implement the new system and test run to ensure effectiveness.
4. Make recommendations for a more efficient goal attainment, flexibility, accurate record management, and transparency in transaction processing.

II. LITERATURE REVIEW

A. The Loan Concept

A loan is a type of debt. Like all debt instruments, a loan entails the redistribution of financial assets over time, between the lender and the borrower. In a loan, the borrower initially receives or borrows an amount of money, called the principal, from the lender, and is obligated to pay back or repay an equal amount of money to the lender at a later time. Typically, the money is paid back in regular installments, or partial repayments; in an annuity, each installment is the same amount. The loan is generally provided at a cost, referred to as interest on the debt, which provides an incentive for the lender to engage in the loan. In a legal loan, each of these obligations and restrictions is enforced by contract, which can also place the borrower under additional restrictions known as loan covenants. Even though we are focusing on monetary loans in this research project, any

material object, however, might be lent. Acting as a provider of loans is one of the principal tasks for financial institutions such as banks. For other institutions, issuing of debt contracts such as bonds might be a typical source of funding.

In finance, a loan is the lending of money from one individual, organization or entity to another individual, organization or entity. It could be provided by an individual, organization or corporate body at an interest. Many borrowers have found the loans to be quite helpful in the pursuit of their individual goals either in business or other personal engagements. On the other hand, lenders also benefit from loans because of the interest attached to each loan, and as borrowers increase the more their business grows.

B. Understanding Loan Scheme Management Systems

Lenders make use of Loan Management Systems to streamline their process of checking for client's eligibility, loan approval or denial, fund disbursement, repayment monitoring, etc.In traditional lending systems, especially in large organization, this process is often chaotic. Sometimes it becomes quite cumbersome to keep track of important records owing to the fact that different customers have different terms and payment dates. The chaotic process can become even more complex to handle as the customer base increases. A Loan Management System therefore is a software system that helps to automate the entire loan process and life cycle. Depending on User Requirements, such a system can help either in part or in whole, such as processing customer information, creating new loans, manage interest rates, repayment monitoring, debt collection and recovery processes, etc. A good Loan Management System can equally provide management with accurate statements or reports at intervals. Normally, an automated loan management/lending system will do better than legacy systems in many ways. Being a digitized system, it can cater for newer generation of customers, and reduce manual errors and risks.

C. Quick Response (QR) Code Technology

According to [13], Quick Response (QR) Code (is a matrix-type (or two dimensional) barcode trademark, usually optical machine readable labels attached to items that record information related to the item. They have the ability to store information both vertically and horizontally as opposed to conventional one-dimensional bar codes that can store information only in the horizontal manner [23]. QR codes often contain data for a locator, identifier, or tracker that points to a website, application, URL, text, or other types of data, which can be easily read by the cameras of mobile devices [13]. The QR code system is one of the most used types of two dimensional codes. The main reasons for its popularity include its fast readability and its greater storage capacity when compared to standard UPC barcodes. QR codes are now used for commercial tracking applications and convenience-oriented applications aimed at mobile phone

users. Notable areas of QR deployment applications include product tracking, item identification, time tracking, document management, and general marketing.

A QR code is composed of black modules (Square dots) arranged in a square grid on a white background. It is capable of encoding four standardized types ("modes") of data (numeric, alphanumeric, byte / binary, Kanji) or, through supported extensions, virtually any type of data. This can be read by any imaging device such as a camera and processed using Reed–Solomon error correction until the image can be interpreted appropriately as required. The data required is extracted from the vertical and horizontal image pattern of the QR code. The QR code can be used to display text to the user, images, videos, and web-links to the user's device [6].

1. Functional Elements of a QR Code: According to[9], the following are the functional elements of a QR code technology: version information, format information, data and error correction keys, finder pattern, separator, required pattern, timing pattern, position pattern, alignment pattern, and the quiet zone. Fig. 1 illustrates the functional elements of the QR code technology.
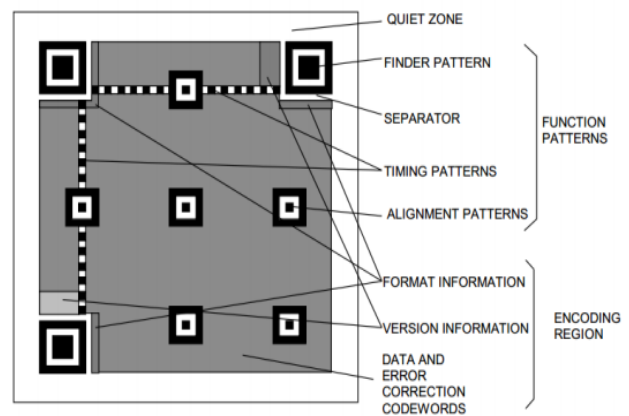
(Source: ISO/IEC, 2005)
Fig. 1 Functional Elements of a QR Code

a. *Version Information:* This element specifies the QR code version that is being used. There are currently 40 different versions of the QR code technology. However, version 1to **7** are the most widely used, especially for marketing purposes [9].
b. *Format Information:* This component contains information about the error tolerance and the data mask pattern, and it is this information that usually makes it easy for the code to be scanned.
c. *Data and Error Correction Keys:* This is where the actual data is stored.
d. *Finder Pattern:* This pattern identifies the symbol and decides the correct orientation it will take. It usually contains three collective structures which are positioned in the QR codes three angles.
e. *Separator:* This envelops the finder pattern and promotes easyidentification of the patterns.
f. *Required Pattern:* They are of three categories.
g. *Position Pattern:* These patterns or markings indicate the QR code print direction or orientation.

h. *Alignment Pattern:* Additional element that aids orientation for especially large codes.
i. *Timing Pattern:* These lines assist the QR code scanner to determine how large the data matrix is.
j. *Quite Zone:* Helps distinguish the scanning zone from its surroundings.

D. Areas of QR Code Technology Deplyment

The ubiquity of smart phones and their camera (typically used as the QR code Scanner) is the reason for its popularity and deployment in diverse areas of human endeavor. QR codes are used over a much wider range of applications such as commercial tracking, entertainment, transport ticketing, product and loyalty marketing, in-store product labeling, and marketing, where a company's product information and other details such as percent discount can be captured using a QR code decoder [9].

E. Research Gap Analysis

In this research paper, we reviewed a number of related empirical studies with the view to discovering their knowledge pap and to seek ways of filling such gaps in the current research effort. Existing systems of Loan Scheme Management so examined were good attempts towards streamlining the operations microfinance banks and other lending business organizations. But the systems are not without identifiable weaknesses and inadequacies. The research works examined include [16], [18], and many others. Some of the research gaps identified include:

1. Lack of scalability and system integration with other microfinance banks, cooperative societies, and other lenders in the same business which can help checkmate incidences of multiple loan access using the same collateral security.
2. Poor security measures to checkmate "insider abuse" and the excesses of fraudulent bank customers.
3. Slow process of loan application validation and monitoring due to heavy involvement of manual operations.
4. Need to exploit the power and potency of the Quick Response Code technology as a veritable technique capable of improving security in the lending businesses of microfinance banks.

III. METHODOLOGY AND REQUIREMENT ANALYSIS

A. The Rapid Application Development (RAD)

The Rapid Application Development (RAD) is the methodology of choice for this project following its high involvement and concentration on user's viewpoint as well as its ability to change system design on the go based on user demands. The fig. 2 shows the different stages involved in RAD [3].

Rapid Application Development (RAD)
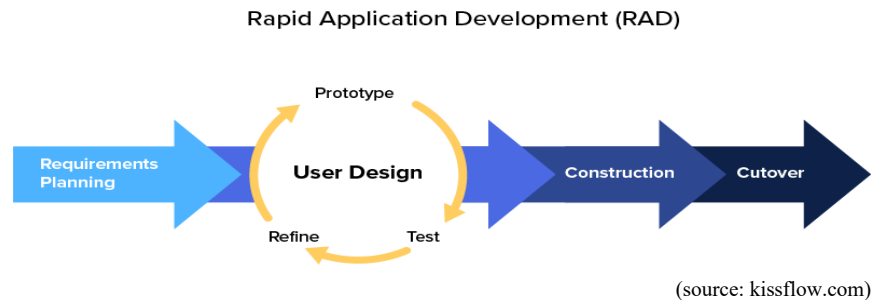

(source: kissflow.com)

Fig. 2 Stages involved in RAD

The choice of this methodology for this research study is based on the following advantages

1. Strong User stake and ownership of the system.
2. Ability to rapidly change system design based on user demands.
3. Concentration on essential system elements from user's viewpoint.
4. Best where speed of development is paramount
5. Tighter fit between user requirements and system specifications.
6. Saves mush time, money, and human efforts [3].

Furthermore, the QR code technology being proposed for use in this study is based on the RSA algorithm that follows asymmetric key cryptography used for bulk encryption and decryption.

B. Data Collection Method and Requirement Planning

Our requirement planning in this work actually started with an interview session with members of staff of staff of selected Microfinance Bank to study their business processes. We also interviewed some key stakeholders in the banking sector, and cooperative societies. Both structured and unstructured questions were posed with the aim of ensuring that accurate and honest information were gathered for user requirements analysis.

C. Requirement Analysis

Specifically, we tried to elicit information in the following areas.

1. Need for Possible Integration and Collaboration among Lending Businesses: Our microfinance banks, cooperative

societies, and other lending business has suffered the incidences of multiple loan access by fraudulent customers, who try to access multiple loan facilities from different banks using the same collateral security. The following questions were therefore posed to the bankers.

a. Do you need an integrated system that serves as regulatory agent to forestall incidences of multiple loan access using a single collateral security?
b. Do you desire an easy way to collaborate with other lending businesses to checkmate activities of fraudulent microfinance bank customers?
c. Would you like to efficiently manage all lending processes to endure drastic reduction in rising cases of non-performing loans?

2. Need for Improved Security Measures to Checkmate "Insider Abuse": Due to the perceived challenge of "insider abuse" and the need to checkmate activities of unscrupulous bank staff, the following questions were posed to stakeholders.

a. Do you require a highly secured system in place such that activities of unscrupulous bank staff will be reduced to its barest minimum?
b. Do you need a technology-assisted system that will not allow loan approvals beyond the required credit limit?
c. Do you require improved loam management system?
d. Do you think your business requires standardized lending processes?

3. QR Code-Enabled Loan Management System: Based on the successes of the Quick Response Code technology in other sectors and application areas, top managers of microfinance banks and cooperative societies were asked the following question.

a. What is your view with regards to the QR Code technology and its ability to secure your lending business from fraudsters?
b. Do you desire a better user authentication for your lending business?

4. QR Code Enhanced Loan Management System and Basic Application Features: To gather this requirement, the following questions were posed.

a. What further features do you expect your loan management system to possess?
b. Do you require improved security features?
c. Give examples of the kind of features a standard loan management system should have.

5. Instant Customer Update via an Alert system: There have been reported cases from unsatisfied microfinance bank customers and borrowers who complain of lack of access to their debt balances, and inadequate communication system with bank management. Therefore, in order to gather user

requirements in the area ofcustomer update and alert systems, the following questions were asked.

a. Do you need a functional alert system that will quickly update your customers on loan performance?
b. Do you think it will help your customers in planning when they are aware of their loan status on a regular basis?
c. What type of alert system would you like to have in place?

6. Report Generation to Improve Planning and Management Decision Making: The following questions were posed in the area of Report Generation and management decision making

a. Do you have any need for better report generation platforms for your management decision?
b. At what intervals do you think such reports should be generated?
c. What is your projected performance enhancement based on your expectations of this improved system?

At the end of our interaction session with both management and staff, including selected customers and borrowers, it was discovered that more than ninety percent (90%) of all questions were answered in the affirmative, showing the need for an improved system of loan management using the QR code technology, and from the information gathered at this stage, the following facts were established:

1. An enhanced system of QR code-enabled platform for effective loan management in our microfinance bank institutions and other lending businesses is required for a sustainable growth and development.
2. Three is need to track incidences of multiple loan access using on single collateral security
3. Existing Loan management systems in microfinance banks and cooperative societies have major weaknesses which also has been the reason for frequent and incessant complaint from unsatisfied customers and borrowers.
4. There is need to maintain higher level of user authentication using the Quick Response Code technology.
5. There is need to forestall ever increasing cases of "insider abuse" and ensure strict compliance with approved lending regulations.
6. There is need to checkmate the excesses of fraudulent bank customers.
7. There is need to speed up loan application validation and monitoring by reduced involvement of manual operations.
8. There is need to ensure timely customer update on loan performance via a good notification system.
9. There is need for efficient report generation module to facilitate effective decision making by management of microfinance banks, and
10. Need to exploit the power and potency of the Quick Response code technology as a veritable technique capable of improving security in all credit institutions.

IV. MODEL FORMULATION AND SYSTEM IMPLEMENTATION

A. Description of Major Activities of the Proposed QR Code-Enabled System

1. Quality Control Subsystem using Integrated Approach: The proposed system will develop a quality control subsystem that will check the quality of recommended loan application by member banks before a final loan approval can be issued. There is need to carry out thorough scrutiny and quality control of recommended loans against all internal rules and external regulations before final approval. Since the lending business is highly regulated, the quality control aspect of loan processing is a critical factor to all lending institutions. The application should be sent to a credible body that analyses all critical variables against internal rules and regulations, and this should serve as the last look at the application before final approval and loan disbursement.

If properly handled by an independent body of credible personnel, the quality control check can end all cases of "insider abuse" and reposition microfinance banks and other lending institution to render qualitative service, while reducing incidences of non-performing credit in the banking sector.

2. QR code technology-based System and Improved Security Measure: The proposed system will include a QR code technology-based module to guarantee improved security of the entire loan process. The central admin manager will have the privilege of generating a QR code for each approved loan which only the individual customer can access, and independent of his/her credit institution. During and after loan disbursement by member banks, individual customer accounts can be accessed using the generated security code at the point of final loan approval. Fig. 3 shows the Activity Diagram of the proposed QR code-enabled Loan Management System.
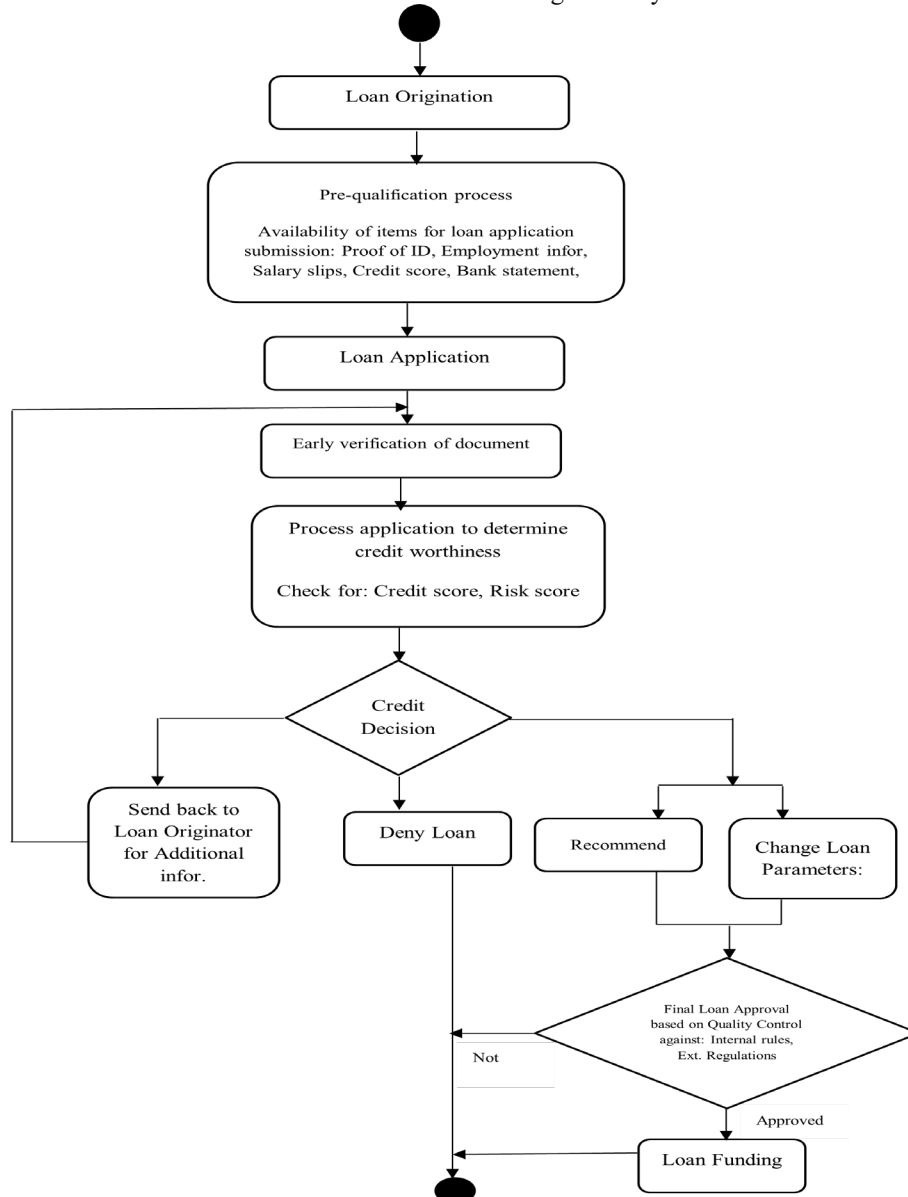

Fig. 3 Activity Diagram of proposed System

B. New Architectural Framework

Fig. 4 is the architectural framework of the new integrated loan management system.It models a QR code technology-based system that guarantees improved security of the entire loan process.
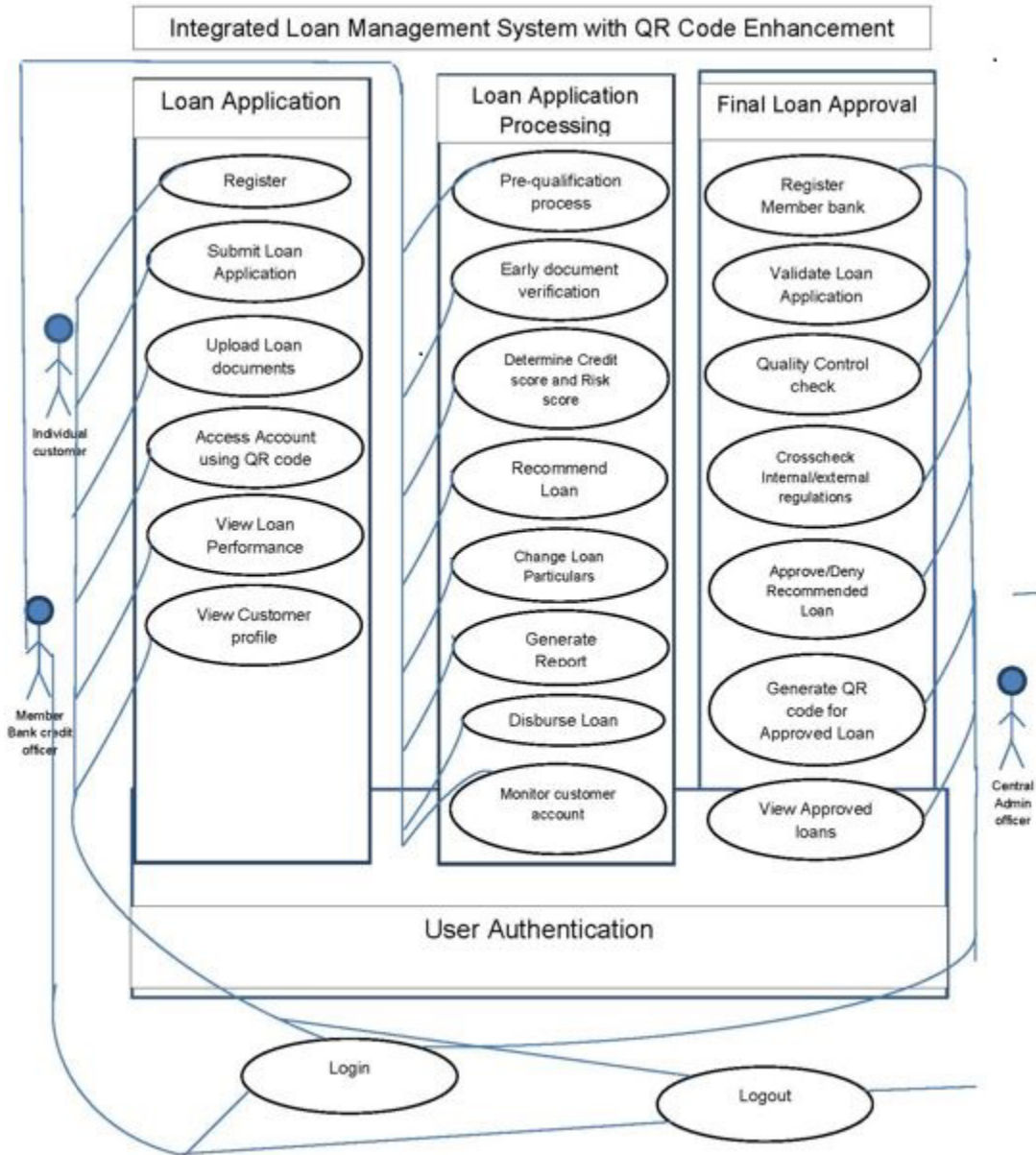

Fig. 4 Architectural framework of the new system

With the new system architecture, the Central Admin Manager will have the privilege of generating a QR code for each loan application at the point of final approval. After loan disbursement by member banks, individual account holders can access their accounts using the generated QR code.

C. System Implementation

Implementation of the New System requires that specific hardware and software be put together to guarantee efficient performance of the integrated loan management system. Various segments of the new system were implemented using the various software development tools as specified below

1. *PHP:* Hypertext Preprocessor (PHP) was used to implement server-side scripting for the new system. It was used to manage dynamic content, database, as well as session tracking for the system. This software is however integrated with MySQL and Apache.

2. *JavaScript:* JavaScript was used to implement the client-side scripts which made our web pages quite interactive for easy engagement with system users.

3. *CSS:* The cascading Style Sheet (CSS) was used to style the HTML document and for a beautiful display of important elements of our web page.

4. XAMP: This was used as the local host or server to test our web pages and clients using our own laptop computers before the work can be released to the main server. It is a good platform that furnishes a suitable environment to test and verify the working of projects based on Apache, Perl, MySQL database, and PHP architecture via the Software Developer's system of the host. We made use of the XAMP version that supports our 64-bit windows 10. It was quite useful.

5. HTML: This stands for Hyper Text Markup Language. We made use of it as the markup language of choice in the creation of our web pages for the new system.

6. Visual Studio: Visual Studio Code natively supports a good number of programming languages as a shareware cross-platform source code editor. It was used in this research work to write and edit our program codes.

V. RESULTS AND DISCUSSION

A. System Testing

All the system components were tested both unit by unit and as a single integrated whole. The testing was done by feeding predetermined sets of data to the various input sections and observed the output produced. Integration testing was performed to verify that the system components work effectively together. Functional testing was performed to evaluate the system in order to determine if the functions described by the requirements specification actually performed as expected. The new system passed all tests carried out on it and final evaluation shows that the system can be deployed for use.

B. System Output

Some of the screenshot of input/output screen are presented as follows.
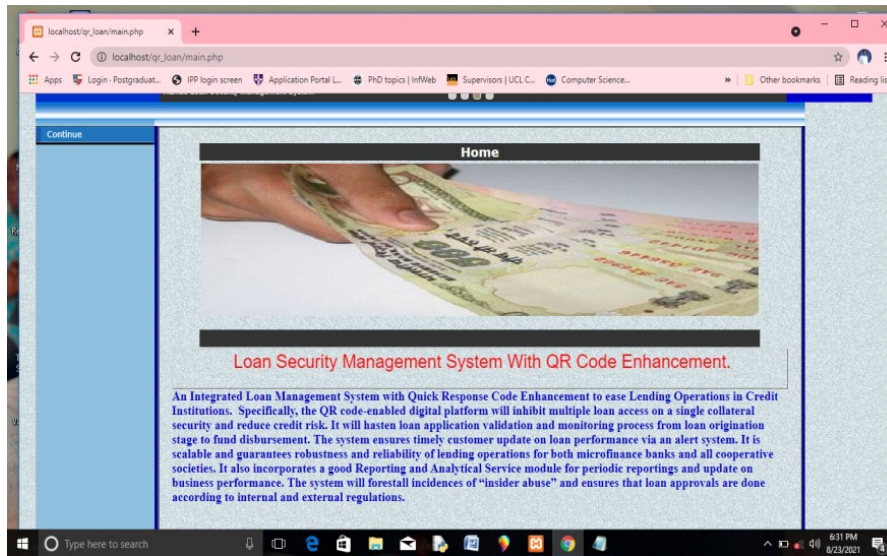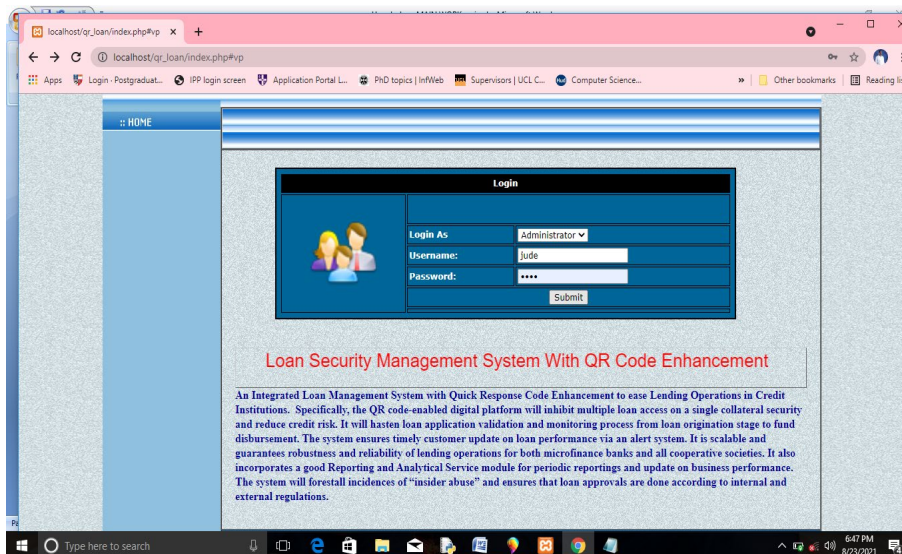

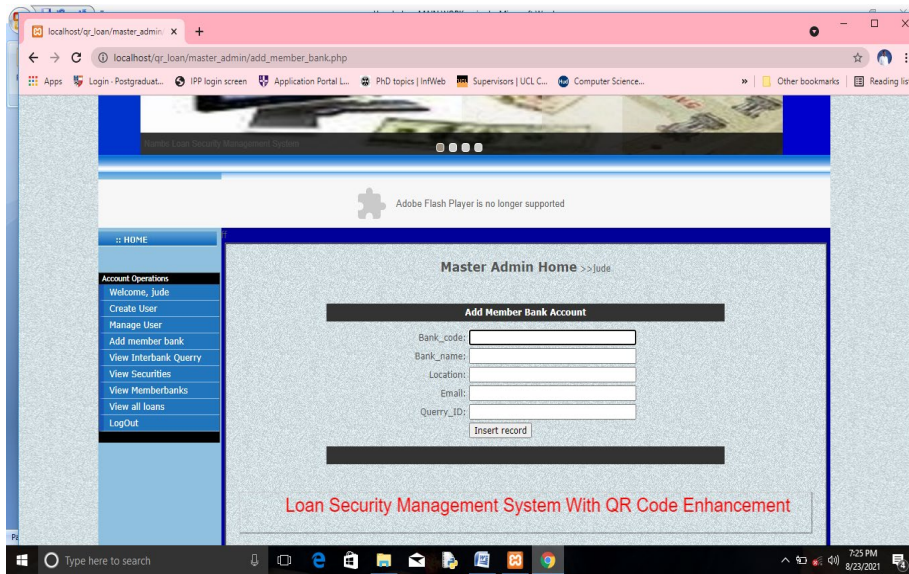Fig. 5 Home page screen

Fig. 6 Login page

Fig. 7 Master Admin section

Fig. 8 QR Code generation screen

VI. CONCLUSION

In this research paper, we have designed an integrated Loan Management with QR code technology enhancement for easy loan application validation and processing in all Lending Businesses.Due to the rising number of microfinance bank customers in need of personal loans, especially in the post COVID-19 era, management is faced with the complex job of loan application verification in order to correctly determine eligibility for a loan. There is the challenge of coping with fraudulent customers who make false claims with their loan application documentations, sometimes seeking to access multiple loans from more than one microfinance banks at the same time, using a single collateral security. There arises a need therefore for an integrated loan management system to link other lending institutions in a collaborative effort to forestall incidences of multiple loan access using single security.

VII. RECOMMENDATIONS

We recommend an early implementation of the findings of this research paper tittles "An Innovative Framework for Integrated Loan management with QR code Enhancement". The system should be implemented and deployed in the Nigerian Banking sector, especially Microfinance banks, and lending institutions, including Cooperative Societies for improved operational efficiency. There is need for a concerted effort by all stake holders, Government Agencies, Bank operators, Businessmen, and so on, to take advantage of the opportunities offered by the emergence the QR code system, Computing and Information Technology, to improve the sector. We also encourage government should encourage the establishment of a central coordinating body in the microfinance banking sector and other lending institutions. There should be an establishment of more stringent regulations to curb the menace of "insider abuse" in the microfinance banking sector.

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