



Architecture and Development of an Automated Workflow System for Employees' Savings & Loan Scheme in Nigerian Universities

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ABSTRACT:- Employees' savings and loan scheme is a voluntary contributory savings scheme from employees' salaries established by employees in most universities in Nigeria to assist themselves whenever the need arises. Employees' are faced with various operational and administrative challenges from their various loan schemes. The major challenge is the delay in service delivery due to their manual workflow system. In this research work, interview and observations techniques were used to gather facts. The software architecture of the automated system was designed, system modeled using use case and sequenced diagrams to show how employees' can interact with the automated system and the system was also developed using Hypertext PreProcessor (PHP), JavaScript, Hypertext Markup Language and MySQL to handle all the system and operational processes. The web based application developed captured the employees' personal biodata and monthly contributory savings through different interfaces developed. The employees' interacted with the system from the comfort of their offices and homes via Internet connectivity. The application also perform functions like online application for loan facilities, checking of total contributions, tracking of loan application status and other services rendered by the savings and loan scheme. We achieved our research objective in the design and development of the web based automated workflow system. The system was tested to be effective and efficient in terms of storage, retrieval of information, security of records, and general operations. The application is recommended for usage in Nigerian universities.

Keywords:- Architecture, Automated Workflow, Savings & Loan Scheme, Nigerian Universities

I. INTRODUCTION

Workflow is the definition, execution and automation of business processes where tasks, information or documents are passed from one participant to another for action, according to a set of procedural rules. Organizations use workflows to coordinate tasks between people and synchronize data between systems, with the ultimate goal of improving organizational efficiency, responsiveness and profitability.

Workflows automate the flow of employee tasks and activities, reducing the time the process took to complete as well as potential errors caused by human interaction. Workflows make processes more efficient, complaint, agile, and visible by ensuring that every process step is explicitly defined, monitored over time, and optimized for maximum productivity. Given optimal, up to date minute process data, managers and employees can take quicker action and make smarter decisions. Workflows empower business users and Information Technology to work together to rapidly modify systems and processes to reflect changes in the business.

Application of workflow technology to mobile computing, systems management, multi databases, the internet, application development, object technology, operating systems, and transaction management has been discussed extensively^[1]. A workflow may describe business process tasks at a conceptual level necessary for understanding, evaluating, and redesigning the business process. On the other hand, workflows may capture information process tasks at a level that describes the process requirements for information system functionality and human skills.

Welfare is seen as a commitment reflected in the expressed care for employees at all levels^[2]. Employee welfare is a comprehensive term including various services benefits and facilities offered to employees by employer. Employee welfare specifically includes providing staff and workers' canteens,

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providing savings schemes, pension funds and leave grants, making loans on hardship cases, providing assistance to staff transferred to another area of the company and providing fringe benefits to workers^[3]. Job satisfaction is generally recognized as a multifaceted construct that includes employee feelings about a variety of both intrinsic and extrinsic job elements. It encompasses specific aspects of satisfaction related to pay, benefits, promotion, work conditions, supervision, organizational practices and relationships with co-workers^[4]. Welfare schemes are a means to improve the productivity and efficiency of the employees. The various types of employee benefits includes pension schemes, personal security, financial assistance, personal needs, subsidized meals, clothing allowance, mobile phone credit, company car and petrol allowance among others^[5].

In some Nigerian Universities, employees voluntarily join any of the different workers union welfare and loan schemes or associations available based on their job classification on assumption of duty^[6].

Despite the numerous positive advantages the savings and loan scheme has been rendering, there are still problems on daily basis in coping with the challenges of day-to-day operations and service delivery of the scheme. Some of the specific challenges are identified below:

- (i) Delay in the scheme services delivery due to manual processes.
- (ii) Computational errors and poor records filing / storage system.
- (iii) Inability for a contributor to check the amount they have saved quickly, make loan request from the comfort of their offices or homes, and tracking of loan status without physically going to the scheme's office.

The main research objective of this research work is to design and develop an automated workflow system for employees' savings and loan scheme in Nigerian universities using Savings and loan schemes in Ambrose Alli University, Ekpoma as test bed.

II. RELATED WORK

There exists different approaches to formally specify and enact business processes and also it is almost impossible to provide a complete overview of related work, especially in the area of workflows and business processes. In contrast to imperative modeling languages^[7, 8] proposed ConDec; a declarative language for modeling and enacting the dynamic business processes based on Linear Temporal Logic (LTL). Declarative Service Flow language (DecSerFlow) was proposed by^[9] to enact, specify, and monitor service flows, which is a sister language for ConDec. Both languages share the same concepts and are supported in the Declare tool^[8]. Our automated workflow approach was inspired partially from *ConDec* and *DecSerFlow* models^[7, 9] with respect to the usage of unified modeling language, but our model has fewer process flows than LTL, but more simplified and expressible than the LTL in terms of functionality, and usability.

Another major paradigm in business process modeling is the artifact-centric approach, which strongly argues that data design should be elevated to the same level as control flows for data rich workflows and business processes. In this area, several researchers like^[10, 11, 12] have been working with artifact-centric or data-centric workflows. As part of the artifact centric models, a declarative approach has been taken in the recent years for specifying the life cycles of business entities, using the *Guard-Stage-Milestone* (GSM) life cycles model^[13, 14, 15]. The GSM model is a declarative process model for specification of interactions between business entities and its operational semantics are based on rules similar to Event Condition Action (ECA) like rules from Active database community. In comparison, their main focus is on business artifacts which takes the data-centric view of processes, where as our automated workflow approach is on the business processes using web based programming languages / tool, modeled using unified modeling language (UML), and developed using the Rapid Application Development (RAD) model approaches, where the functional control flow is more explicit than data-centric processes.

III. MATERIALS AND METHODS

The materials and methods used in this research work included data collection, software architectural design, web application architectural design, modeling of the system's interaction using use case and sequenced diagrams and building of the software prototype using the right choice web development programming languages.

3.1 Data Collection

We used interview and observation techniques to gather data about the various the savings and loan schemes in Ambrose Alli University, Ekpoma, Nigeria.

3.2 Software Architectural Design

Software architecture intuitively denotes the high level structures of a software system. It can be seen as the set of structures needed to reason about the software system, which comprises the software elements, the relations between them, and the properties of both elements and relations^[17].

Software architecture also denotes the set of practices used to select, define or design software^[18].

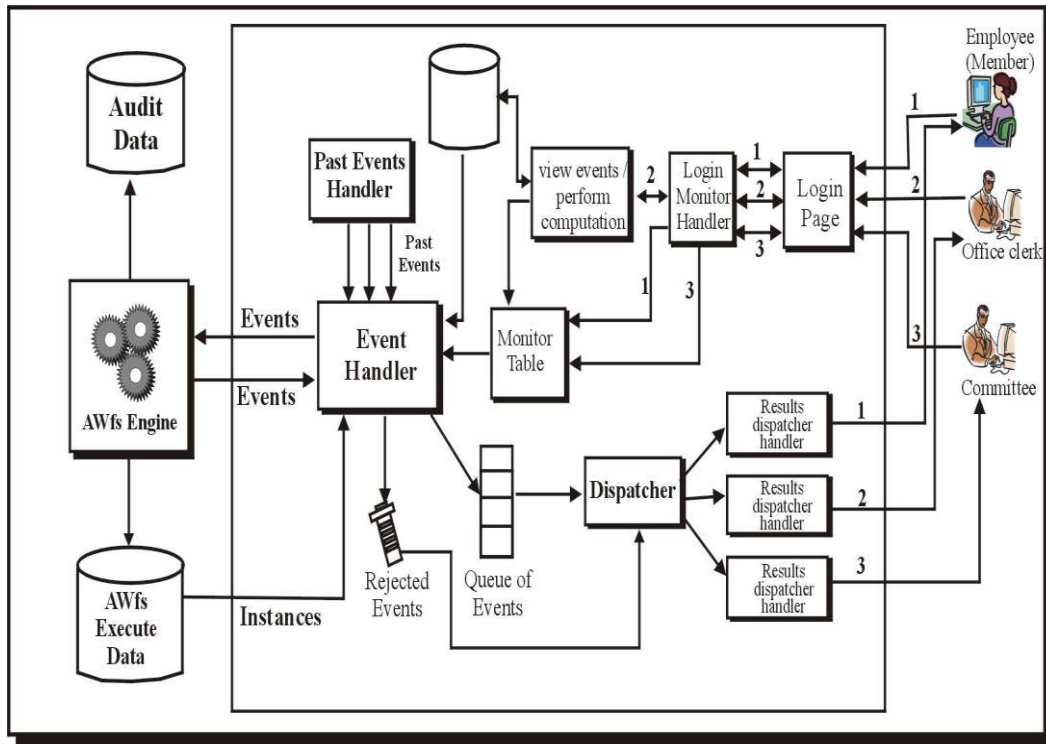


Figure 1. Automated Workflow System Architecture Adopted from [6]

Figure 1 depicts the software architectural design of the proposed automated workflow system for savings and loan scheme. Process here is a program in execution to perform some kind of task, and the process definition of this software is built using a hierarchical decomposition method in order to control the complexity of the design. The processes in this design are also structured to operate on different levels.

The login page accepts login parameters from the different users requesting for access; it sends details to the next phase login monitor handler which monitors and performs users authentication by verifying the parameters entered with details it has in the monitor tables before granting the different users access, rights and privileges. Users can then perform certain actions based on their rights / privileges. In this research work, there exist basically four (4) types of users, namely, employee member user, office admin or office clerk user, and approval committee user, and system admin user. The role of the system admin is silenced in the normal operations, so it is not represented in the architecture. The actions or events are processed by the event handler which sends and receives actions to and fro the automated workflow system engine (AWfs Engine) using certain rules and decisions. The event handler commits such actions to the database for storage, and also sends events messages to queue of events for onward transmission to the various users through the dispatcher handler.

3.3 Web Application Architecture

The web works based on the client/server architecture, that is, both a central server and a client application are responsible for some amount of processing. Web applications (WebApps) are applications that are accessed with a web browser over a network such as the Internet or intranet. We structured our proposed web application as a 3-tier application. That is the web browser constitutes the first tier, a middleware engine using some dynamic web content technology such Hypertext Preprocessor (PHP), JavaScript, and Hyper Text Markup Language (HTML). The database server being the third tier in which we used MySQL which is a relational database management system.

Figure 2 shows the web architectural design in block diagram. Here, connection is established to the web server via the Internet using client wi-fi enabled devices. The web browser is used to make request to the web server; the web server searches the middleware engine for the information requested by the web browser, if found or not, the web server responds by returning the interrupt back to the browser which either displays the home page of the site found or it displays site not found. The developed application is a dynamic web site, i.e. it interacts with the database (MySQL) to retrieve data from it or commit data to it from the web application interface displayed on any browser used.

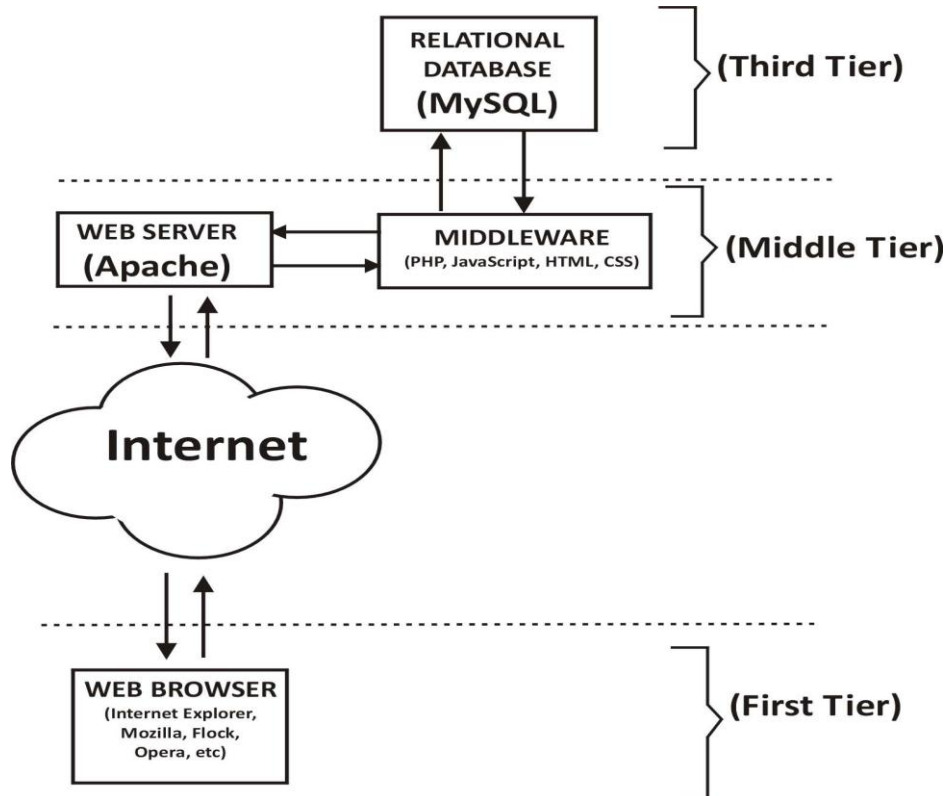


Figure 2. Web Application Architecture

3.4 System Modeling using UML diagrams

Unified Modeling Language (UML) is a standardized general-purpose modeling language in the field of object-oriented software engineering. It includes a set of graphic notation techniques to create visual models of objects-oriented software intensive systems. We used the use-case and the sequenced diagrams to model our proposed application because it provides a wide array of diagrams for analysis and design modeling at both the system and the software level.

3.4.1 Use-case diagram

A use case diagram is a representation of a user's interaction with the system. Figures 3 and 4 shows the use case diagrams for the different types of user, and also it portrays the users interaction with the system features at their various levels.

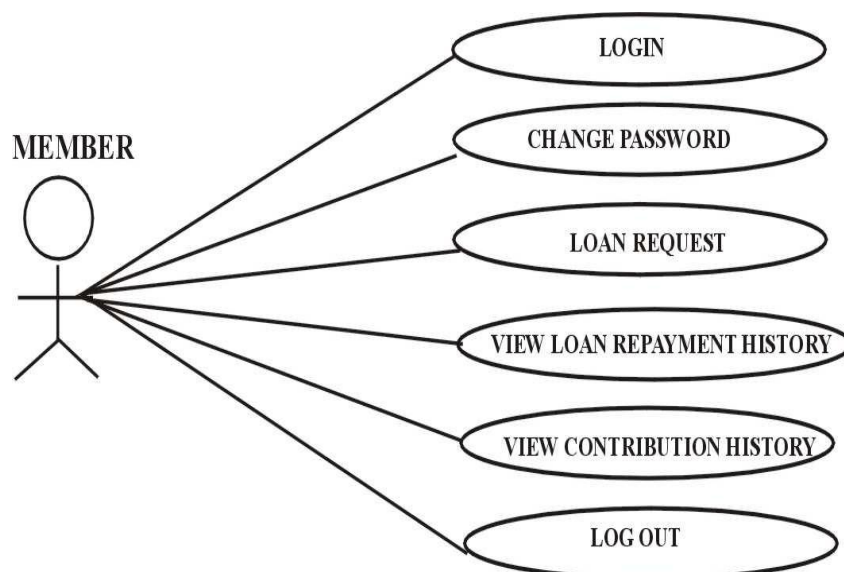


Figure 3. Member interaction with the developed system features

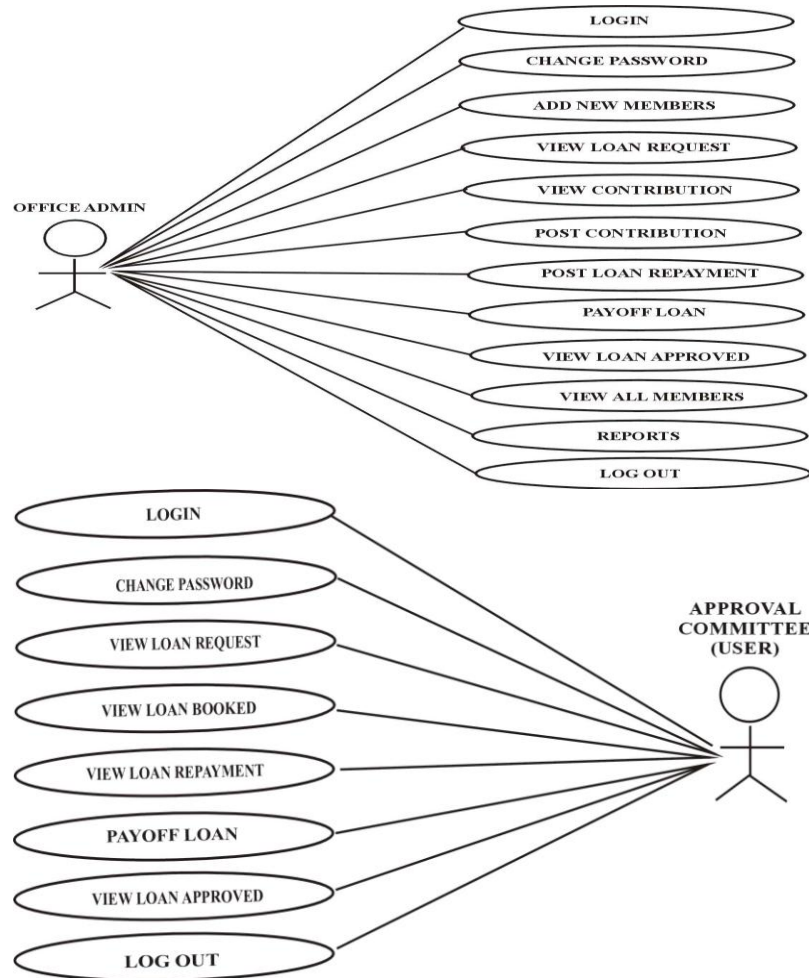


Figure 4. Office admin and approval committee interaction with the developed system features

3.4.2 Sequenced diagram

A sequence diagram evolves as the systems development progresses. It shows the interaction between users of the system / objects or class in order to get a particular task or process done. The sequenced diagram shown in Figure 5 depicts interaction between different users of the system from the loan application stage to loan approval and finally the report generation stage.

Here, employee who is a member of the welfare scheme request to login to the automated workflow system application through the login interface, and the application grants the request if the correct users details entered is correct. Next, the member can request to change his or her password, and the request will also be granted. Member can request to view his or her personal contribution, before requesting for loan facility through the loan request interface; the request will be granted. Next, the office admin request to view loan applications from members, request is also granted. Office admin treats request and then forward to the approval committee. Approval committee request to view loan request forwarded by the office admin, request is granted. Approval committee approves or rejects the loan request based on certain criteria, and then sends the decision back to office admin for further processing. Members at this stage can also make request again to view their current loan status, the application will grant the request. Office admin can also make request to process the loan repayment plan and then request to generate reports, request will be granted by the application. Finally, the approval committee can also request to generate reports, request will also be granted.

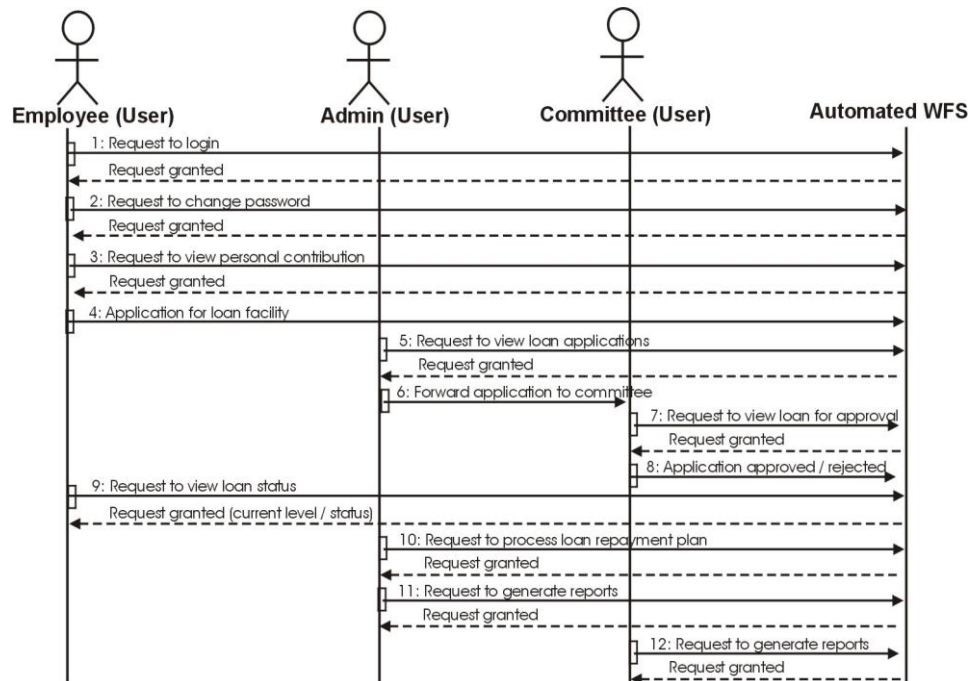


Figure 5. Interaction between users and the developed system for loan application processes

3.5 Programming Language for Building the Software

At this level of abstraction, the syntax and semantics of a programming language for the development of the system is defined. The choice of programming language used in software development should be of utmost importance. We built our proposed system using web programming languages like Hypertext Preprocessor (PHP), JavaScript, Hypertext Markup Language and MySQL. These web languages were carefully selected because of their strengths and the purpose we need to achieve.

IV. IMPLEMENTATION AND TESTING

In implementing our proposed system, we considered the hardware and software platform requirements necessary to fully deploy our web application solution.

Table 1: Computer system specification (Server)

Processor	Intel Xeon
Memory	16GB
Hard Disk Drive Space	1 Terabyte
DVD ROM Drive Speed	16X Rewritable
Display	1024 x 768 Resolution, SVGA
Network Interface Card (NIC)	Fast Ethernet NIC (100Mbps/1Gbps)

Table 1 shows the server computer system specifications in which the developed application will be deployed to and tested from. The processor is Intel Xeon, with a random access memory of 16GB which is large enough to hold the operating system, apache web server software and the developed automated workflow system for employees' welfare and loan scheme application running processes temporarily in its memory. The hard disk drive storage capacity is 1 Terabyte which is also large enough for storing the application and data files. The DVD ROM Drive is 16X speed for installing the application system and backup of data files. The monitor display supports a high resolution capacity of 1024 x 768 picture elements (pixel) for clearer picture quality, and a Fast Ethernet Network Interface Card (NIC) of 100 Megabits per second (Mbps) speed. This is necessary for quick access to and fro the server system.

Table 2: Client devices specification

Client Devices	Specifications
Notebook computer	Intel duo core processor, 2GB RAM, 120GB HDD, DVD ROM, and Built-in WLAN card.
Smart Phones	iPhone, Black Berry, Samsung, Techno with built-in WLAN card.
Desktop computers	Pentium IV Processor, 1GB RAM, 100GB HDD, SVGA, NIC
Tablets	Techno, Samsung, etc with Built-in WLAN card

Table 2 shows the various client devices specifications our software solution tested with for hardware compatibility issues. They were all successful in making request to the server.

4.1 System Testing

After integrating all the modules that will implement the system features and functions, we then tested the integrated system as a whole. Under the system testing, four fundamental testing activities were actually carried out, namely, functionality testing, security testing, navigation testing, and compatibility testing.

(i) Functional testing: we tested the page content, and online forms developed (loan request form, and membership application form).

(ii) Security is a primary concern when communicating and conducting critical and sensitive businesses over the Internet or intranet. A user of the web application wants assurance that their personal and financial information is secure. In securing our developed web application, we considered the following: User's authentication, User's access rights to certain information, locking the toolbar of the web browser to prevent viewing of source code disclosure of any vital information.

(iii) Navigation testing: Accessing navigation is also a part using the web application. Most users expect the following from our web application: Easy and quick access to the information they want, confirmation of where they are at any point, facility to return to previous states or the home page, consistent look and layout of every page, uncluttered web pages. After considering some of these expectations, we developed our web application based on key issues with navigation testing that includes: moving to and from pages, scrolling through pages, testing hyperlinks within the web application.

(iv) Software compatibility issues in terms of client devices operating system and web browser software to be used were key challenges for us when developing this web application. We ensured that the users sees a web page as we intended, and that the users can select different web browser software and client devices to run our developed web application using the right choice of cross platform programming language. We tested our web application on the following web browsers : Internet Explorer, Opera, Mozilla Firefox, Flock, and Crazy Browser from various client devices successfully without any incompatibility issues

V. RESULTS AND DISCUSSIONS

The software architectural design adopted, and the programming languages used in the development to the software prototype. The expected results were achieved starting from the home page interface, security login page, users control panel, online loan request application form, processing form, and finally the report interfaces. Figures 6, 7, 8, 9, 10 and 11 shows different snapshots of some of the vital interfaces developed.

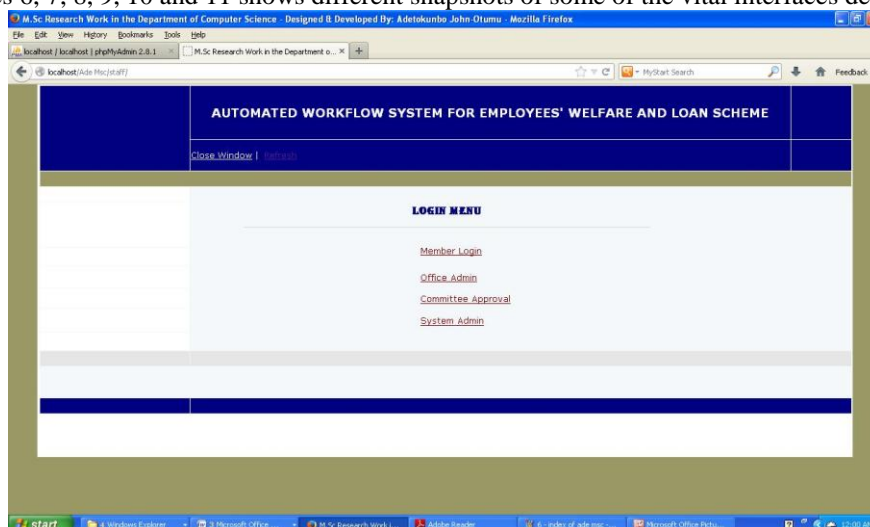


Figure 6 home page of our proposed web application

Figure 6 is a snapshot of the Automated Workflow System for Employees' Welfare and Loan Scheme home page we developed. When a user enters the correct domain name address from any client's device web browser Uniform Resource Locator (URL) address bar, the application home page is the first user's interface that will appear for interacting with the system. It has a login menu that can branch out to four different users' control panel.

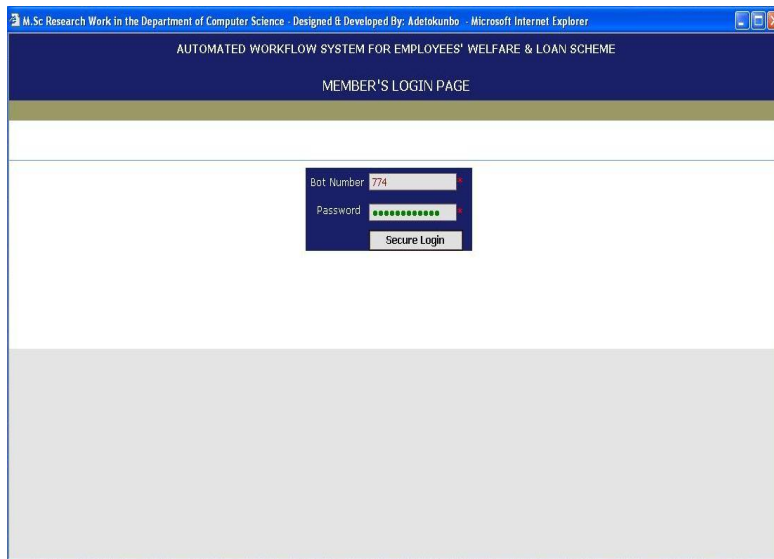


Figure 7 member login page for authentication

Figure 7 shows the member's login page for authenticating the system users. The user must enter the correct parameter (BOT Number and Password) in order to gain access to the system features. When wrong details are entered, access is denied to the system features.



Figure 8 member's control panel

Figure 8 is a snapshot of a member's control panel with its information displayed as a result of the correct authentication process. User can make loan request, view loan status, view repayment history and contribution history.

While figure 9 shows a snapshot of the view loan request for processing interface on the office admin user control panel sent by a member requesting for loan. The office admin views the details, cross check, before adding his input by certifying the amount to be okay on the approval comment text box, and then route the message to the approval committee by clicking the sent for approval before finally clicking the submit button to post and end that process.

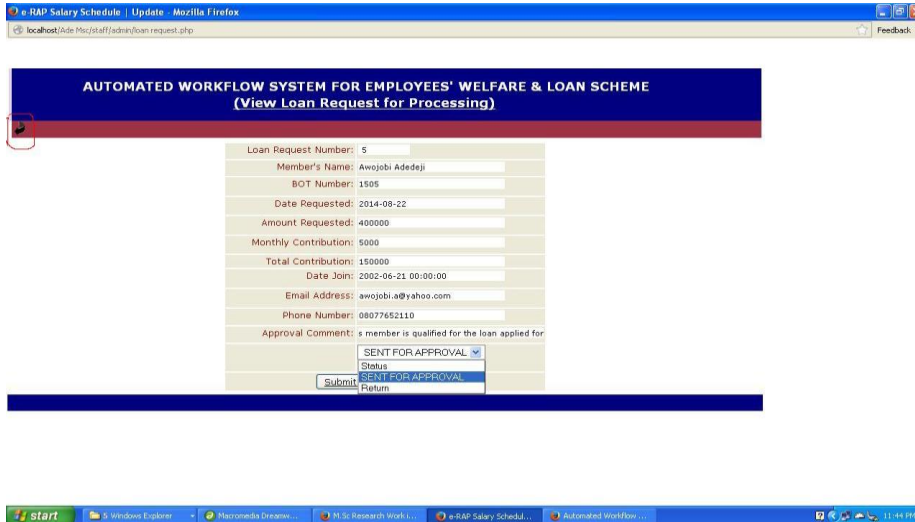


Figure 9 loan request for processing interface

Figure 10 shows a snapshot of the sample output report generated (softcopy) on list of members currently saving with the welfare scheme to date.

S.D	First Name	Surname	Department	BOT No	Oracle No	Monthly Contribution	Amount Contributed	Bank	Bank Acc No	Loan Amount	Monthly Rentals
6	Salami	Jako	Electrical /Electronics	1005	1000	2,000.00	10,000.00	Guarantee Trust Bank	3000010000	0.00	0.00
8	Ehir	Agbokabho	Banking and Finance	7005	7000	4,000.00	120,000.00	Keystone	7000110011	0.00	0.00
3	Adetokunbo	John-Otumu	Banking and Finance	774	41010	5,000.00	260,000.00	UBA	1002600277	0.00	21,667.00
7	Abraham	Peko	Law	6005	6000	10,000.00	460,000.00	Union	600011001	0.00	27,083.00
5	Ayodeji	Akomolafe	Chemistry	2001	2010	10,000.00	350,000.00	UBA	1200340076	0.00	0.00
9	Oluwale	Oluwafemi	Electrical /Electronics	8005	8000	8,000.00	250,000.00	Sterling	800010010	0.00	0.00

Figure 10 Sample output report generated on list of members (softcopy)

Staff Names	BOT No	Loan Amount	Monthly Rentals	Total Repayment	Interest Rate	Tenor	Date Disbursed
Orave Helen	bot111	240,000.00	13,000.00	312,000.00	15.00	730	2014-03-06
John-otumu Adetokunbo	774	400,000.00	21,667.00	520,000.00	15.00	730	2014-03-09
		640,000.00		832,000.00			

Figure 11 Sample report generated on loan disbursed for the month of march

Figure 11 shows a snapshot of the report generated on loan disbursed for the month of March 2014. The report captures the staff name, BOT No, loan amount, interest rate, amount to be paid on monthly basis, and date the amount was disbursed.

5.1 Findings

The following were our findings from this research work:

- i. The proposed automated workflow system for employees' savings and loan scheme routed documents very well on the network and database to the users responsible for working on them within the organization, thereby reducing the delay in end to end services delivery.
- ii. The proposed system was able to store, retrieve, secure records, and transmit information from one user to another more effectively and efficiently.
- iii. Members of the savings scheme were able to check their savings or contribution with the scheme, make loan request and track loan status with ease online.

5.2 Contribution to knowledge

We contributed to knowledge in the sense that the proposed automated workflow system for employees' savings and loan scheme provided new software architecture with single solution platform for any savings and loan scheme within university system in Nigeria.

VI. CONCLUSION AND RECOMMENDATIONS

We achieved our research objectives completely. The proposed automated workflow system provided new software architecture with single solution platform for any savings and loan scheme administrators within the University system. Test results shows that the proposed system carefully reduced the delay in the end-to-end services delivery. We strongly recommend the application for usage in the savings and loan schemes present in Nigerian universities.

VII. FUTURE RESEARCH WORK

Besides the need of further extension to the software architecture in terms of integrating multi-software agent-based architecture for monitoring the entire workflow, this research work also leaves many open challenges and issues for future research. We will briefly mention some of them in the following sections below.

7.1 Software Methodology

Rapid Application Development (RAD) Model was adopted for the development of this web based application. We strongly suggest other software methods specifically made for web based application development like the Web Engineering (WebE) process to be investigated.

7.2 Security Issues

Web threat is very rampant in most web based applications. Our research work concentrated mostly on security issues based on within our web application operations using users' authentication and users' rights and privileges. Further research work should also consider the areas of security from external attack like SQL code injection, Cross Site Scripting (XSS), and so on.

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