DEVELOPMENT OF WEB-BASED ENTERPRISE WORKFLOW MANAGEMENT INFORMATION SYSTEM: A CASE STUDY OF COMSYSTEM COMPUTER AND TELECOMMUNICATION LTD (CCTL), EKET

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ABSTRACT

In this paper, a web based workflow enterprise Management Information System (WfMIS) is developed to replace the traditional paper-based workflow management system used at Comsystem Computer and telecommunication Ltd (CCTL). The WfMIS was developed through a light weight software development methodology known as Modified User-Centered Incremental Model (MUCIM).The system is implemented on windows platform using ASP.NET, SQL Server 2012, and Internet Information Server (IIS) web server.The system was tested at CCTL Eketand the results shows that the proposed WfMIS was able to eradicate most of the challenges faced by computer and equipment maintenance unit and their clients due to the bottlenecks associated with the manual and paper-based order request process that has been use at CCTL Eket.

INTRODUCTION

In recent times, workflow management system (WfMS) has continued to attract the attention of enterprises that are looking for ways to implement technologies that will replace their inefficient traditional paper-based manual system and also facilitate business process automation and re-engineering efforts. Business process management (BPM) provides a holistic management approach to supporting this effort by providing sophisticated tool kits (modelling tools) to document processes in a standard form and to build workflow process models that are easily transformed into computed-based solutions. The goal of BPM is to continually improve the business and information processes in the company [1]. Business process represents sequence of activities which, organization undertakes to transform business inputs to corresponding business related outputs [2]. Once an organization has captured its business processes, software development projects are faced with the decision on how to support these processes properly. At this point, workflow technology comes into the picture [3].

Workflow management involves: process modelling, that requires workflow models and techniques for capturing and describing a process; process reengineering, that requires techniques for optimising the process; and workflow implementation and automation, that requires methodologies and technologies for using information systems and human performers to implement, schedule, execute and control the workflow tasks as described by the workflow specification [4]. On the other hand, a Workflow Management System

(WFMS) is defined as: "a system that defines, creates and manages the execution of workflows through the use of software, running on one or more workflow engines, which is able to interpret the process definition, interact with workflow participants and, where required, invoke the use of IT tools and applications" [5, 6, 7, 8].

In this paper, development of a web-based Workflow Management System (WfMS) for capturing and managing requests for computer systems maintenance and equipment repair at CCTL Eket is presented. This offers greater opportunities for management of workflows. The WfMIS is based on the "to-be" swim lane workflow process diagram developed for the Computer Maintenance and Equipment Repairs (CMER) unit of CCTL Eket. The system is designed to provide the computer lab technicians and the unit management and their clients with a tool for capturing and monitoring equipment maintenance events, reviewing equipment history and resolving equipment malfunctions. The system allows clients to report faults, which are automatically routed to the CMER unit for approvals and computer lab workers for execution. A Modified Rapid Application Development (MRAD) that incorporated object-oriented design (OOD) approach was employed. The OOD was implemented successfully using ASP.NET as workflow engine. The proposed system is able designed to eradicate most of the challenges faced at the CMER unit and their clients due to the bottlenecks associated with the existing manual and paper-based order request process that is currently running at the CMER unit of CCTL Eket.

REVIEW OF RELEVANT LITERATURE

In Business and Workflow Process Management Initiatives (BWPMI) the vital element is business process. According to Workflow Management Coalition [9], "a business process is a set of one or more linked procedures or activities which collectively realize a business objective or policy goal, normally within the context of an organizational structure defining functional roles and relationships". Similarly, according to [2] and ISO 9000:2000 standards, a 'business process' is "a structured and measured, managed and controlled set of interrelated and interacting activities that uses resources to transform inputs into specified outputs (goods or services) for a particular customer or market" [10, 2]. The interrelated activities of business process when modelled or properly defined provide the avenue through which business processes can be managed or optimized for business efficiency and effectiveness. Business Process Management (BPM) provides methods to enable continuous analysis, optimization and management of the business processes, resulting in higher business process visibility [11]. BPM involves managing the end-to-end work that organizations perform to create value for their customers [12]. BPM software is a model-driven workflow environment that makes the model executable, while keeping the model as central focus for future process changes.

Similarly, workflows are at the core of business processes. According to [13], workflow is concern with the automation of procedures where documents, information or tasks are passed between participants according to a define set of rules to achieve, or contribute to, an overall business goal [9].Workflow is used to automate the repetitive activities of business processes by so doing bring automation and efficiency to the business process. Workflow management (WfM) is a technology that supports the reengineering of business and information processes. Basically, Workflow Management Systems (WFMSs) are software systems designated to

implement Workflow management tasks i.e. manages workflow execution, by interpreting the process definition, interacting with workflow participants and, where necessary, call up external other tools and applications. The Workflow Management Coalition (WfMC) defines

workflow as: "the automation of a business process, in whole or part, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules." [5, 6, 7. 8].

METHODOLOGY

The development of theweb-based enterprise Workflow Management Information System (WFMIS) for the management of requests for computer maintenance and equipment repairs at CCTL is conducted using a Modified User-Centered Incremental Model (MUCIM) method of Figure 1. The development methodology starts with requirement elicitation. During the preliminary requirement stage, user and system requirements were acquired mainly via interviews, observations, focused group brainstorming and discussions along with use case diagram modeling and low fidelity prototyping. Among other sources, majority of the requirements were obtained through interaction with the CCTL lab workers and their clients. After the requirement elicitation, the requirements are analyzed after which the requirement specification is produce. Subsequently, the requirement specifications produced are used as inputs for the development of the "as-is" workflow process model which was then re-engineered to develop the "to-be" workflow process model. Then, the MUCIM continues with definition of the WFMIS functionalities based on the "to-be" workflow process model.

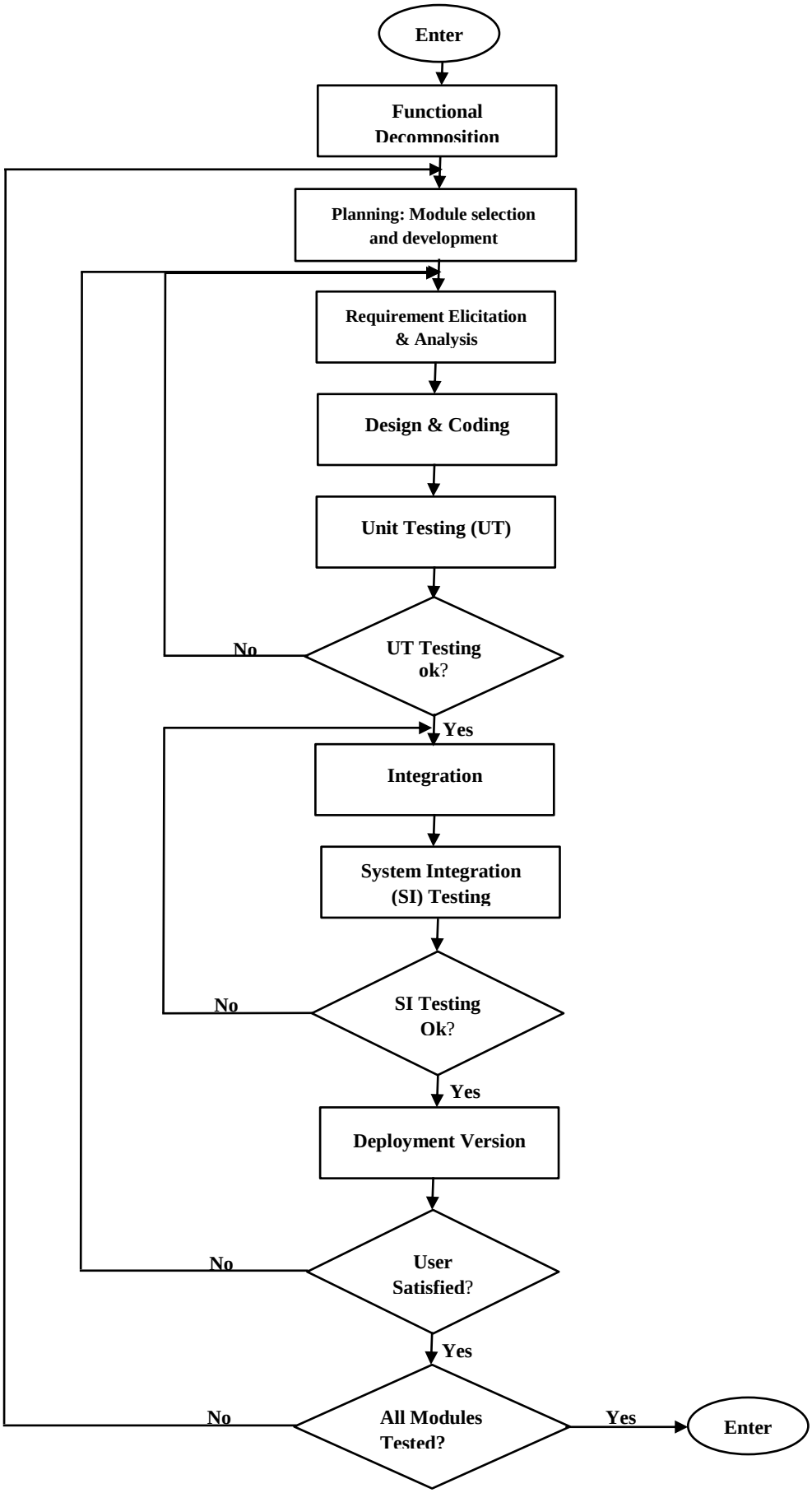

Figure 1: The Modified User-Centered Incremental Model (MUCIM)

THE "TO-BE" PROCESS MODEL DEFINITION

A. USER REGISTRATION AND USER ACCESS MANAGEMENT

User registration starts (in Step 1 of Figure 2) with the user/client notifying the system administrator (Admin Worker) of any access needs or issues. Upon the reception of the user/client login challenge notification, the Admin Worker signs in (Step of Figure 2) and creates (Step 3 of Figure 2) new user account or rectifies the access issues via manage settings (Step 4 of Figure 2). The Admin Worker then provides feedback through e-mail to the user/client (Step 10 of Figure 2). In the case of new user, Admin Worker sends account details (username and password) for sign in via e-mail to the user/client; the registration process ends (Step 5 of Figure 2).

B. THE ORDER SERVICE REQUEST (OSR) PROCESS

The "to-be" Order Service Request (OSR) process model, shown in Figure 2 starts in Step 6 with a registered client signs in Step 7 of Figure 2 using his account details. Non-registered system users are registered by Admin Worker via registration process stated above. Upon successful login, the client can submit order or report a fault by updating online OSR form (Step 9 of Figure 2). Once the request is submitted by the client, the system automatically notifies the client's Departmental Manager (DM) who needs to authorize it (Step 17 of Figure 2). In order to authorize OSR form, the DM signs in (Step 18.), views and then authorizes the request (Step 19.). The DM may choose to reject request or subject the request to a number of modifications. If the OSR is rejected, the system will automatically notify the client via e-mail of the rejection (Step 12.), then the order process ends (Step 13.). In the case where the OSR form is modified, the client will be notified (Step 11.) via phone by the DM of the required changes. On the other hand, if the DM authorizes the request (Step 19.), the system will automatically notify the Lab Worker (Step 14.) who will needs to sign in to process the authorised OSR form for the Work Order Process in Step 15. Then OSR process ends in Step 16 after the Work Order Process in Step 15.

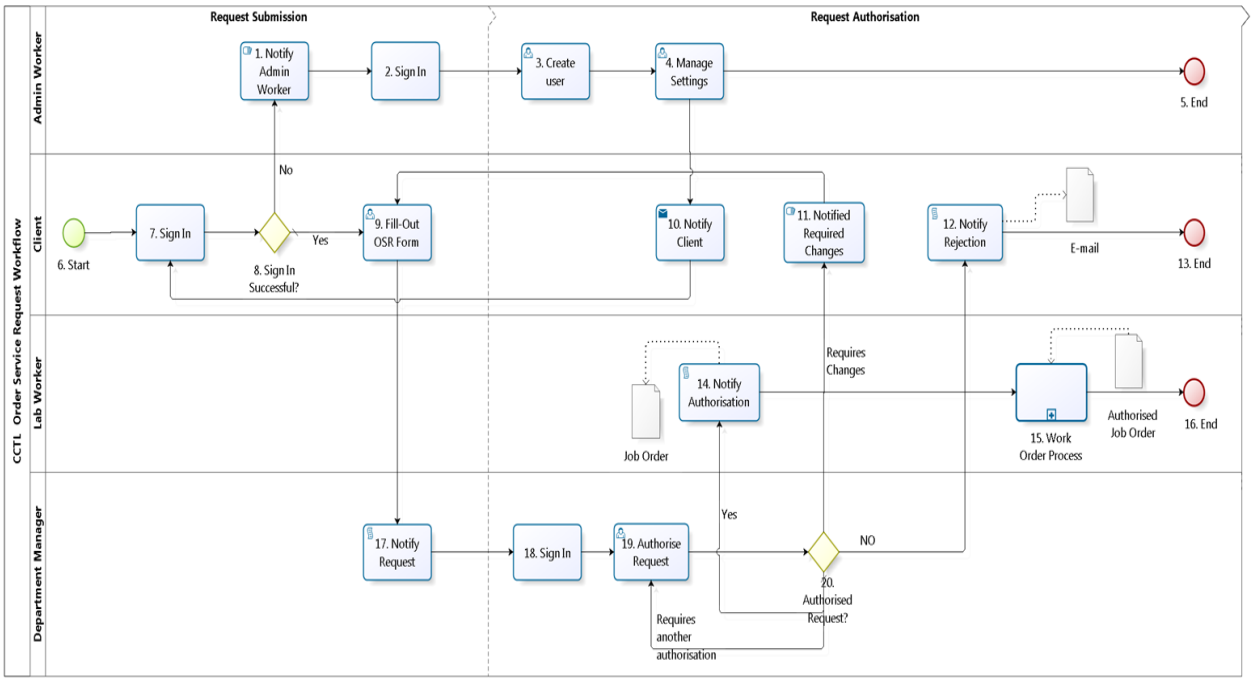

Figure 2: The "To-Be" CCTL Order Service Request Workflow Process

C. The "To-Be" Work Order (WO) Workflow Process

The "to-be" WO process starts with work order creation phase of OSR process, where the Lab Worker in the ITTCM unit signs in (Step 24 of Figure 3) updates/creates online work order (Step 25 of Figure 3) and submits it for the Lab Manager's approval when material item is needed for the execution of the OSR. The Lab Manager is the IT/Technical Computing Unit Manager. When material item(s) is/are not required, upon online completion of WO, the Lab worker proceeds with the execution of the work order (Step 29.). When material item(s) is/are needed for WO execution, upon online submission of completed WO by the Lab Worker, the system will automatically notify the Lab Manager (in Step 38). Lab Manager sign in (Step 39.), approve request (Step 40.) At this stage, the Lab Manager may request for modification for number of times within the time frame from the Lab Worker via phone before final approval. Upon approval by the Lab Manager, the system automatically sends notification (Step 28.) to the Lab worker to progress to WO execution processes. This is usually the case when material item(s) is/are needed for WO execution.

The WO execution phase starts with execute work order (Step 29.) and terminates with update WO status (Step 36.), where the status describes the final execution state, which can be completed or deferred. In the case where work process is completed, the Lab Worker proceeds with arrange delivery process(Step 35). Otherwise, if work process is not completed, WO is deferred (Step 32.) and work order process (Step 34.) restarted. At the end of the WO process, WO status is updated (Step 36.), client is notified (Step 21.), and then the entire "to-be" OSR workflow process (Step 37).

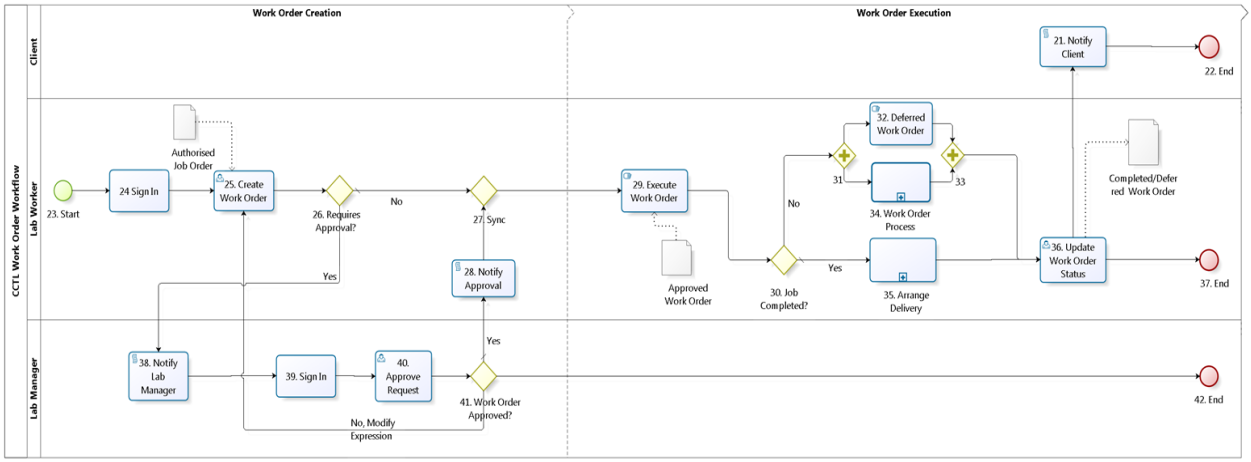

Figure 3: The "To-Be" Work Order (WO) Workflow Process

WFMIS USE CASE DIAGRAM

Use Case model is used to represent user's interactions with the system. In this paper, use case model of Figure 4 is used to capture the requirements of the WfMIS system and also depicts the different types of users of the system and the various ways that they interact with the system. Five types of actors interact with the system, namely; Admin Worker, Clients, Department Manager, Lab workers and Lab Manager. The description of the interactions of each of the actor in the system is presented in the description of the **functionalities and workflow activities of the** WfMIS **actors.**

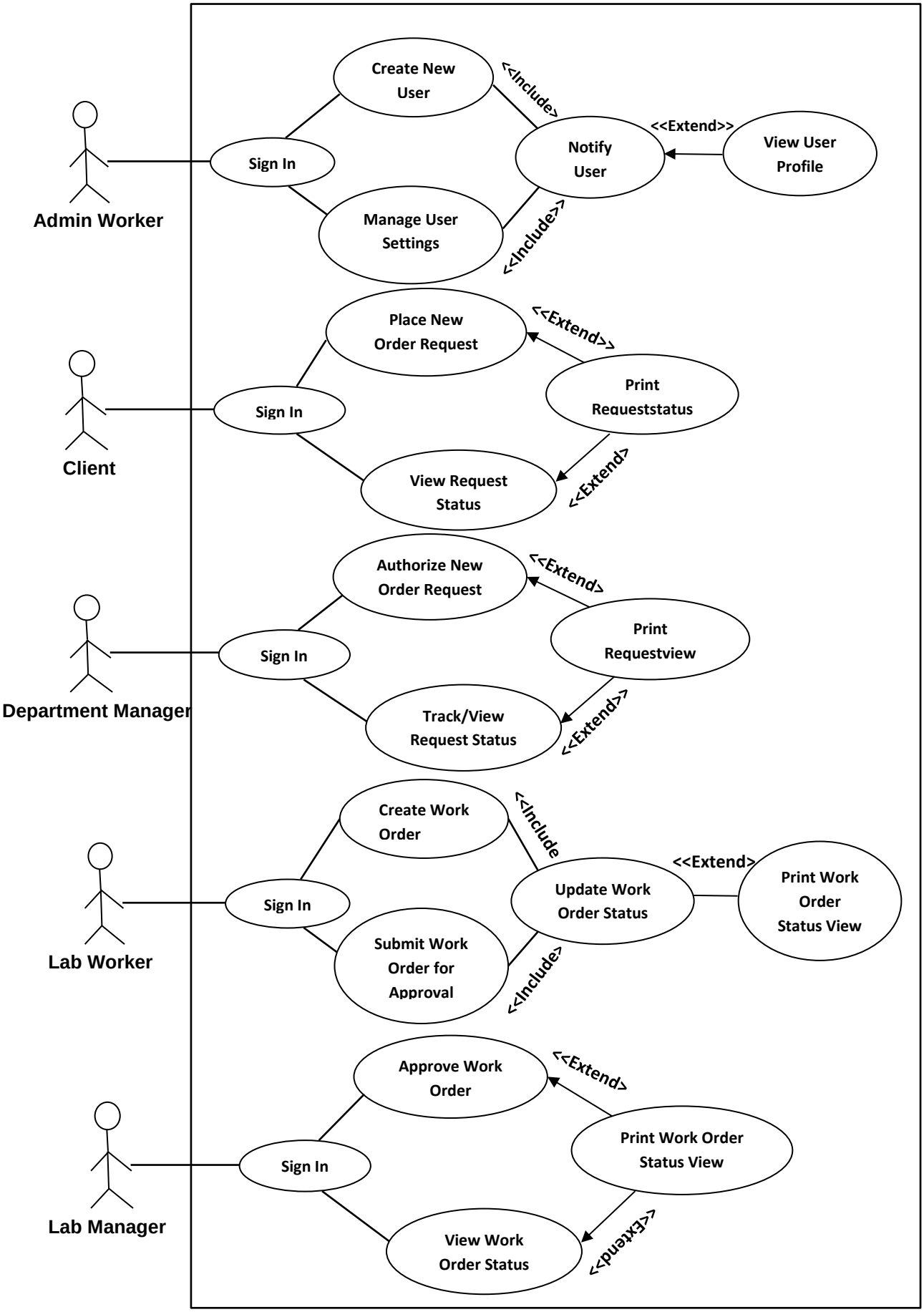

Figure 4: WFMIS Use Case Diagram

FUNCTIONAL DECOMPOSITION OF THE WFMIS

The functional decomposition of the **WfMIS** as given in Figure 5 is developed from the "to-be" process model of Figure 2 and Figure 3.

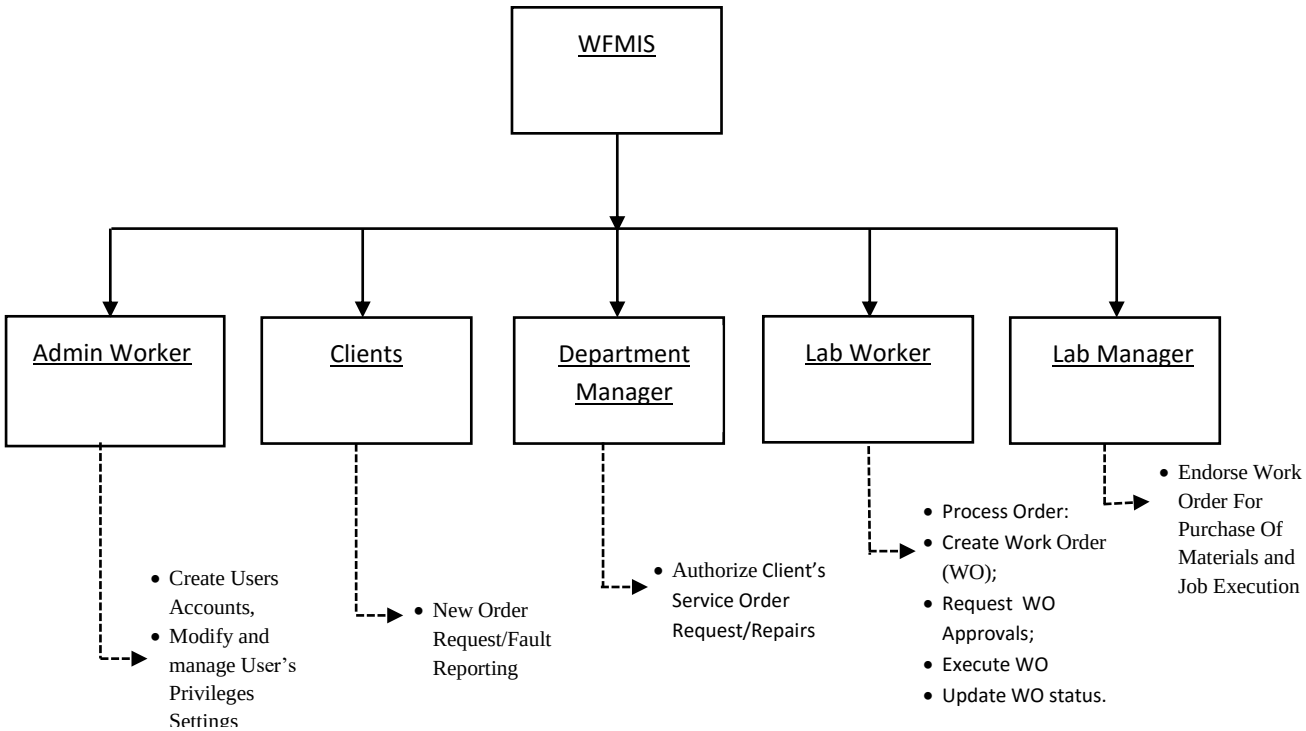

Figure 5: Functional decomposition Diagram for the proposed System (WfMIS).

THE FUNCTIONALITIES AND WORKFLOW ACTIVITIES OF THE WfMIS ACTORS:

a). The Admin Worker's Functionalities And Workflow Activities…… Admin worker's **functionalities** are given in the **functional decomposition diagram of Figure 6 while the** Admin worker's workflow activities are given in Figure 7

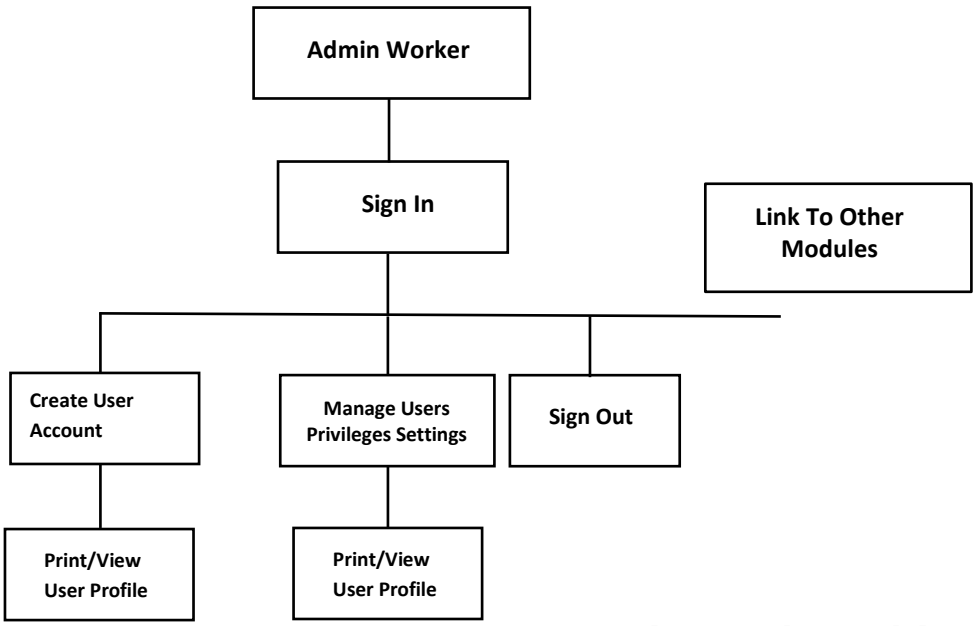

Figure 6: Functional Decomposition Diagram for the Admin Worker Module.

Admin worker's workflow activities in Figure 7starts with sign in, create user account information and save the record; system validates the entry and proceeds with inserting the record to the UserAccount table in the database. If the system encounters error while validating entry, error message is displayed. Then the process will be repeated once again.

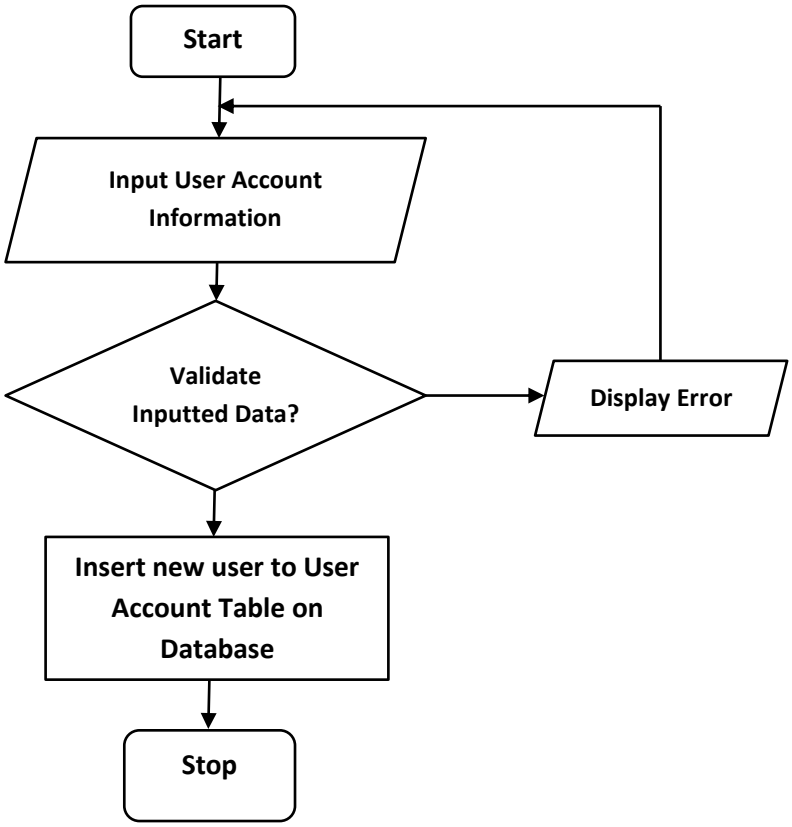

Figure 7: Workflow for the Admin Worker's Functionalities

b). The Client's Functionalities and Workflow Activities

The Client's functionalities are given in the functional decomposition diagram of Fig 8 while the Admin worker's workflow activities are given in Fig. 9. The client's workflow in Fig 3.8 starts with sign in, inputting new order requests or reporting a fault, save new order request; system validates the entry and proceeds with inserting the record to the Order Request table on the database. If the system encounters error while validating entry, displays error. Then the process will be repeated once again.

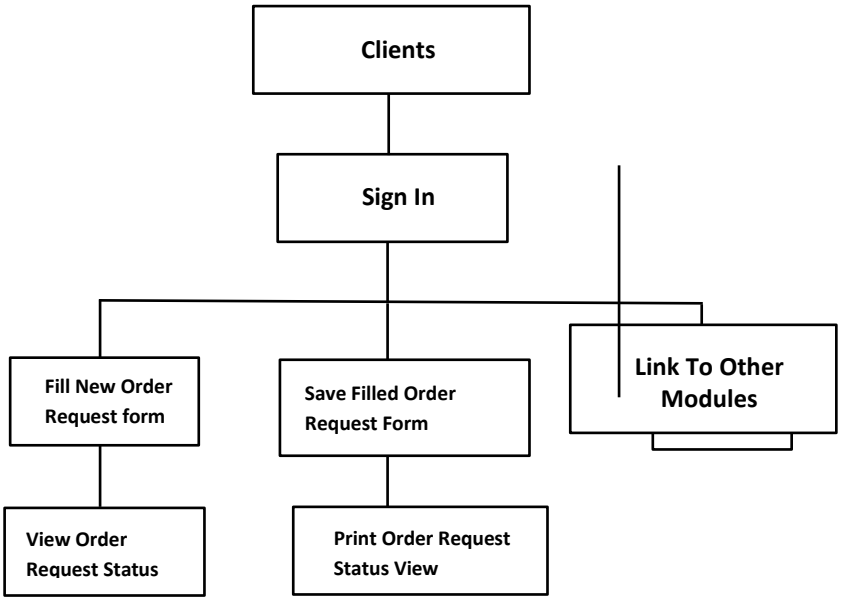

Figure 8: Functional Decomposition Diagram for the Client's Module.

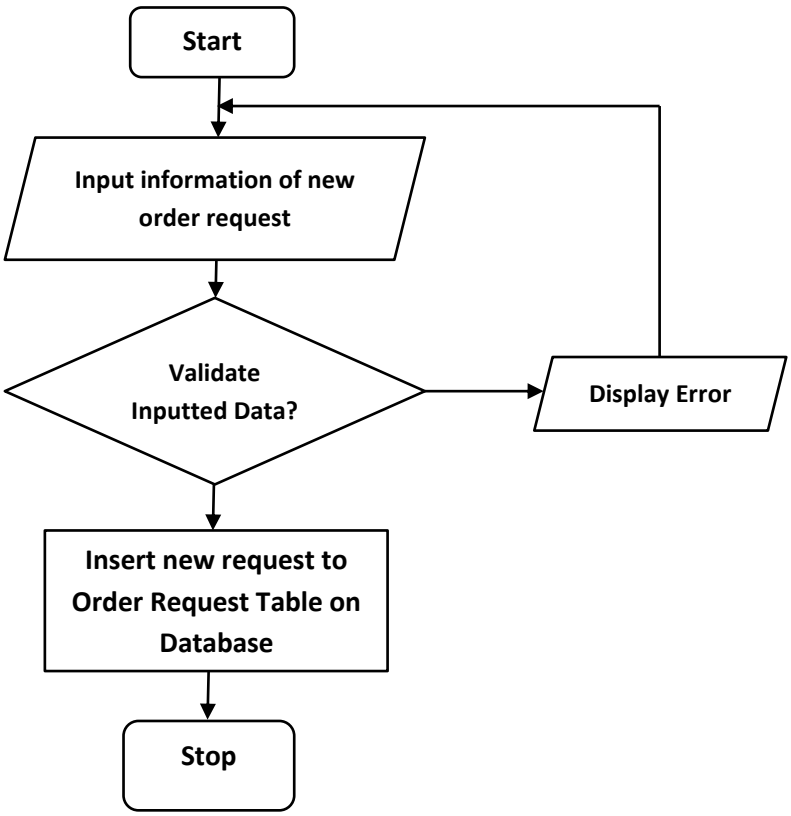

Figure 9: Workflow for the Client's Functionalities

c). Department Manager's Functionalities and Workflow Activities

The functionalities of the Department Manager's module includes;

- Home button to navigate to other module/home page
- Sign into the system and change password
- Request status category radio button
- New order request pane with optional authorize or reject check boxes
- Submit Button to save record to the database

- View/print order requests status
- Sign Out

The Department Manager's workflow starts with sign in, Click radio button to select appropriate request status, select new order requests, select/check appropriate optional check box to approve or reject and save record via submit button; system validates the entry and proceeds with inserting the record to the Order Request Status table in the database. If the system encounters error while validating entry, displays error. Then the process will be repeated once again.

d). Lab Worker's Functionalities and Workflow Activities

The functionalities of the Lab Worker's module includes;

- Home button to navigate to other module/home page
- Sign in to the system and change password
- Order request status category radio button
- Work order creation pane
- Save Work Order button to save record to the database
- View/print work order status
- Sign Out

Lab Worker's workflow starts with sign in, click to the radio button to select appropriate order request status, select work order creation pane, update relevant data and submit for approval if material item(s) are included in the work order, update work order status; save work order to save record; system validates the entry and proceeds with inserting the record to the WorkOrder table on the database. If the system encounters error while validating entry, displays error. Then the process will be repeated once again.

e). Lab Manager Functionalities and Workflow Activities

The functionalities of the lab manager module include:

- Home button to navigate to other module/home page
- Sign into the system and change password
- Request status category radio button
- New order request pane with optional approve check box
- Save button to save record to the database
- View/print order status
- Sign Out

The Lab Manager's workflow starts with sign in, Click radio button to select appropriate request status, select new work order, check appropriate optional check box to approve work order with material item(s) and save record via save button; system validates the entry and proceeds with inserting the record to the WorkOrderStatus table on the database. If the system encounters error while validating entry, displays error. Then the process will be repeated once again.

WFMIS CLASS DIAGRAM

The WfMIS class diagram, **Figure 10** provides captures of some aspects of objected oriented design used in the WfMIS design. Specifically, the WfMIS class diagram provides an overview of the WfMIS by describing the objects and classes inside the system and the relationships between them.

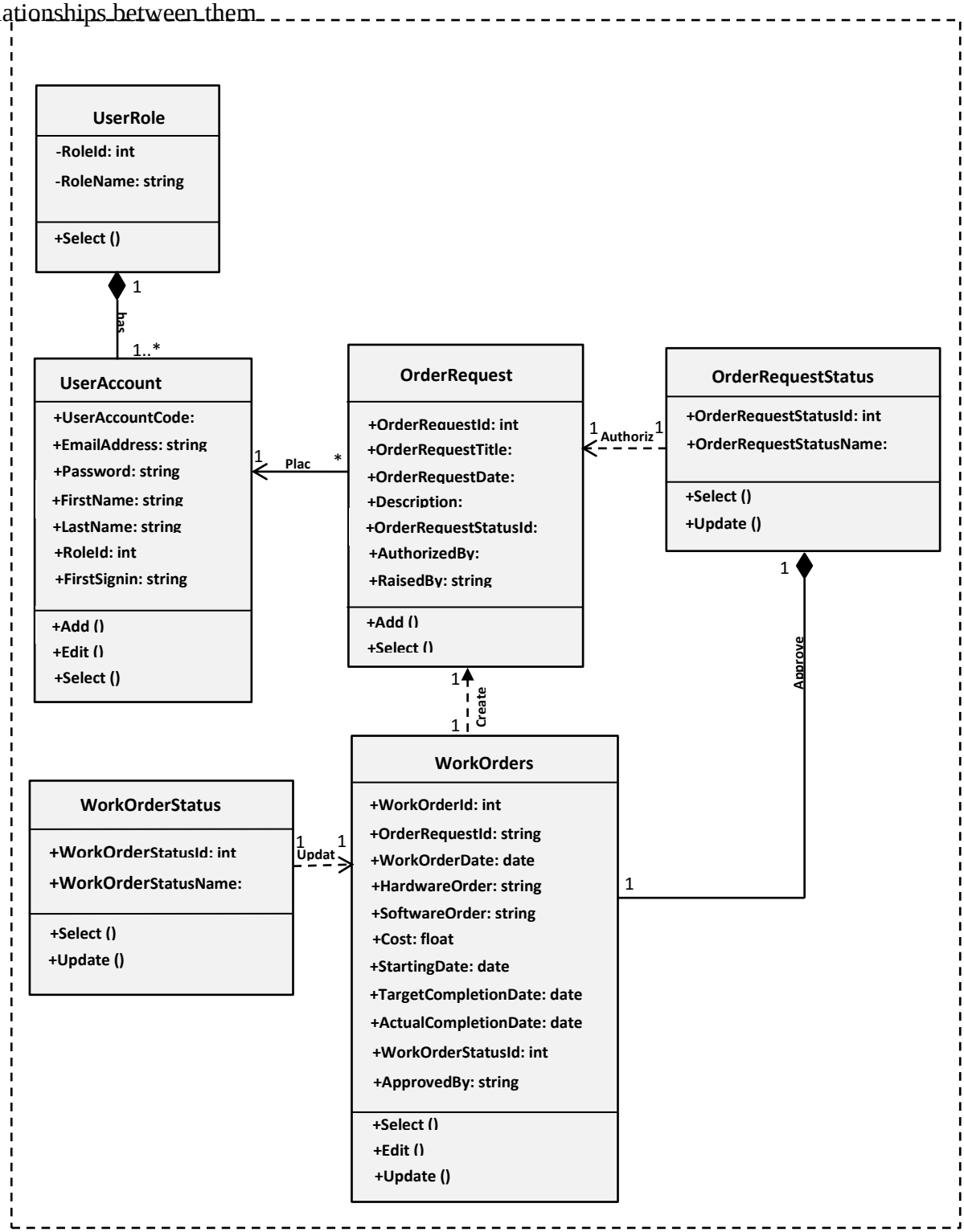

Figure 10: The CCTL WFMIS Class Diagram

THE WFMIS DATABASE ER SCHEMA

The database schema is based on the entity-relationship (ER) diagram (Fig. 11) which is a graphical representation of the database entities and their relationships to each other,

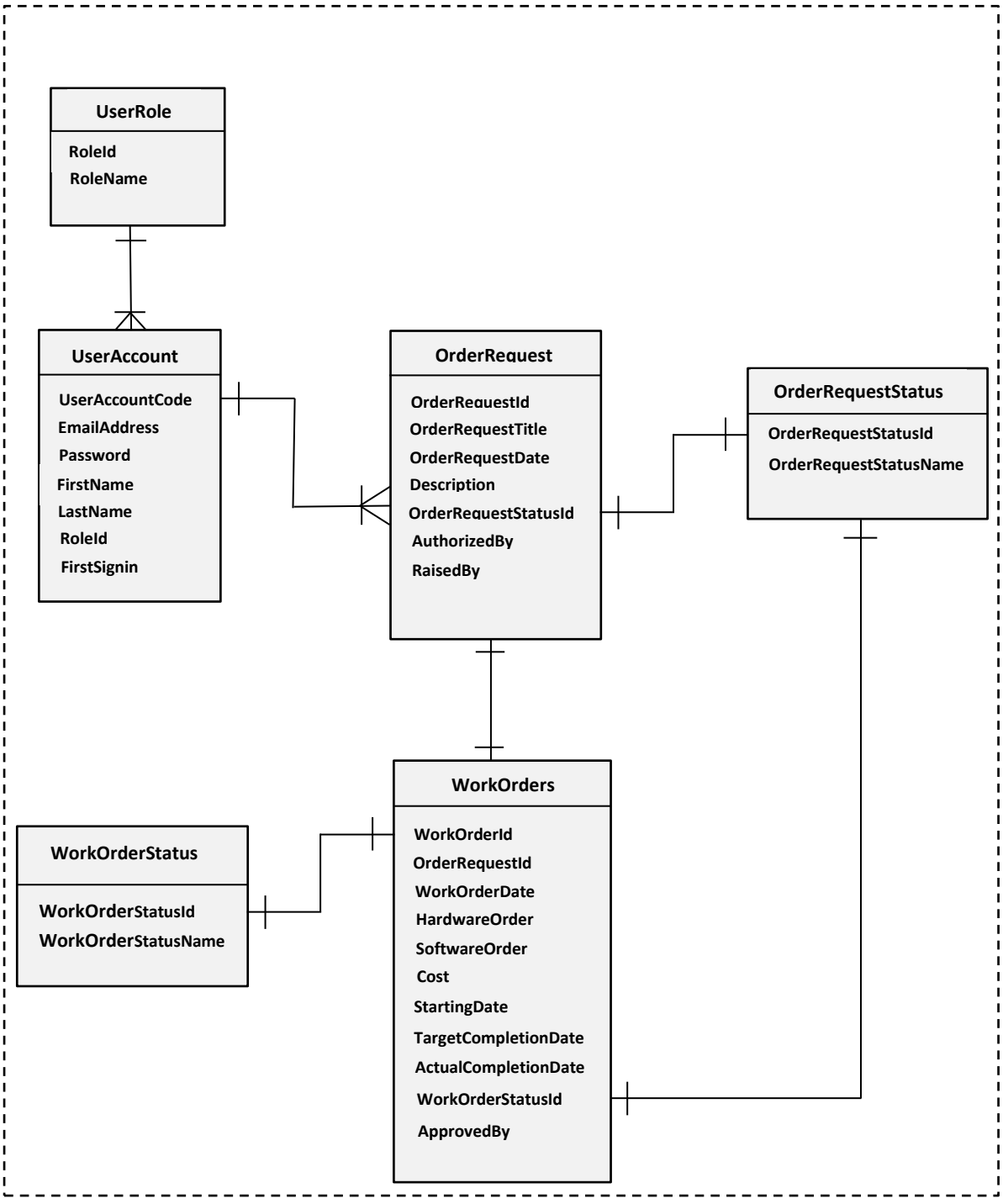

Figure 11: WFMIS Database Entity Relationship (ER) Diagram

RESULTS AND DISCUSSIONS

Home Page Screen Shot

Figure 12: Screen Shot of the CCTL WfMS Home Page

Figure 12 is the screen shot of the CCTL WfMS Home Page. On the Home Page the five major modules in the system are shown. The modules are based on the five major categories of actors in the system. New user (client) desiring to place order request must request access to the system through phone call or email routed to the Laboratory Administrator who creates or modifies the user'slogin particulars and access profile.

On Figure 13 is the **Screen Shot of Order Submission Page.** New order request form is access after login by clicking on the New order request button in Figure 13. At this point, the client provides the order request details. On click of save order request button, the order is inserted into the system database. The workflow engine then automatically routes a mail to the department manager responsible for authorizing users need, notifying him of the user's request order.

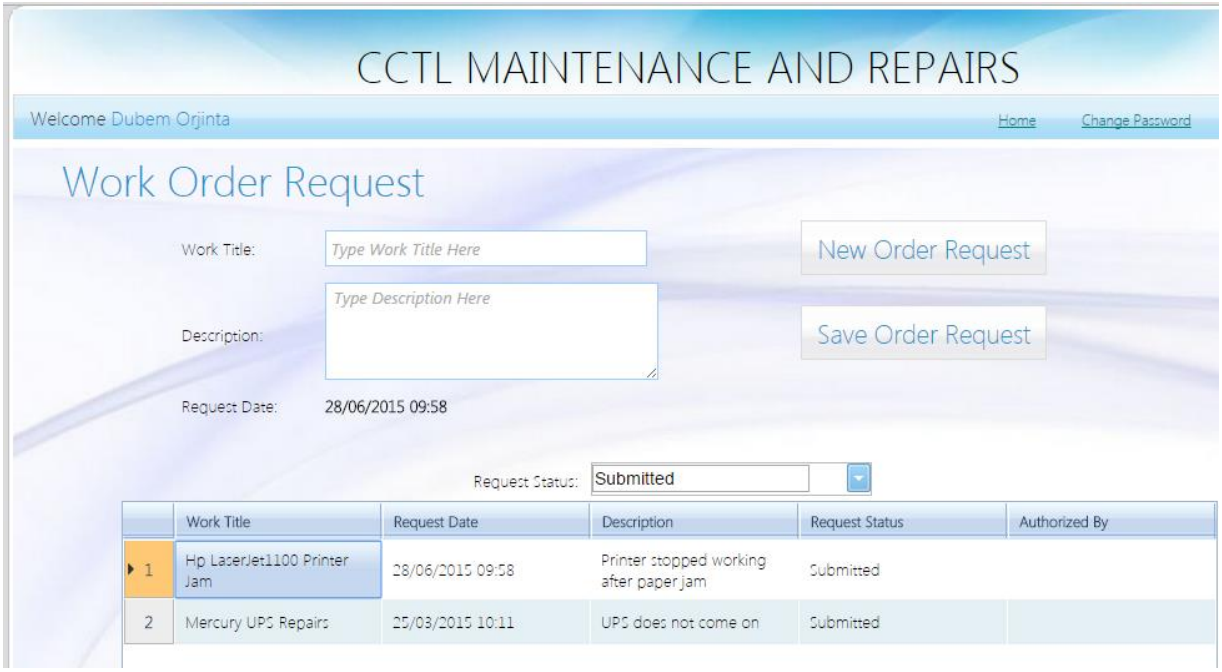

Figure 13: Screen **Shot of Order Submission Page and Order Request Records**

Upon reception of the user job order request, the department manager sign in to his/her page and authorize or reject order request as may be appropriate as provided in Figure 14. Furthermore, the workflow engine then automatically routes a mail to the lab worker responsible for creating /updating work order to enter relevant work order details.

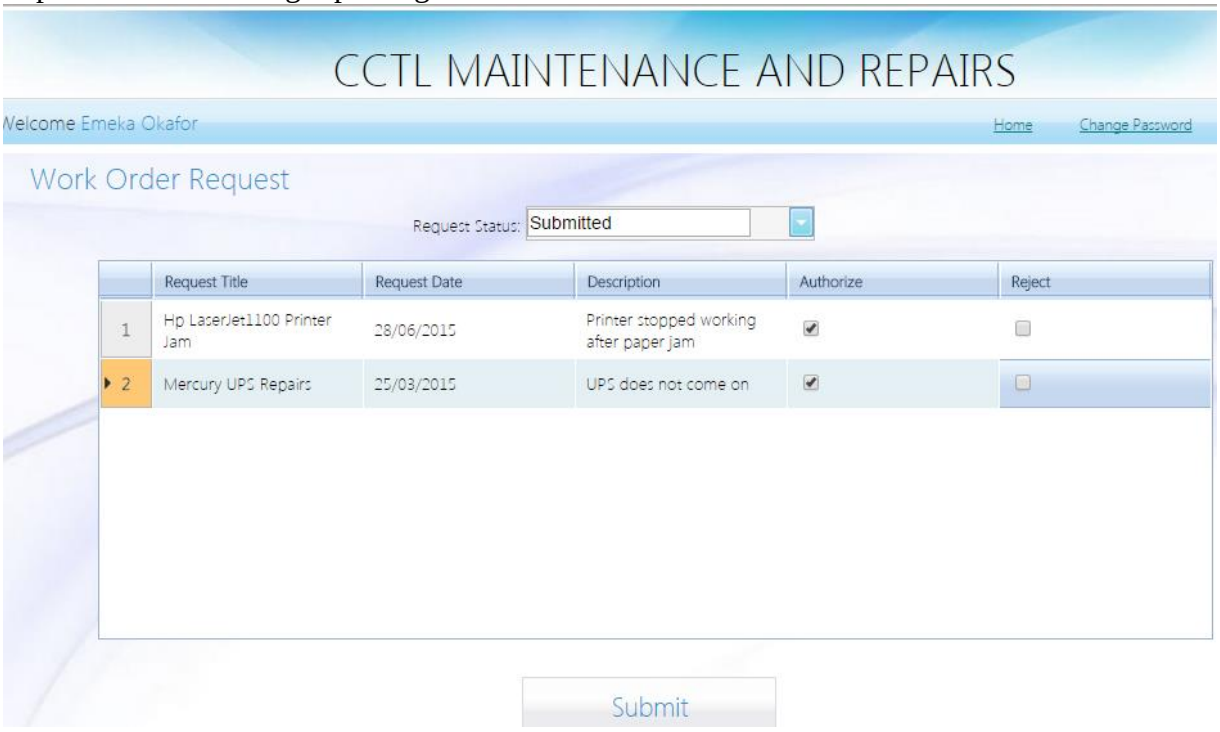

Figure 14: **Screen Shot of Job Order Authorization Page**

Upon reception of the job order authorization, the lab worker sign in to his/her page and select the job order request, create/update relevant work order details and submit for lab manager approval as shown in Figure 15. Then, workflow engine automatically routes a mail to the lab manager for endorsement of the work order.

Figure 15: Screen Shot of Work Order Page

Upon reception of the authorized job order request, the lab manager sign in to his/her page and approve or request for order request change as may be appropriate, needed to complete the job as reported in Figure 16. Next, workflow engine automatically send approval notification to the lab worker for work order execution.

Figure 16: **Screen Shot of Work Order Approval Page**

Work Order Status Page

Upon reception of the approved work order, the laboratory worker executes the job as stipulated in the work order or defers the work to a later date. Afterwards, the laboratory worker updates the work order status to complete the work process/workflow.

Figure 17: Screen Shot for a typical completed Work Order Status.

Each system user has the ability to view and print job order/work order status view from his/her profile using browser printing module. Figure 18 and Figure 19 are screen shots of work order status reports printed via laboratory manger and laboratory worker system profiles.

CCTL MAINTENANCE AND REPAIR

Welcome Ikenna John Home Change Password Sign Out

Work Order

Order Requests

Approved

	Work Title	Request Date	Description	Hardware Order	Software Order	Cost	Starting Date	Target Completion Date	Actual Completion Date	Work Status
1	Hp laserjet printer paper jam repair	03/04/2015	Office printer Hp laser jet stop printing due to paper jam	Nil	nil	5000	03/04/2015	03/04/2015	06/04/2015	Approved
2	Faulty LG monitor repair	03/04/2015	Monitor power led does not come up.	Change power pack	nil	10000	03/04/2015	04/04/2015	06/04/2015	Approved
3	CPU Maintenance	25/03/2015	CPU is dusty, requires servicing	Vacuum creaner	–	4500	25/03/2015	26/03/2015	28/03/2015	Approved
4	Dell Flat Screen	25/03/2015	Dell monitor does not come up	Replace Power Pack	-	13000	25/03/2015	26/03/2015	28/03/2015	Approved

Save Work Order

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Figure 18: Laboratory Manager View/Print page

CCTL MAINTENANCE AND REPAIR

Welcome Ikenna John Home Change Password Sign Out

Work Order

Order Requests

Completed

	Work Title	Request Date	Description	Hardware Order	Software Order	Cost	Starting Date	Target Completion Date	Actual Completion Date	Work Status
1	Hp laserjet printer paper jam repair	03/04/2015	Office printer Hp laser jet stop printing due to paper jam	Nil	nil	5000	03/04/2015	03/04/2015	06/04/2015	Completed
2	Faulty LG monitor repair	03/04/2015	Monitor power led does not come up.	Change power pack	nil	10000	03/04/2015	04/04/2015	06/04/2015	Completed
3	CPU Maintenance	25/03/2015	CPU is dusty, requires servicing	Vacuum creaner	–	4500	25/03/2015	26/03/2015	28/03/2015	Completed

Save Work Order

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Figure 19: Laboratory Work View/Print page

CONCLUSION

The design and implementation of a web based enterprise (SME) WfMIS recommended for capturing and managing requests for computer systems maintenance and equipment repair at CCTL Eket has been presented. The system is designed to provide computer lab technicians and management with a tool for monitoring equipment maintenance events, reviewing equipment history and resolving equipment malfunctions. The system allows clients to report faults, which are automatically routed to the management for approvals and computer lab workers for execution.

A Modified Rapid Application Development (MRAD) that incorporated object-oriented design (OOD) approach was employed. The OOD was implemented successfully using C# based with ASP.NET as workflow engine. Relational database is used to store/document information regarding the WfMIS activities and events. The system has been tested and results shows that the proposed system was able to store, retrieve, and secure records more effectively and efficiently than the manual approach that is currently employed at CCTL Eket. The users who are members of the enterprise were able to report faults or place order, check order status with the technology (WfMIS) at their description. They are also were also able to place order request from the comfort of their offices and track the status of their application online in the office any time and form anywhere. The proposed system was able to eradicate most of the challenges faced by users and their clients due to the bottlenecks associated with the manual and paper-based order request process that is currently running at CCTL Eket.

RECOMMENDATIONS

Based on the results and findings from this research work, the following recommendation is given:

- The future research for this project would be the development and integration of enterprise-wide workflow processes rather than departmental workflow management system presented in this paper.
- Also, future WfMIS implementation should include mobile versions for mobile phone users.
  Further studies are therefore required to develop such enterprise-wide WfMS that has support for divers technologies like mobile phones, ipads etc.

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