International Journal of Advance Research in Science and Engineering
Vol. No.9, Issue No. 08, August 2020
www.ijarse.com
IJARSE
ISSN 2319 - 8354

A COMPARISON OF THE EFFECTIVENESS OF UNIFIED MODELING LANGUAGE AND DESIGN AND ENGINEERING METHODOLOGY FOR ORGANIZATIONS

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ABSTRACT

This paper compares the effectiveness of Design and Engineering Methodology for Organizations (DEMO) and Unified Modelling Language (UML) in modeling business processes and workflows from business rules. The study used Business processes and workflows from the Admissions office of Kashim Ibrahim College of Education Maiduguri. Case Study and Quasi experimental design, with a target population of 15 and sample size of 15 was used. Primary data gotten from interview, and review method was used. The business process and workflow gotten from the admissions office was modeled using approaches of both Design and Engineering Methodology for Organizations and Unified Modelling Language. The models developed were evaluated and assessed by professionals using the Quality based Modelling Evaluation framework (Q-ME). The Unified Modelling Language is rated as the preferred methodology for modelling the business processes and workflows of the case presented.

Keywords*:UML, DEMO, Business Rules, Business Processes, Workflows, Model Quality*

1. INTRODUCTION

Modelling is a vital part of an efficientorganizational design and information systems development. They allow decision makers to direct efforts towardrefining the most important parts of a system being studied by removing the complexity of the real system.

UML have emerged as "the industry's modeling language"[1]. This modelling approach have been used in quiet a number of organizational modeling for both large scale and small-scale organizations [2].UML is a graphical language that was designed to be very flexible and customizable in modeling Organizations, software applications etc. It enables creation of different types of models, including models for understanding business processes, workflow, sequences of queries, applications, databases, architectures, and more [3].

Design and Engineering Methodology for Organizations (DEMO) focuses on developing theories that describes the working of an organization and also a description of its business activities [4].In DEMO, the functioning of organizations is viewed from three levels: the documental, the informational and the essential level [5]. The focus of DEMO is on the essential level. Although importantly, the analysis and design of the informational and documental level of the essential model are performed after a sound understanding of the business processes [6].

Authors have proposed a number of definitions for business rules. From the information system perspective, business rules are statements that define or constrain some aspect of a business. It is intended to assert business structure, or to control or influence the behavior of the business [7]. Business Rules control the execution of Business Processes, affect the structure of the Organization and its Business Objects, and constrain the behavior of Business Actors [8]. Some Business Rules express Business Goals and represent business knowledge and can be categorized as functional, structural and behavioral [9]. Business Rule is measured by attributes such as Atomicity, Business related, Declarative, Consistent and Unambiguous[8].

Business processes is a collection of related, structured activities or tasks that produce a specific service or product [10]. Examples of business process includes, Steps in executing an order, creating a marketing plan, and hiring an employee[11]. Business processes express an organization's behavior, and these processes exist independent of whether they are modeled or not [10]. Business Process is measured by Definability, Customer, Order, Value-adding, Embeddedness, and Cross-functionality [10].

Workflow is a collection of tasks organized to accomplish some business process [12]. Through workflow, an organization can automate its business processes to make it easier and more efficient and hence provide better outcomes of products and/or services. Workflow technology delivers work items to appropriate users, and help the users by invoking appropriate applications and utilities. Furthermore, it allows management and employees to keep track of the progress of the work item from whichstatistics on how efficient the steps of the process are can be generated[12]. Workflow is measured by Functional Aspect, Behavioral Aspect, Information Aspect, Organizational Aspect and Flexibility Aspect [12].

Model Quality has been defined in many ways, ranging from extremes as conformance to requirements to fitness for use [13]. The International Standards Organization (ISO) has done an effort to unite the different views on quality in a general definition stating that quality is the total of properties and characteristics of a product or service that are relevant for satisfying specific requirements and obvious necessities. Model Quality can be measured by the attributes such as Expressiveness, Arbitrariness, Effectiveness, Comprehensibility, Coherence, Completeness and Efficiency [13][14].

2. MODELLING THE ADMISSIONS OFFICE USING DESIGN AND ENGINEERINGMETHODOLOGY FOR ORGNIZATIONS AND UNIFIED MODELING LANGUAGE

2.0 Description of Modelling Case

The chosen case study is the Admissions office of Kashim Ibrahim College of Education Maiduguri.To be admitted to pursue a program at Kashim Ibrahim College of Education Maiduguri, applicants must satisfy the College's minimum entry requirement for that particular program.

A complete application consists of: the application form itself, transcripts and application fee. Once the form is submitted to the College, the admissions Officer makes (an assessment) verifies the applicant's details for authenticity, if everything is OK then the Admissions Officer schedule an interview with the applicant, at this stage applicant can either pass or fail the interview, based on the outcome of the interview a feedback is sent to applicant. Acceptance letter (conditional admission) is sent to successful applicant with a fine of payment attached from the Bursary Department or else Rejection letter will be sent. After the applicant makes the payment to the Accountant, they are considered as student. The management verifies the payment, if the candidate has paid the minimum amount requested then the Registrar issues identification number and the management generates the unconditional admission letter else a feedback is sent to the student.

2.1Modelling the Business Processes with DEMO

2.1.1 Global Business Architecture

Figure 2.1 gives the model drawn using the Global Business Architecture of DEMO. It models the business process within the case study.

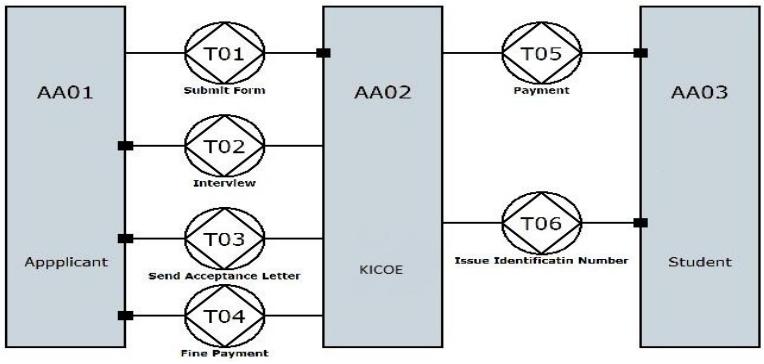

Figure 2.1 Global Business Architecture of the Admissions Procedure

The DEMO Global Business Architecture is the starting point for modelling Business Systems using the DEMO method. Here, business systems relevant to the domain being and the interactions between these systems are modeled. The systems generated are called "Aggregate Actors". Aggregate Actors in the study case for example are "Applicant" and "Student". The target system itself is also modelled as an aggregate actor which in this case is Kashim Ibrahim College of Education (KICOE). The aggregate actors interact through transactions. In a transaction, one aggregate actor (the initiator) requests another aggregate actor (the executor) to perform a certain business action, e.g. Submit Form, pay for Registration, Issue Identification Number, etc. are transactions.

2.1.2 Construction Model

Figure 2.2 gives the construction model of the admission process.

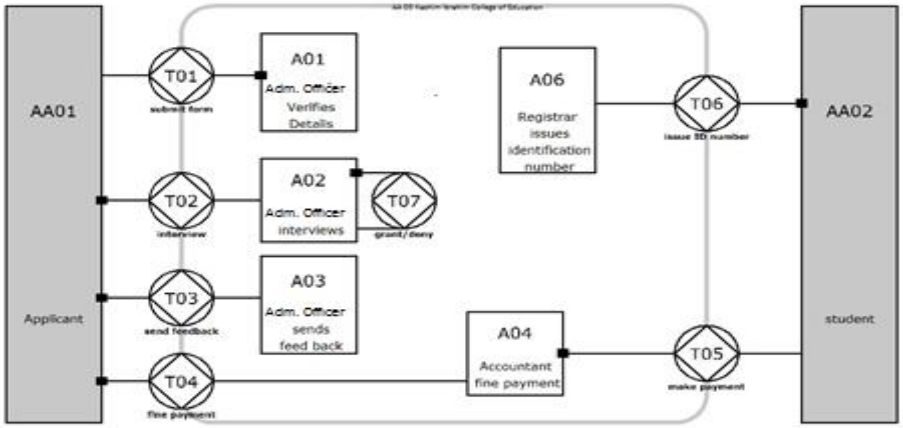

Figure 2.2 Construction Diagram of Admission Procedure

Table 2.1 Transaction Result Table of Figure 2.2

Transaction kind	**Transaction result**
• Submit form (T01)	• Form Submitted (RT01)
• Interview (T02)	• Interview Conducted (RT02)
• Send feedback(T03)	• Feedback Sent (RT03)
• Fine payment (T04)	• Payment requested (RT04)
• Make payment (T05)	• Paid (RT05)
• Issue identification Number (T06)	• Identification Number issued (RT06)

Key: T= Transaction, RT= Resulting Transaction

In the Figure 2.2 above we identified six transaction kinds, which we called submit form (T01), interview (T02), send Acceptance letter (T03), fine payment (T04), payment (T05) and issue identification Number (T06).

In Table 2.1 above the resulting transaction are respectively “Form Submitted (RT01)”, “Interview Conducted (RT02)”, “Acceptance Letter Sent (RT03)”, “Payment requested (RT04)”, “Paid (RT05)”, “Identification Number issued (RT06)”.

By convention, the executor of T01 gets the actor role number “A01”; in Figure 2.2 we called this actor role “Make Assessment”. Similarly, the executor of bothT02, T03 and T04 was designated by “AA01”; we called “Applicant”, likewise, the executor of T05 and T06 gets the actor role number “AA02” which we called “Student”.

Moreover, we call the initiator of T01 "Applicant"; we gave this external (and by convention composite) actor role the number "AA01, accordingly the initiator of T02 which we called "Adm. Officer" we gave this internal actor role the number "A02, correspondingly, the initiator of T03 which we called "Acceptance Letter issuer" we gave this internal actor role the number "A03, likewise, the initiator of T04 which we called "Accountant" we gave this internal actor role the number "A04, and the initiator of T05 which we called "Cashier" we gave this internal actor role the number "A05 also the initiator of T06 which we called "Registrar" we gave this internal actor role the number "A06. We are now able to devise the first part of the Construction Model of Kashim Ibrahim College of Education, represented in an Actor Transaction Diagram and a Transaction Result Table.

2.2 Modelling the Workflow with DEMO

2.2.1 Process Model

Figure 2.3 gives the process model of the workflow within the case study

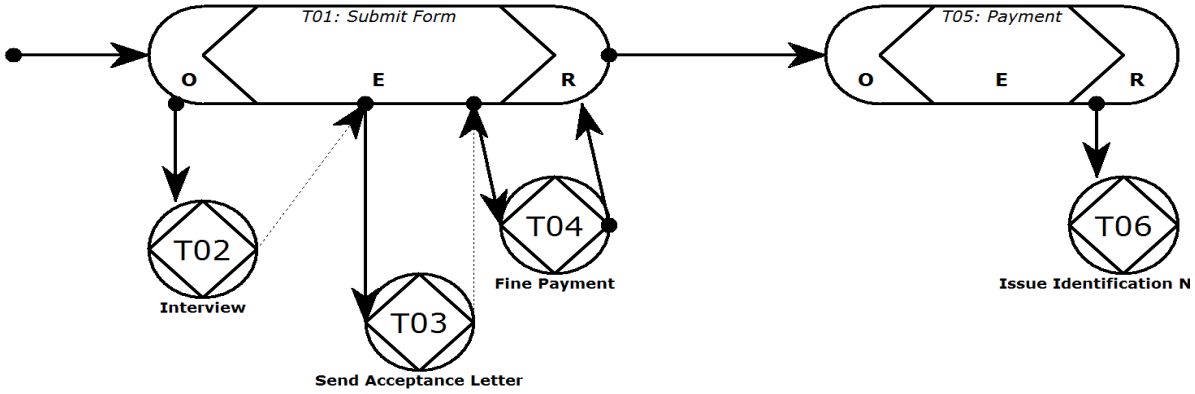

Figure 2.3 Process Model of the workflow

The process model in Figure 2.3 shows how different transactions are related. The diagram depicts two kinds of links between transaction steps: causal links and conditional links. A causal link for transaction T01 was initiated from an external source. The causal link for transaction T01 to a transaction T02 means that T2 is initiated from within T02. A conditional link from transaction T02 to a transaction T03 means that T03 has to wait for the completion of T02 before it can proceed. Correspondingly, a conditional link from transaction T03 to a transaction T04 means that T04 has to wait for the completion of T03 to be able to proceed.

After successful completion of transaction T04 the result face of transaction T01 will then be processed. The causal link from transaction result face of T01 to transaction T05 means that T05 is initiated after the result face of T01 and finally the causal link for transaction T05 to transaction T06 means that T06 is initiated after the result faced is processed T05.

2.2.2 Action Model Rules

The following shows the code for different action model rules within workflow of the admission office.

when Form is submitted[Assessment] **is** requested

if [Assessment] has been started **and**

(the Documents [Submitted] has been Assets)

then interview **of** [Applicant] **must be** promised

else interview **of** [Applicant]] **must be** declined

when interview **of** [Applicant] **is** promised

then Acceptance letter **of** [Applicant] **must be** promised

else Acceptance **of** [Applicant] **must be** declined

when Acceptance letter **of** [Applicant] **is** promised

then payment **of** [fees] **must be** requested

if everything is ok

then payment **of** [fees] **must be** accepted

else payment **of** [fees] **must be must be** rejected

when payment **of** [fees] **is** accepted

then Identification Number **of**[student] **must be** promised

when Identification Number **of**[student] **is** promised

then Identification Number **of**[student] **must be** accepted

2.2.3 State Model

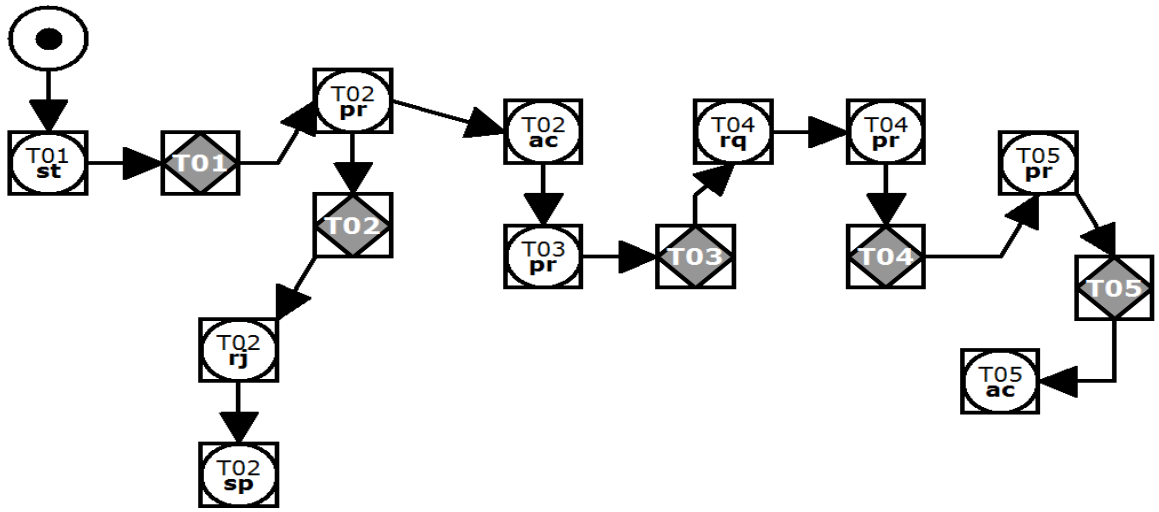

Figure 2.4 State Model of Kashim Ibrahim College of Education

The State Diagram above shows the communicative actions and production actions for each transaction. Each transaction follows a predefined order of communication actions. The success path of a transaction is a sequence that consists of a state (st), request (rq), promise (pr) and accept action (ac). In Figure 2.4 the transaction "T01 st" in the state action, has production act of "T01" Form submitted, interview was promised in Transaction T02 and a production act "T01" interview conducted was processed, the interview can be reject as shown by Transaction "T02 rj" which leads to termination of the process in Transaction 'T02 sp", accordingly, the interview can be accepted as shown by "T02 ac", then an acceptance letter was promised in Transaction "T03 pr" and a production act "T03" acceptance letter Issued was processed, A request for payment was processed in Transaction "T04 rq" and the production Act "T04" paid was processed, then transaction "T05 pr" issue identification number was processed with a production act "T05" identification number issued was processed, finally the transaction "T05 ac" identification number was processed.

2.3 Modelling the Business Processes with UML

2.3.1 Use Case Diagram

From the requirements document, the different use case within the AdmissionsOffice of Kashim Ibrahim College of Education was extracted. Figure 2.5gives the use case diagram of these use cases.

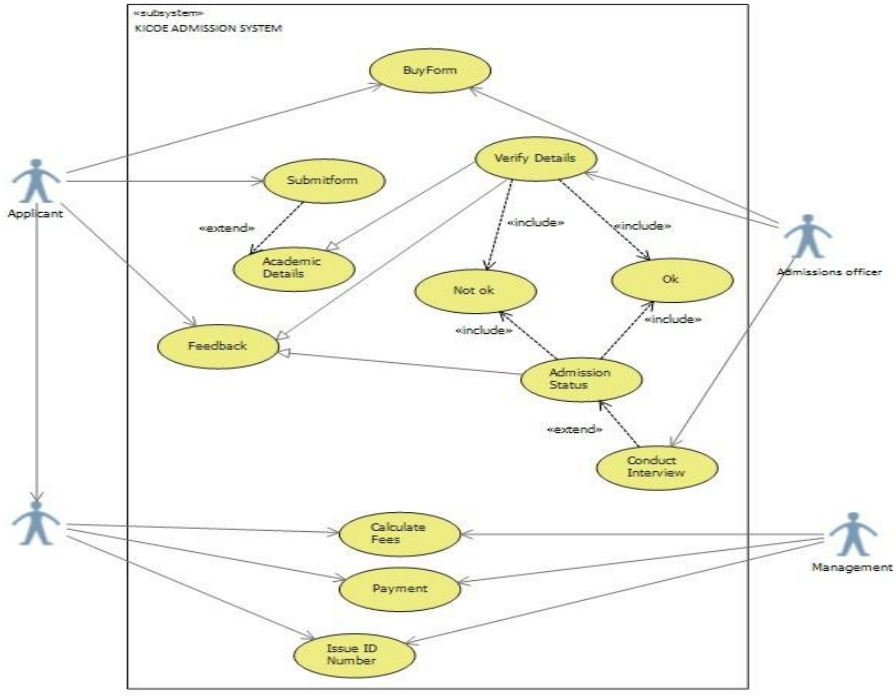

Figure 2.5 Use Case Diagram of KICOE Admission

There are twelve use cases and three Actors based on the requirement documentation of the Admission system, as shown in Figure 2.5

Actors: *Applicant, Admissions Officer and Management*

Use Case: *Buy Form, Issue the Application Form, Submit Application, Academic details, Verify Details, Conduct Interview, Admission Status, Accept, Reject, Fees Calculations, Payment, and Issue Identification Number.*

Process *Buy form*: this use case is for buy form, it interacts with *Applicant* and *Admissions Officeractors*. It receives purchase order from the *applicant*, and the *Admissions Officer* is notified of the order. Process *Submit Application*: this use case is for submitting the filled *application*, it extends *Academic Details*. The use case interacts with the *Applicant*. Process *Verify Details*: this is for verifying the submitted application. It interacts with *Admissions Officer* the process includes an *OK* and *Not OK* use cases it also interacts with the *feedback* use case. Process *Conduct Interview*: this is for conducting interview, its interacts with Applicant and Admissions Officer, It extends the *Admission status* use case which in turn includes an *OKand Not OK* use cases. Process *OK*: This use case is for indicating the successful outcome, while the process *Not Ok* is the opposite of *OK* process. Process *Fees Calculation*: this is for calculating the school fees. It interacts with the *Management Actor* and the *Applicant*. Process *Pay Fees*: this is for paying school fees. It interacts with *Applicant* and *Management*. Process *Issuing Identification Number*: this is for issuing ID number. It interacts with *Applicant* and *Management*.

2.3.2 Class Diagram

From the admissions use cases described in Section 2.3.1 and Figure 2.5, the following class diagram shown in Figure 2.6 was obtained.

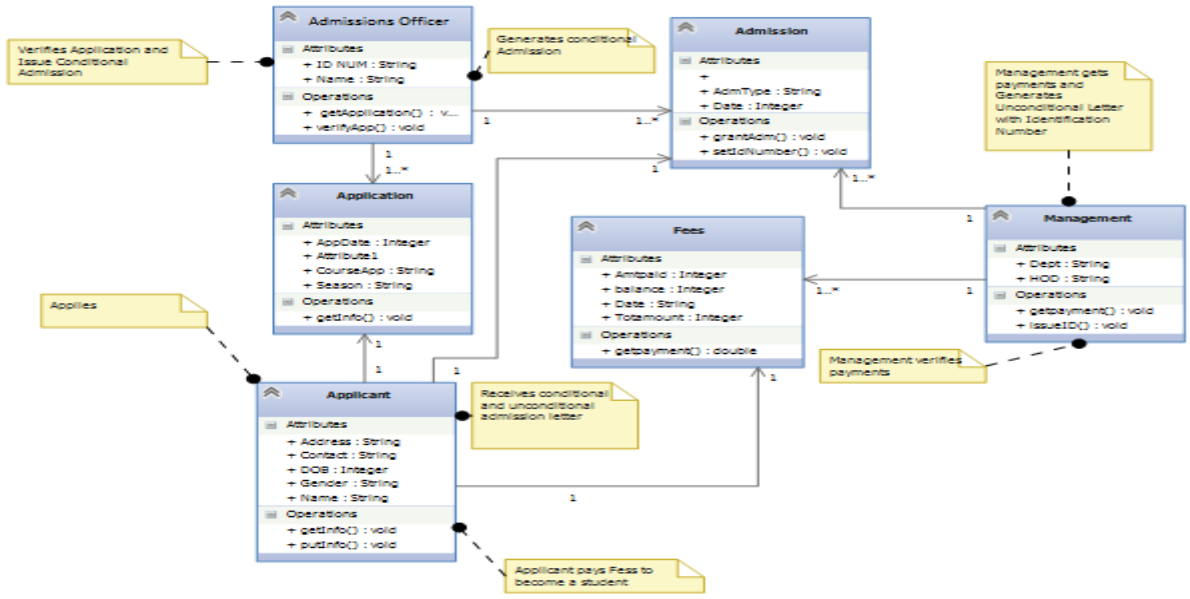

Figure 2.6 Class Diagram of the Admission Procedure

The apply association between the Applicant and Application classes expresses the relationship such that one applicant applies for one admission at a time. Accordingly, the association between the application and the Admissions officer classes expresses the relationship such that the one Admissions officer verifies one or more application documents. Furthermore, the admission class and the Admissions officer class relationship expresses the association such that the one coordinator can issue one or more conditional admissions. Also as shown in Figure 2.6 the association between application and admission classes expresses the association that one applicant is entitled to one conditional and one unconditional admission. Moreover, the association between Management and Admission classes expresses the relationship such that Management verifies one or more Fees payment and generates one or more unconditional letter with identification numbers. The association between Applicant and Fees classes expresses the relationship such that an Applicant makes one or more payments.

2.3.3 Component Diagram

According to the requirements of the system, a Component diagram as is shown in Figure 2.7 is obtained.

Figure 2.7 Component Diagram the Admission Procedure

The Component diagram in Figure 2.7 depicts six software components which depend upon each other. The Submission component depends on the applicant component for data, likewise, management component depends on the verified details from the Admissions Officer component which in turn depends on the submission components as well as on the admission component. The database depends on the later components for data which updates and stores admitted students' information.

2.3.4 Deployment Diagram

The deployment diagram in figure 2.8 Models the physical deployment of artifacts on nodes.

International Journal of Advance Research in Science and Engineering
Vol. No.9, Issue No. 08, August 2020
www.ijarse.com
IJARSE
ISSN 2319 - 8354

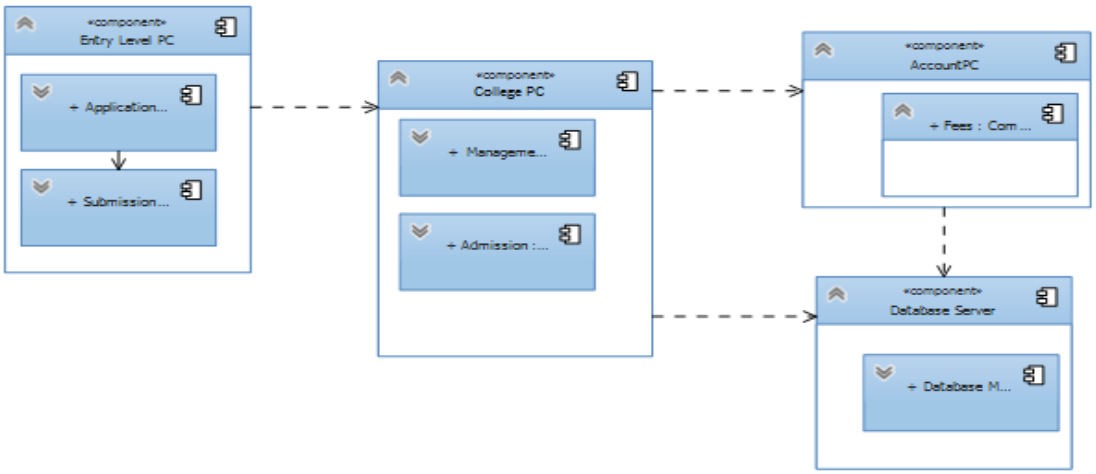

Figure 2.8 Deployment Diagram of the Admission Procedure

The devices nodes appear as boxes. In this case Entry Level PC, College PC, Account PC, Database Server and the artifacts allocated to each node appear as rectangles within the boxes. In Figure 2.8 the artifacts are Applicant Information, submission, Management, Admission, Fees and Database Management. Nodes may have sub nodes, which appear as nested boxes in Figure 2.8 the sub-nodes submission is nested in the Applicant artifacts, Admission nested in Management artifacts.

The diagram also depicts the dependencies among the Nodes, College PC depends on Entry Level PC for Data, the Account PC depends on College PC for data and finally the Database server depends on both College PC and Account PC for Data.

2.4 Modelling the Workflow with UML

2.4.1 Sequence Diagram

From the admissions class diagram in section 2.3.2 and according to the requirements of the system, a Sequence diagram is obtained.

International Journal of Advance Research in Science and Engineering
Vol. No.9, Issue No. 08, August 2020
www.ijarse.com
IJARSE
ISSN 2319 - 8354

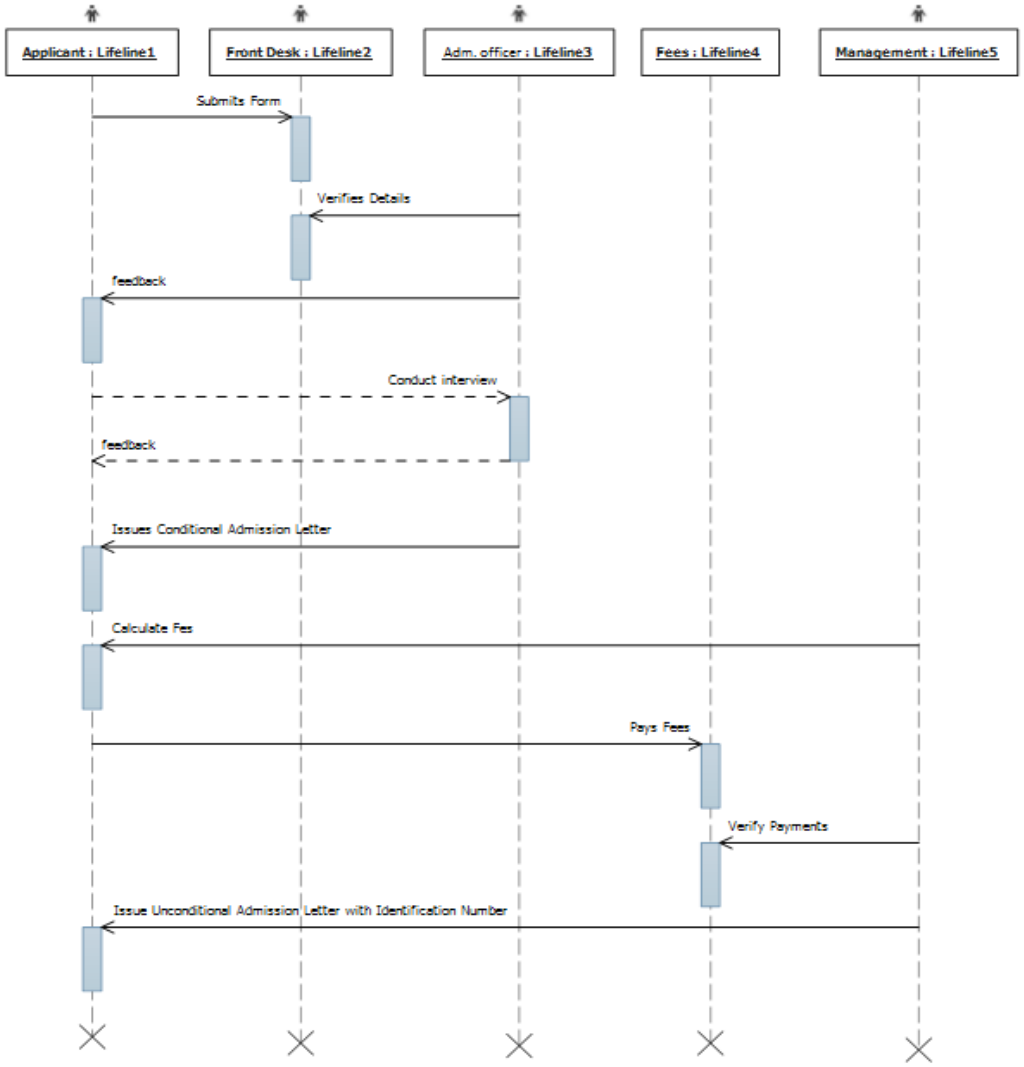

Figure 2.9 Sequence KICOE Admission Procedure

In Figure 2.9 the scenario begins when the Applicant buys a form, wanting to be admitted to the College. The System issues to the Applicant an application form. The Applicant fills the form and submits it to the front desk. The Admissions Officer verifies the submitted form and conducts an interview with the applicant and the he sends a conditional admission Letter. Then the management calculates the fees to the applicant and the applicant pays the fees and finally the management verifies and generates Unconditional Admission with an identification Number.

International Journal of Advance Research in Science and Engineering
Vol. No.9, Issue No. 08, August 2020
www.ijarse.com
IJARSE
ISSN 2319 - 8354

2.4.2 Activity Diagram

From the Admissions Sequence Diagram section 2.9 and according to the requirements of the system, an Activity Diagram is shown in Figure 2.10.

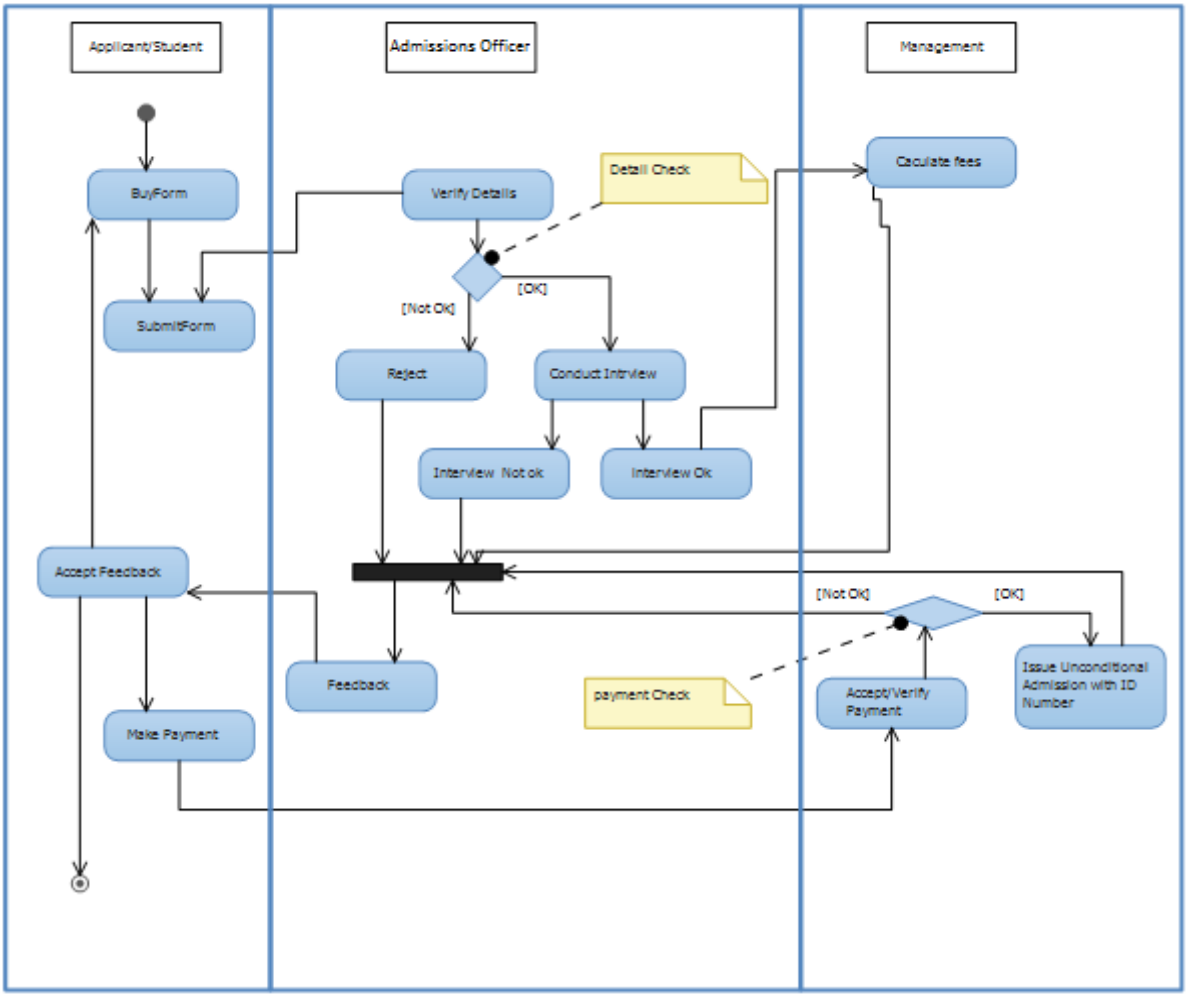

Figure 2.10 Activity Diagram KICOE Admission

In Figure.2.10 the Activity starts by buying and submitting a form, then the process is passed to the Admissions Officer process for verification, after the details have been verified then a decision is reached on whether conduct an interview if OK the interview is conducted. If the decision turns out to be Ok then Conditional Letter is issued and the fee applicable is calculated. Then the Management process checks for payment and if paid the management process issues an unconditional Admission Letter with An Identification Number and the process stops. But if the decision made after the details have been verified and is found Not OK, the admission is rejected then the process stops.

3. RESULTS AND DISCUSSION

3.1 Modeling Business Processes with DEMO

It was observed that DEMO business process model provides a way of modelling of the activities that must be conducted in for a business process and their interrelationship to be carried out. This was realized by the Global Business Architecture in Figure 2.1. The construction model in Figure 2.2 was able to show a more detailed activity that occurs in the admission procedure. The transaction initiator and executor are all realized in the construction model. DEMO is incomplete in the sense that it does not distinguish core and supportive processes.

3.2 Modeling workflows with DEMO

It was also found that the process models in Figure 2.3 captures the workflows from the case, the model was able to show the transaction that needs to be processed first and which follows next. The model in Figure 2.4 was able to capture the flows of activity from one point to the other and various results produced at the end of every transaction. The model uses the Action Model rules in Section 2.2.2 in guiding the workflows.

3.3 Modeling Business Processes with UML

It was observed that UML as well provides a way of modelling of the activities that must be conducted in order to carry out a business process and their interrelationship. This was realized by the use case diagram in Figure 2.5. Use case descriptions capture detailed steps in main scenario and alternate scenarios. The class diagram in Figure 2.6 captures the associating relationships between the classes involved in the admission case. It also captures the data model and the operation that a particular class performs. The component model of the UML shows all the components need to setup the system, and the interdependency on one another.

3.4 Modeling Workflows with UML

Workflow was modeled in Figure 2.7 using Sequence diagram, the diagram depicts the order and interoperation between processes, the behavior of the system was also captured through the flow of activity within the admissions office. The Activity diagram documents the flow within the use case, sequential, branched or concurrent flow and were model in Figure 2.8

3.5 Comparison of DEMO and UML Models

The models were taken to professionals for evaluation and assessment of the effectiveness of the models developed using DEMO and UML methodology. The professionals were grouped into two, such that group A makes assessment of the effectiveness of DEMO models and group B to make assessment of the effectiveness of UML models. The evaluation was based on Quality based Modelling Evaluation framework, called the Q-ME framework [15]. At the end of the assessment an evaluation table was given to them to score the methodologies as a group. The score table was

on a 0 to 5 grade level, 0 represents lack of conforms, 1 represents low conforms, 2 represents moderate conforms, 3 represents neutral conforms, 4 represents high conforms and 5 represents very high conforms.

Q-ME framework measures the model quality with the following attributes to make an objective assessment of Models possible. These Quality attributes are:

Comprehensibility: A measure of understandingworking and way of modelling by the participants.
Coherence: the degree to which the individual sub models of a modelling technique constitute a whole.
Completeness: the degree to which all necessary concepts of the application domain are represented in the way of modelling.
Efficiency: the degree to which the modelling process utilizes resources such as time and people;
Effectiveness:the degree to which the modelling process achieves its goal.

3.6 Evaluation of DEMO and UML

Completeness: It was observed that both DEMO and UML are suitable and complete in business process analysis, as depicted in Figure 2.1 and Figure 2.3 the diagrams show the global interaction of business processes of admissions office, the models show the way of modelling of the activities that must be carried out in order to carry out a business process and their interrelationship. The interaction between the external and internal environment was captured hence the requirement for elicitation of the Business processes and Workflows was obtained.

However, it was revealed that DEMO does not offer adequate modelling constructs for describing the features of the ICT-infrastructure, Whereas UML does offers modelling constructs for describing the ICT infrastructure. Hence DEMO is in-complete in representing all the modelling requirements.

It was discovered that UML uses Activity and Sequence Diagrams to express workflows in concise manner as shown, Figure.2.9 and Figure.2.10. Accordingly DEMO expresses the workflow in a concise manner as shown in section 2.1. Conclusively both DEMO and UML can be used to express workflows.

Effectiveness: from the models above it was shown that DEMO models does not provide the means to model dynamic Business processes, communication between objects and it does not show business process and workflow execution, in contrast UML models expresses the dynamic Business processes and workflow and it does provide the execution sequence of both Business processes and workflow as shown in Section 2.4. Also it shows the communication between objects as shown in Figure 2.10

Comprehensibility: it was observed that DEMO uses distinct symbols to represent an activity, role transaction and relationship while UML uses the same symbol in some diagrams to represent some activities e.g. Use-cases, Activity

diagram etc. By sharing a single notation across business system, business analysts and system analysts can better communicate their needs, which is key to building a system that solves the customers problems

Coherence: UML diagrams did not capture many natural constructs found in business processes such as cases and the notion of interaction with the operational environment in which the process functions Whereas DEMO is able to capture and the notion of interaction with the operational environment in which the process functions.

Table 3.1: Comparison of DEMO and UML based on Q-ME Properties

	Completeness/ Suitability	Coherence	Comprehensibility	Efficiency	Effectiveness	SUM
DEMO	4	3	3	2	1	13
UML	4	2	4	3	4	17

4. CONCLUSION

As the result shows in table 3.1 UML is considered the best Methodology to model Business processes, workflows derived from Business Rules. It is more complete and suitable to illustrate visually the case at hand using various diagrams.UML Methodology not only captures adequately all Business processes and workflows, they are also distinctively more reliable tools at diagraming a Business process and workflow scenario.

Moreover, as an object oriented modeling tool, it supports other links toward developing the comprehensive business process and workflow modeling and data modeling goals with connection capability to the other unified modeling tools in UML such as use case, class diagram, component diagram, Activity diagram and etc. to fully address Systematically the whole system behavior and structure.

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