Development of a prototype for an integrated students projects management system for University of Botswana

By

Bigani Sehurutshi
ID: 200500435

Supervisor
Dr O.T Eyitayo
Co-Supervisor
Mrs T. Taukobong

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Approval Page

This dissertation has been examined and is approved as meeting the requirements for a partial fulfilment of the requirement for the degree of Masters of Science in Computer Information systems.

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CO-SUPERVISOR	DATE
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Statement of Originality

The work contained in this dissertation was completed by the author at the University of Botswana from August 2012 to May 2015. It is the original work except where references are made, and neither has been nor will be submitted for the award of any other University.

STUDENT'S SIGNATURE DATE

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Definition of key terms

Case: An instance of a process.

Data model: Description of objects represented by a computer system together with their properties and relationships.

Workflow: a sequence of processes through which work is done from initiation to the end.

Process: A series of tasks or actions taken together to achieve a certain goal. It can be a map of work to be done.

Processmaker: The system allows public and private organization to automate documents intensive, approval-based processes across departments and systems.

Process modelling: It is a simulation of a process using business processing modelling notation.

Prototype: A process of preparing a technique or system that demonstrates the feasibility of a solution to the problem

Reengineering: Set of processes that dismantles existing processes into individual activities and puts them back together in a new set of workflows.

Abstract

The University of Botswana is a research intensive University. Majority of the students from undergraduate to PhD level are mandated by regulations to undertake some research projects as a requirement for their degrees. The current support for student's projects is handled in a manual way. The main objective of this study is to look at the current processes and model a better workflow and a prototype for the whole process of students' project management from the point of registering topics to the final submission of the projects. The specific objectives of the project are firstly, to assess the current state of operations for student research project management in the University; secondly to model a workflow to make it more efficient and thirdly to design, develop and evaluate prototype system based on the workflow.

The study was composed of five phases. The first phase involved gathering information on research management processes currently in use. Research is more of a project which spans across different phases with a beginning and an end period. The current procedures of managing research work across departments in Faculties are complex and strenuous. There are no proper tools in place to help in the administration of these projects.

The second phase was about modelling the current processes into flowchart. This dissertation examined existing procedures and tasks undertaken in such projects and explored the possibilities of automating the processes to create a management system. The third phase was about reengineering automated workflows. The intent was to reengineer the processes to make the tasks more efficient and user-friendly from the existing system. There is a serious need for shifting from people-dependent processes to machine-controlled processes.

The third phase involved improving the workflow using a reengineering methodology. After improving workflows there was need to find out how effectiveness the processes are. A system usable to users is considered very effective so the study focused on the usability aspects of the workflows. Phase four dealt with the design of a prototype to illustrate the system and aid in the process of usability testing. Heuristic evaluation and user testing were carried out in phase five. The testing revealed that the prototype for student's research management system was regarded as easy to use and very useful which makes the prototype a better improvement to the current manual system in place.

The completion of this dissertation demonstrated a viable concept of project research management system which met the users' expectations. It is a valid concept which can be considered in future developments of the institution. The system will be quite useful because of the effective processes of monitoring, supervising and managing students' research projects.

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Chapter One: Introduction and Background

1.1 Background

University of Botswana (UB) was established in 1982. UB began as part of a larger university system known as UBBS, or the University of Bechuanaland (Botswana), Basutoland (Lesotho), and Swaziland. It was founded in 1964 to reduce the three countries' reliance on tertiary education on South Africa. After Botswana and Lesotho became independent in 1966, the university was called the University of Botswana, Lesotho, and Swaziland (UBLS). In an unexpected move in 1975, Lesotho withdrew from the partnership and established its own national university. For several years, the joint University of Botswana and Swaziland continued until in the early 1980s, when the university was amicably divided into two separate national universities (UB, 2008).

UB has three campuses in Gaborone the capital city, Francistown and Maun. It has a student's enrolment of about sixteen thousands distributed amongst the seven faculties which are; Business, Education, Engineering and Technology, Humanities, Science, Health Sciences and Social Sciences. Each faculty comprises of departments and they offer programs from diploma, bachelor's degree through to masters and doctoral degrees. For quite some time UB only offered undergraduate programmes and then introduced its first postgraduate programmes in the late 1990s. The first of these were Masters Degrees in English and History. Today, all faculties offer postgraduate programmes. The Botswana College of Agriculture, which awards degrees through UB, functions as an eighth autonomous faculty. In addition to the School of Graduate Studies there are a number of research centers and centers of study including the Harry Oppenheimer Okavango Research Centre; the International Tourism Research Centre; the Centre for Strategic Studies; the Centre for Culture and Peace Studies; the Centre for the Study of HIV and AIDS; the Centre for Scientific Research, Indigenous Knowledge and Innovation; the Centre for Academic Development; and the Centre for Continuing Education (Bailey, 2011).

Table 1.1 shows the faculties and departments that are currently in the University.

Table 1-1: Faculties and departments

Faculty	Departments
Business	Accounting and finance Management Marketing Tourism & hospitality

Faculty	Departments
Education	Adult Education Educational Foundations Educational Technology Family and Consumer Sciences Languages and Social Sciences Education Mathematics & Science Education Physical Education Health & Recreation Primary Education
Engineering and Technology	Architecture and Planning Civil Engineering Electrical and Electronic Engineering Industrial Design and Technology Mechanical Engineering
Health Sciences	Environmental Health School of Medicine School of Nursing Medical Laboratory Sciences
Humanities	African Languages & Literature English Chinese Studies French History Library & Information Studies Media studies Theology & Religious Studies Confucius Institute Visual & Performing Arts
Science	Biological Sciences Chemistry Computer Science Environmental Science Geology Mathematics Physics
Social Sciences	Economics Social Work Sociology Statistics Law Political & Administrative studies Population Studies Psychology

1.2 Students research projects

Student Project in our context is referred to as a research in which scholars extend their knowledge to make some contributions to their respective areas. The contribution made can be beneficial to the community or it can be used by other scholars to investigate the topics further. Students' projects are carried out from first degree or diploma through to doctoral level. At lower levels projects are/is more of developments of competency whereas in upper levels it's about adding to the knowledge (Howard, 2001).

Traditionally in academia, students are expected to write research projects as a requirement for them to earn their degrees. What really are the purposes of these researches? The purpose of these research projects is to provide students with a guide and approach on how to conduct research and to make contributions to the world's body of knowledge. The research aspect goes a while from the routine learning exercise to producing a valid knowledge or a point of view not available before. There exist four major types of researches which are theoretical, substantive, methodological and practical (Surratta, 2004).

One of the forces towards attaining the University mission is to strive at advancing scholarship and conducting research through the discovery, integration, dissemination and application of knowledge. These have made research to be included in university curriculum at undergraduate and graduate levels so that every student will graduates from the school while having taken part in research. Every department administers researches in their own manner which they have given several names such as; research paper, dissertation, thesis, final essay, study and project. There is no universal approach into carrying out these studies, but each department follows its own procedures in conducting the researches. From the initial step of finding a topic to the final stage of submitting, various steps are carried out depending on the discipline and the level of study. For example, undergraduate student from the Computer science department follows a different approach from a graduate student in the same department. However, although there are different approaches, guidelines have to be followed to ensure that the differences between research projects are kept to a minimum. Research projects in their nature vary from one to another and it is not possible to set down rules or standards which will apply and govern all the cases. Project research processes exists but are executed differently.

A process can be defined as a set of related activities that together create value through services to provide defined results in support of organization's goals and objectives (Sommerville, 2011). Research projects are made up of hundreds of processes. The current state of research processes have been inefficient, out of date , overly completed, burdened with bureaucracy, labor intensive, time consuming and irritating to manage.

There is need for technology change to these students' project processes so that we can eliminate such burden. There are a host of processes associated with research projects. This study sought to examine research projects and their nature format with a view of coming out with a prototype to manage the projects. A large number of them have repetitive tasks which gives us the potential to enhance such processes with technology.

Research still remains the core business in almost all the institutions of learning including the University of Botswana. The University has its mission of striving to become a research intensive institution by year 2016. Conducting a research is therefore encouraged for students at all levels of studies from bachelors to masters and PhD degrees.

1.3 Problems with managing students research project

The supervision process of dissertation and research projects has attracted a lot of attention from the higher education community in the world. Many books, scientific articles and guidelines have been produced to explain this process, advice students and their supervisors about the key issues that may be encountered and help both of them to establish an effective supervision relationship.

There are however many factors that determine the success of research students in doing their programs. Numerous research have pointed out that there are high proportions of students who fail to complete their studies within the time given. Many factors contributing to this and the major problem is related to the supervisory contribution. One of the factors they identified is a good relationship between student and supervisor that will ensure their research project is completed successfully. Their take is that by improving supervisory approach, the study process and research progress can be enhanced. (Abiddin, Ismail and Ismail, 2011). This was also confirmed in a study by Tahir et al (2012) where they found out that Supervisors should be friendly, approachable and flexible as well knowledgeable and resourceful and that effective supervision means to be able to establish good and professional relationships with students for thereto be maximum benefits from students. Romdhani, Tawse and Habibullah (2011) noted that without a clear supervision process and administrative tools to monitor the progress and check the conformity of the implementation of the supervision process, supervisory challenges will increase and student satisfaction will deteriorate

A lot of research has been done on supervision but most of it are on supervisors and not on administrative tools to monitor progress. Yan (2012) emphasised the need for improvement of quality of thesis supervision and instruction. Apart from the supervisory approach, one major problem that has not received a lot of attention is the workflow of students' project. Although many academic staff have invented their own specific paper based guidelines and pro-forma documents to ease and control the supervision process

between all involved parties based on their experience and best practices, they have not been supported by a central online collaborative system that can help them to easily monitor and control the whole workflow (from identifying a project idea to final assessment) and support smooth data handover between all involved parties.

A study on the Computer Science Program in Universiti Kebangsaan Malaysia, of students who were required to develop a software prototype and write a dissertation for their final year project showed that over five years, an increasing number of the students failed to complete prototype development within the allocated time. The original practice used a log book to document meetings and discussions between supervisors and students. There is no monitoring process to trigger specific actions to make sure all deadlines are met. (Bakar et.al , 2011) .

1.4 Problem statement

Over the years, experiences from University of Botswana (UB) show that workflow management is a major problem. Currently every department conducts and manages their research courses independently. Each department follows their own procedures of managing their theses and most of the final copies of projects can be found in lecturer's offices, School of Graduate Studies offices and only a few are stored as soft copies in the library and office of Research and Development. The University lacks a systematic approach in dealing with these volumes of projects submitted every year as well as the administrative procedure.

With undergraduate projects, it is not easy for a coordinator to easily find out the current status of students and how they have been responding to supervision. Asking supervisors to provide this report have generally not yielded quick responses for coordinators. There is therefore the need to provide a centralised way where students' projects can be managed and made accessible to students and staff in real time.

Another problem with the current setup is that it becomes difficult to monitor patterns and carry the statistics concerning the researches done across the university. Poor monitoring and evaluation hinders informed decision making by the relevant authorities.

One of the problems encountered over the years include students not graduating the year they were supposed to because there were no follow ups on reports from internal and external examiners. Sometimes the graduate studies department cannot report the current state of a student's project.

The issue of inefficiencies causes a lot of delays in the process. A dissertation passes through a lot of stages and through different stakeholders, It becomes difficult to manage

the dissertation flow. Other stakeholders may forget the deadlines or forget that the dissertation is with them. Examiners are given a month to submit their reports, but it sometimes, arrive after five months. There is no clear way of tracking progress between the examiners and School of Graduate studies. Sometimes, reports dispatched through a courier may not reach the examiner.

These are some of the constraints, which this study sought to address. Having in place a unique system that monitors workflow can therefore help with some of the problems identified above.

1.5 Workflow Model

According to the Workflow management Coalition (WFMC Documentation, 1996), workflow is defined 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". Day to day activities carried out in an environment involving people, business process, tasks and information flow which support decision making processes constitute of a workflow. During the course of the workflow changes may occur in the process and status of tasks. Automation is involved in workflows, for example setting up software that automatically forward mail regarding certain interests to all members of a specific group. Workflow technologies have been widely used in areas of telecommunication, manufacturing, production, finance, laboratory sciences, and healthcare and office automation (Aalst, 2000).

The model was developed in 1995 and it forms the generic workflow application structure. It consists of five interfaces; workflow definition interchange, workflow client application interface, invoked application interface, administration and monitoring interface and interoperability (Hollingsworth, 1994). Workflow management involves automation of processes to combine human and machine-based activities, particularly those involving IT application and tools. The workflow management system gives a sequence of work activities and has knowledge of processes' life cycles.

1.5.1 Modelling workflows

Workflow modelling needs a language that is intuitive and easy to use. A formalized approach to analyse the workflow model is needed. While designing a workflow one describes which tasks have to be done and in what order. Process approach takes precedence hence a good modelling language is required to design a workflow.

Process modelling simulates a system using business process modelling notation. The notation makes us understand the system logic and know the ones in charge of every task in the system.

The workflow management systems have the following components;

- Business rules – anything that captures and implements business policies and practices.
- User and authorization management.
- Forms – users interact with the system through the form and pass it to the other next user.
- Databases – are required for data storage.
- Emails – are very critical in workflow systems because they distribute information between individuals within an organization. The electronic mail speed up processes in the system as it enhances communication.

1.5.2 Management of workflows

Allocation of work items to resources (people and machine) is critical to the efficiency and effectiveness of a workflow. Resource – it's anything that carries a particular task in a workflow. Each resource is uniquely identifiable and it has a certain capacity. A resource can carry out a limited number of tasks. Resources are classified into resource classes and it may belong to more than one category. Resources can be classified by their functionality or upon position held in the organization. A functionally-based resource is known as role or function. If a task is linked to the correct role one can ensure that the resources carrying the role out is sufficiently qualified and authorized. A resource class based on place in the organization rather than functional characteristics is called organizational unit. It ensures a task is carried out in the right place of the organization (Aalst, 2000).

To ensure that each activity is performed by suitable resource, allocation principle has to be done in process definition to specify which conditions must be met by the resource.

1.5.3 Bottlenecks in workflows

A process in the workflow can only be changed when one or more of the following symptoms are noticed.

- Number of cases in progress too large. If there are many cases in progress, this indicates a problem.
- Completion time (too) long compared with actual processing time.

- Level of service (too) low – A workflow's level of service is the degree to which the organization is able to complete cases within a certain deadline.

If completion time fluctuates widely then there is low level of service. The above symptoms point to a possible bottleneck.

1.5.4 Improving workflows

After identifying bottlenecks in the workflows by observing the symptoms mentioned above, the causes have to be handled. There is a strong relationship between reengineering and workflow management. Reengineering enables drastic improvements to processes with an aim of improving cost, quality and service. The use of workflow systems makes it easy to adapt processes and possible to work in a completely different way. Process reengineering efforts result into a purchase of workflow management system. Workflow systems and process reengineering are natural partners (Aalst, 2000). Reengineering come from process enhancement defined above.

1.5.5 Process enhancement of workflows

In organizations there is a need to change the old method of providing services to the customers. This could be done through the use of the modern technologies to bring those changes. Computerizing old methods for doing things doesn't necessarily improve service delivery or yield an efficient performance. Before technology chips in business processes have to be re-engineered, improve and redesign to magnify efficiency and effective delivery of services. Information Technology enables business process enhancing but does not substitute it.

Business process enhancement as defined by (Knott, 2000) , involves establishment of goals or expectation for one or more processes, make an analysis how they are carried out and adjust to those processes if the result did not meet goals/expectations. It involves assessing the current state of operations to identify inefficiencies, gaps, and risks and then recommend change to specific area that impede productivity. Identifying all those inefficiencies is like turning weaknesses into strength and disadvantages into advantages (Knott, 2000). There are two more enhancement approaches aimed at elevating how organizations work which are; process improvement and process re-engineering. Process improvements is said to be "a disciplined approach to the simplification and streamlining of business process using measurements and control to aid continuous improvement. It involves a less dramatic immediate departure from traditional practices, although cumulative effect of ongoing improvement can be substantial. Process improvement program work from existing processes and seek to achieve a continuous incremental change. On the other hand process reengineering is a fundamental approach to the thinking and radical redesign of business processes to bring about dramatic improvement

in performance. Reengineering, is defined by Motiwalla (2009) as "a business process or set of processes that dismantles existing processes into individual activities and puts them back together in a new set of business flows or sets of business flows". It improves efficiency and services with greater returns. Process reengineering requires a management approach as it involves an intensive change management process. Resistance to change is quite common hence process reengineering will require a certain level of change management to succeed. Processes are designed to meet the company goals. Reengineering, achieves rapid and dramatic improvements by replacing old processes with the new ones. Examples of reengineering may include changing from paper to electronic documents and converting paper driven to electronic driven work flows. It actually involves changes in structures in processes within the business environment. The entire technological, human and organizational dimension may be changed. Business process enhancement will form the core element of my research as we try to move away from the current inefficient processes. There are a number of tools that help in mapping out existing processes and new ones. In achieving the development of a management prototype for the student's projects, there is the need for efficient workflows and reengineered of some processes.

1.6 Objective of the study

The current support for student's projects is handled in a manual way. The main objective is to study the current processes and model a better workflow and a prototype for the whole process of students' project management from the point of registering topics to the final submission of the projects. It will cater for projects at the following levels: Bachelors, Masters and PhD degrees for all the departments in the University.

The specific objectives of the project are:

1) Assess the current state of operations for student research project management in the University.
2) Model a workflow to make it more efficient.
3) Design, develop and evaluate prototype system based on the workflow.

1.7 Organisation of the dissertation

The dissertation is divided into eight (8) chapters. The remaining chapters are;

- Chapter two – Literature Review: the second chapter reviews the relevant existing literature pertaining to the research project. Research, theses and workflow management systems are discussed in this chapter.

- Chapter three – Research Methodology: this chapter consists of various methods used in the research project.
- Chapter four – Analysis of research processes: this chapter analyses current research processes and improve them to eliminate bottlenecks.
- Chapter five – Prototype design and development: this chapter proposes a design solution for the improved workflows.
- Chapter six – Prototype Implementation: this chapter outlines implementation of the prototype based on the design.
- Chapter seven – Project Evaluation: this chapter consists of results of the evaluation and analysis.
- Chapter eight – the last chapter consists of: summary of study, contribution, limitation, recommendation and Conclusion of the study.

Chapter two: Literature Review

2.1 Introduction

The purpose of this chapter is to present a review of literature related to this study. The review looks at system currently in use for research management at the University of Botswana. It further looks at some theses management system. The last section is about workflow management systems.

2.2 University of Botswana Research management systems

This section describes three systems currently in use for research management at the University of Botswana

2.2.1 Converis

The University of Botswana approved a research strategy in 2008. The strategy was aimed at elaborating the meaning of increased research intensiveness. Converis research management database was implemented in order to improve the research innovations. The database is used to transfer data and objects from office of research and development to the University library. It is also being used for the archiving of research outputs and performance materials for the University (University of Botswana, 2012). Converis is a configurable research information management system that can manage the complete research lifecycle, from the earliest due diligence in the grant process through the final publication and application of research results. Converis is mainly being used to manage staff research process within the University.

2.2.2 UBRISA (University of Botswana research, Innovation and Scholarship Archive)

UBRISA was also introduced in line with the university's objectives of increasing the visibility of each research. It was agreed that all research essays, theses and dissertations written in partial fulfilment of the requirements for masters and fulfilment of the requirements for MPhil and PhD to be filed electronically. The theses full texts were to be accessed by the public after a year. A review of the UBRISA website depicted that since its inception no theses or dissertation have been uploaded, meaning the UB Library is still receiving hard copies from students (University of Botswana, 2011).

2.2.3 Course Management systems (CMS) in UB

Course management systems highly used in UB are Moodle and Blackboard. CMS is a class of Information systems that manage teaching and learning. They contain web-based tools to support activities and course management procedures. They are mainly used for teaching and learning. In addition to delivering course contents, they are also used deliver contents for the

research courses in the university. They are mostly used to provide means of communication and knowledge sharing between research coordinators and students.

2.3 Theses management systems

The management of research projects for university students is said to be an intensive process. It is so complicated because it is influenced by a lot of factors. Students fail to complete their research projects on time mainly due to supervisory contributions (Abiddin et al., 2011). Serious monitoring is required in order to guide students to complete their research work in time. Most institutions of higher learning are proposing effective ways which can bring quality achievement in managing research projects.

2.3.1 Supervisory management system as a tool for monitoring Computer Science projects

A final year supervisory management system as a tool for monitoring CS projects was realized in the University of Kebangsaa, Malaysia. The tool was designed after observations showed an increase in the number of students failing to complete final year projects within an allocated time and the decreasing quality of projects was a major concern.

The tool involved three parties being; students, supervisors and the head of department. The head of department assigned lecturers to supervise students. Log books were used to monitor progress of students' projects. Web-based tools were used to ease communication amongst all parties involved. The system consisted of three modules; appointment module, students and lecturers profiles module and schedule monitoring, log book administration module. The system was written in PHP (hypertext preprocessor). The user interface was designed using macromedia Dreamweaver CS3 and MySQL for database. Human computer interaction theories were adopted (Bakar et al., 2011). The tool has ability to set appointments, detect project delays and trigger deadlines for every stage. It lacks reporting functionality, log book module and it focuses on student supervision only.

2.3.2 Making connection between a final year students and potential projects supervisors

Another effort to help the coordination of undergraduate's final year projects in De Montfort University was initiated. The system automated practical tasks in the projects. The system was brought in to help students who were un-aware of potential supervisors in the faculty. At first students were free to go to a supervisor of their choice. That resulted in too many students going for the same lecturers and a few or no students choosing other potential lecturers. The other problems were the delays encountered during submissions. The system was designed to handle tasks of processing hundreds of paper projects proposal forms received from students. Processing papers in a short period of time was a stressful and error prone exercise for the coordinator. To address the problem and facilitate effective communication, a web based

project management system (ProMS) was developed in PHP, MySQL for databases. ProMS handled supervision, strong marking and feedback and generation of forms. It allowed communication between staff, students and uploading of information (Clement & Bounds, 2013). The system has email communication and information is accessible and can be edited. It has little functionality.

2.3.3 Students projects performance system for effective final year and dissertation project supervision

Edinburgh Napier University proposed an integrated and collaborative online supervision system for final year and dissertation projects. The idea was initiated in order to provide a high quality supervisory processes and effective relationship. (Romdhani et al., 2011) Suggested that there is a need for a supervisory process to be supported by a central electronic technology system to record, monitor, revisit supervision process and enhance the students learning process. He further said that from the student's perspective having in place a unique electronic supervision system alongside the traditional face-to-face and paper based supervision methods, can ensure guaranteed assessment and handling smooth data and reports transfer between all parties. The system minimized administration overheads and gave better control of project progression and monitoring (Romdhani et al., 2011). The system consisted of the following

- ✓ Project database for all dissertation proposed by lecturers.
- ✓ Supervisory team database for tutors and supervisors.
- ✓ Performance management plan for defining milestones, tasks and goals.
- ✓ Training and workshop database for professional workshops and training required by the students.
- ✓ Assessment forms to be completed by the supervisor and examiners.
- ✓ Communication infrastructure for group work and communication.

2.3.4 Integration of project management skills to manage a fourth year research project

In Cape Peninsula University of Technology (South Africa) experienced a daunting final year students research projects. They encountered problems of students undertaking research projects for the first time, whereby they do not learn passively by sitting down in lectures, receiving notes and worked out examples and writing examinations. Students faced a challenge of executing a significant research project without passive learning from class. Most students in the University were trapped at the research threshold after successfully completing their course work (Haldenwang et al., 2006). Students found the research projects as the most difficult programmes in the University. In the University it was discovered that students are not prepared to tackle research tasks and take initiative in all aspects. In trying to mitigate stressful research tasks experienced by students, the university proposed an innovative solution whereby project management and research projects are combined in one course (Haldenwang et al., 2006). The solution involved;

- ✓ Creating a structured environment using web based e-learning environment.
- ✓ Introducing research methodology
- ✓ Developing students project management skills so that students can manage their research projects.

The course consisted of the research project and the project management theories. The course consisted of lectures, tests, assignment, reports, presentation a written dissertation. Staff got involved through finding topics, marking the draft and final versions of proposals. The solution proved to be a good idea as students encountering problems with research were identified at an early stage.

2.3.5 Web based system for supporting thesis research process and knowledge sharing

In a study by Yan (2012), a web based system was designed to support the master's degree thesis research process and the knowledge sharing. The study identified the main steps on the research process. It then presents an instructional model based on the analysis of practical thesis research workflow. In a study of hundred Chinese universities analyzed audit was carried and it found out that Universities differ in theses time management and process organization. His study also highlighted that most researches follow the generic steps of; topic selection, thesis writing, oral examination and evaluation of excellent theses. They came up with the processes in the figure 2.1 where by the thesis research is a combination of problem based learning and thesis management process. (Yan et al., 2012). A web based supporting system called THEOL was designed according to the instructional mode for the Master's Degree thesis shown in figure 2.1. The system features three key modules: research process supporting, research group management and knowledge sharing, which have functions to support the whole thesis research process, multi-supervision from the teachers, and rich resource sharing during whole process.

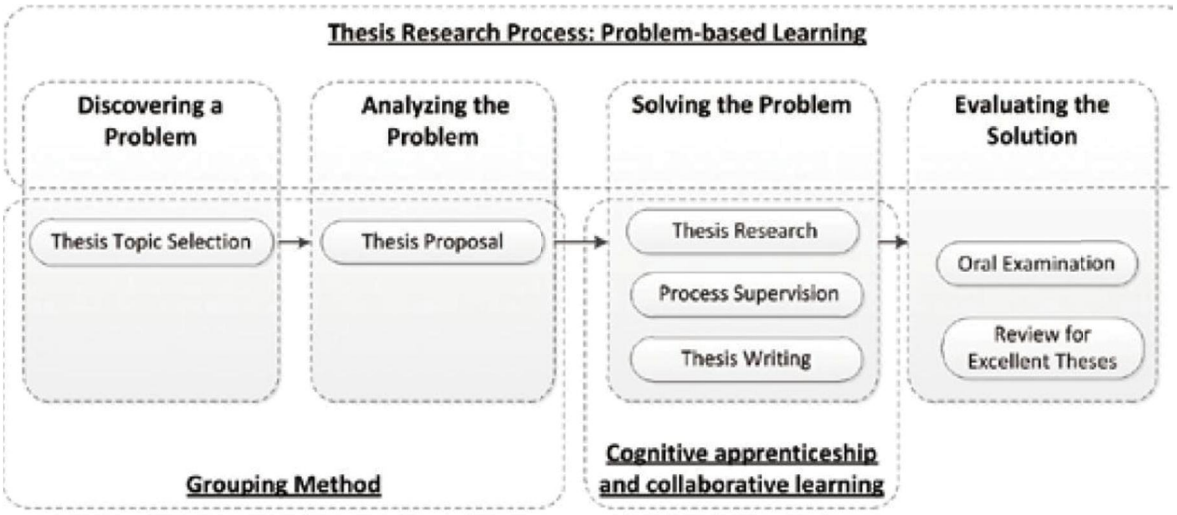

Figure 2-1: Model for the Master's degree thesis research process (Yan et al., 2012)

2.3.6 Thesis completion tool on Moodle

A tool was developed in the eTheNet project to support thesis supervision in the Moodle environment. The thesis tool has two tools; thesis contract and schedule tools which can be used either separately or together. The tool enables students to schedule their thesis and send the contract for the approval of their supervisors. The schedule tool enable students to monitor and specify the schedule defined in their contract. The schedule tool includes a calendar on which students write down session dates and appointments with their supervisors. Students can also monitor calendar which displays the phases of their thesis already completed. Students' calendars enable their supervisor to monitor the progress (Moodle, 2014). MySQL and PHP were used for the tool. The tool offer calendar for appointments, progress monitoring and schedule tools. It doesn't have reports and extensive communication.

2.3.7 Oracle Peoplesoft Campus Solution (Managing Lifecycles of research students)

Oracle developed Peoplesoft Campus Solution to provide research Institutions with efficient, flexible solution to manage students' research projects from time of application through association with supporting committees including tracking progress milestones, monitoring time to completion and thesis evaluation. Research universities must invest in extending and enhancing the features and functionality they need to efficiently manage student's lifecycle. An evaluation management system that supports the ability to track and assess the progress of a graduate candidate's evaluation is new technology.

Candidate' management

Universities are mandated to better manage administrative resources, increase efficiencies, and reduce costs while meeting higher expectations for accountability and the continuous release of new regulations (Oracle, 2013). Peoplesoft campus has extended its students administration system to help research institution centralize and manage information about research programs. Candidate management features include;

- ✓ Central source for a research candidate during admission application process that allows for automation and efficient management
- ✓ Easy progress-tracking of the candidate topic selection and approval, progression towards thesis completion and submission dates.
- ✓ Ability to track other assignments the candidate may receive from supervisors.

Thesis management and Evaluation

A foremost challenges faced by researchers, faculty and students in research institution is the amount of time required to manage administrative tasks. Time taken by stakeholders to perform administrative tasks has an impact on the research project. Peoplesoft solution include enhancement that automate the thesis management and evaluate processes. The enhancements are;

- ✓ Track multiple submission and monitor real trip progress
- ✓ Submit and view evaluation results and final approval
- ✓ Self-service request to the supervisors
- ✓ Monitor progress, make comments and see status and approval

2.3.8 Web based Undergraduate Project Management System

A thesis project management system developed in the department of Computer Science at Xian Institute of Post and Telecommunication (XIPT). The system was developed to facilitate existing traditional manual undergraduate project administration, and make all operations such as projects submitting by staff, assessing the assigned projects by assessors, process controlling and final papers and marks submitting. WebUPMS provided many conveniences for Faculty and administration when they is an increased number of students, making process administration quite a daunting task that the traditional manual project administration method was not suitable anymore. With over one thousand students taking their thesis projects at XIPT, they formed the project management procedure by dividing the whole processes into four phases:

- ✓ Faculty prepares the proposal of projects (University of Botswana, 2011)
- ✓ Students choose their interested projects
- ✓ Administration manage and control the project processes
- ✓ Assessor group assess and grade the students project work

The system was developed with modular base with flexibility in the mind. It was implemented role-based, access-control by giving four classes of users, being; system administrators, academic staff, assessors, and students (Li et al., 2007).

2.3.9 Comparison of the reviewed systems

In summary, Table 2.1 describes the reviewed systems and what aspect of management of students' research projects they help with.

Table 2-1: Comparison of reviewed Systems

Reviewed systems	Advantages	Disadvantages
University of Kebangsaa supervisory system	Ability to set appointments Clustering systems functions into modules. Monitoring and detecting projects delays. Deadline triggering for every stage. Lecturers can detect students' progress.	Lack detailed reporting. Focused on student's supervision. Log books focused on report writing only. No emails, no assignment of tasks by the system. Log book module not implemented.
De Montfort University ProMS	Email system embedded. Information uploaded can be edited. Information is accessible and searchable. Extensive communication.	Mainly connect student and supervisor. Focused on project proposals only. Little functionality.
Edinburgh Napier University dissertation system	Provided database of dissertation. Access to assessment forms Provide training. Control of project progression.	Concentrated on supervision only. Lack effective communication tools like emails. No deadline triggering.
Cape Peninsula University of Technology system	Topics were provided to students by staff. Students are taught project management skills.	Time taken to study project management theories could be utilized in research. Combining the two courses two make it one can a lot of work for students.
Thesis process support system for Chinese Universities	Clustering of tasks into steps Group management. Knowledge and resources sharing. Research supervision in groups.	Lack of clear communication. No monitoring of progression.
Moodle Thesis Completion tool	Provide schedule tools. Calendar for appointments. Research progress monitoring.	No reports. Lacks extensive communication. Few systems functions.
Oracle Peoplesoft Campus Solution	Automated application admission to research. There is progress tracking. Can view final approvals. Self-service request to supervisors.	No reports. Lack deadline triggers. Lack communication tool like email.
Xian Institute of Post and	Clustering of tasks into phases.	Lack reports.

Reviewed systems	Advantages	Disadvantages
Telecommunication Project management system	There is project processes control Modular based development.	No email linked to the system. Little functionalities

The most important features need in the University to solve the current problems include:

- ✓ Email system
- ✓ Processes separation into modules
- ✓ Appointments
- ✓ Deadline triggering
- ✓ Reporting
- ✓ Progress monitoring

None of the systems described includes all the desired features. The prototype system will cater for the features required by the University.

2.4 Workflow management systems

A workflow is referred to as an automation of business process, in whole or a part, during which documents, information and tasks are passed from one participant to the other for activities. Participants' maybe be persons or automated processes (WFMC Documentation, 1996). A process is said to be a number of tasks that need to be carried out and a set of conditions that defines the order of the tasks. Workflow management involves managing flow of work such that the work is done at the right time by the proper persons. Workflow management systems aim to help business goals to be achieved with high efficiency by means off sequencing work activities and invoking appropriate human or information associated with these activities (WFMC Documentation, 1996). It also ensures integration of people and programs.

Benefits of workflow systems

- ✓ Better control of work.
- ✓ Better use of staff (sorting, delivery, assignment, logging, tracking and reporting).
- ✓ Automated assignment of tasks.
- ✓ No misplaced tasks or work.
- ✓ Communication through emails and group discussions.
- ✓ Group coordination for scheduling and time management.
- ✓ Improved efficiency through business processes.
- ✓ Improved customer service through consistency in processes.

The benefits of workflow system address most of the limitations for the existing systems. Addressing such limitations can be helpful in delivering the most relevant system to manage research projects. Some of the workflow management system is discussed below.

2.4.1 Joget

Joget – is a workflow management system that serves a web platform that simplifies the process of developing workflow apps for user to run workflows for the system processes. It provides the following features. Simple and rapid deployment, Process engine supporting XPLD standard, Graphical workflow designer and form builder, Process monitoring, people driven and long running processes with plugin architecture, Integration via JSON or java API (JOGET, 2013) . Workflow designer is a graphical tool which allows process designers to create process flows based on their business processes. Once the process is designed, its design can be deployed to the workflow engine directly from the workflow designer or saved as XPDL file. Workflow engine is the heart of the system which executes process deployed by the workflow designer. Workflow management console is a web based application that allows uses and administrators to use system through a web browser. Advantages of Joget include;

- ✓ Open source system,
- ✓ Simplicity;
- ✓ Drag and drop features,
- ✓ Doesn't require any developer studio or IDE for its functions,
- ✓ Plugin Architecture: supports plug in architecture to achieve extensibility and adaptability of product features and platform independent (JOGET, 2013).

2.4.2 Processmaker

Processmaker – The system allows public and private organization to automate documents intensive, approval-based processes across departments and systems. Users with no programming languages can design and run the workflows using the system. It contains two main components; a design environment and a run-time engine. The design environment includes tools to map processes, defines rules, create dynamic forms and input/output documents. The run time engine allows for cases to be started and run through the process (ProcessMaker, 2013). The system organizes itself into users, groups and department and roles assigned to the users. It has a richer field form types and with many field types and it provide HTML and XML views to manage the forms. It is designed using LAMP/WAMP stack and can be operated on Linux or Microsoft as the operating system. It uses object-relational mapping Propel to map Process maker's PHP classes to databases. That makes the generated application compatible with different DBMS, including MySQL, PostgreSQL, Oracle, and SQL Server (and Sybase if using Linux/UNIX). It is designed on the Gulliver framework which uses RBAC to manage roles, uses WSO2 to manage web services with SOAP, and uses two mail engines: PHP's

built-in mail function and PHP Mailer, and is web-based and cross-browser, though it is optimized for Mozilla Firefox. Using SOAP, Processmaker can connect, through web services, to other systems, including but not limited to DMS and CRM systems, middleware, messaging, PM Mobile, etc. Using LDAP, Processmaker is able to manage high user authentication (ProcessMaker, 2013).

Advantages of Processmaker
Processmaker is a simple, cost effective, open source workflow software solution. It helps organizations of all sizes to easily design, automate, and deploy approval-based business processes. Processmaker is simple to use and easy to extend.

2.4.3 Bonita

Bonita Open Solution - An open sources business process management and workflow suite created in 2001. It comprises of three integrated modules; Bonita studio, form builder and user experience. The Bonita studio allows you to draw processes directly on the studio whiteboard using notation of BPMN. At every step that takes an input a form will be automatically created with fields based on the data variables defined. The user experience provides an email-like interface for managing steps, cases and processes.

2.5 Conclusion

The three systems (Processmaker, Joget and Bonita) are the only solutions available in UB to offer a better way of improving research projects. The systems don't offer much innovation, and are only used by academic staff members.

The management systems discussed provides very critical layout and aspects for a research management system required for the University of Botswana students. The generic steps for the management system as proposed by Yan (2012) add a stable design which is easy to follow and understand. It is very important to design systems for a target group based on their requirements. The reason the study focused on investigating the current processes for students is to collect and be familiar with the way they work. Adopting these systems directly in UB will mean new different processes and methods will be brought in by the system which may be total different from the known processes.

In summary, workflow is the critical components of the system as it dwells much on processes, tasks and user participation. Researchers have agreed that workflow management is mandatory to an efficient and reliable system. The management of workflows includes, process automation and enhancement. With regard to the benefits of workflow management, researchers agreed that workflows are managed easier through proper modelling. It is emphasized that the notation for modelling makes us understand the system's logic and everyone in charge of a particular task in the system. It is stated

that proper allocation of work items to resources is critical to the efficiency and effectiveness of a workflow.

It is believed that management of workflows has to be coupled with process enhancement. Goals for adjusting current processes have to be established and the current setup have to be identified to identify inefficiencies. Process enhancement methods are categorized as process improvements and process engineering. It is said that process improvements seek to adhere to a continuous incremental change whereas reengineering focuses on radical change of processes to bring about dramatic improvements.

In this dissertation a proposed project management system build with the aid of a workflow management system. Proper modelling of workflows was done. Methods of improving workflows such as enhancement and reengineering were put into use to build efficient workflows. Some were developed to handle the submission and post-submission process of the theses.

Chapter three: Methodology

3.1 Introduction

The study is composed of five phases. The first phase was intended to model the current manual system of managing researches in Faculties at the University of Botswana. The second phase was designed to model the manual system from the user requirements in phase one into workflows. The third phase improved workflows to eliminate human-dependent processes which bring some inefficiency. The purpose of the fourth phase was to use the formulated workflows to develop a prototype for the research management system. The final phase was to evaluate the designed prototype interface design through heuristic evaluation, perceived ease of use and perceived usefulness.

Table 3-1: Five phases for the study

	PHASE 1- analysing the current research project management processes	**PHASE 2- Modelling the current processes**	**PHASE 3- Improve workflows**	**PHASE 4- Prototype design for the improved workflows/ Implementation**	**PHASE 5- Evaluation**
Design	Descriptive and Tabular form	Descriptive through flow charts	Workflow reengineering methods	User interface designed	Heuristic evaluation Perceived ease of use Perceived usefulness
Sample and Setting	From Six Faculties, two departments per Faculty	Flowcharts for Undergraduate(Computer Science), Masters and PhD	The flowcharts were improved		Undergraduate student Masters students PhD students and staff members
Procedure	Interviews and Literature survey	Identify steps through use of flow charts	Improved through flow charts.	Prototype implementation	Heuristic evaluation survey Perceived ease of use survey Perceived usefulness survey

Results	The current processes and stakeholders were identified	Workflows were built for the current workflows	Flow_charts showing improved workflows were designed	Prototype was designed using Processmaker	Usability issues were identified Perceived ease of use identified Perceived usefulness identified

3.2 Capture and modelling of the current manual system into workflows

The goal of the phase was to capture and model the current manual into workflows. The aim of the phase was to identify processes for undergraduate, masters and PhD which are used for managing researches.

3.2.1 Procedure

Two departments were selected from the each of the six faculties. A survey was carried out to capture how research management is done in the respective departments. Interviews were conducted with department projects coordinators. Table 3.2 was used to for summarizing the captured data. The chosen department the format was used to collect the data.

Department	Project name	Preliminary work	Stakeholders	Marking criteria	Budget	Time frame	Milestones delivered	Post research work	Grading

Table 3-2: Sample for data collection in departments

The headings in the table are explained below;

- ✓ Department- name of the department.
- ✓ Project name – name used to refer to a research project
- ✓ Preliminary work – work done before the actual research
- ✓ Stakeholders- all relevant users involved in research
- ✓ Marking criteria- factors considered when marking research projects
- ✓ Budget- project funding
- ✓ Time frame- time taken
- ✓ Milestones delivered- tangible deliverable submitted.
- ✓ Post research work- work done after research
- ✓ Grading- factors considered when grading

3.2.2 Modelling workflows

After capturing data as above, workflows were modelled based on the phases outlined. Department of Computer Science was used to formulate a generic workflow which can be adopted by other departments. For post graduate students, workflows were designed based on the procedures outlined by the School of graduate Studies.

3.3 Improving workflows

The goal of this phase was to improve the workflows created in the first phase. The aim of this phase was to move from human controlled processes into automated processes which can be monitored. The principles of process improvement were taken into practice. They include; reducing long processes, automated processes, database for data storage and email creation.

The workflow reengineering methodology (WRM) is a proposed methodology that uses workflow management automation to enable process reengineering. It uses more accurate, real time process measurements, gathered by a workflow tool to improve efficiency, effectiveness and flexibility of workflow. The methodology consists of five phases. To fully benefit from Information Technology we need to address the fundamental ways that Information Technology could be used to reengineer traditional processes to achieve cost saving, improve customer satisfaction and bring about today's highly competitive markets. Workflow management technology is an approach that automates, integrates, and manages work. It incorporates flexible process modelling, simulation and real time status monitoring. The following phases were used for the study

Table 3-3: Phases for Workflow reengineering Methodology

Phase	Tasks
1. Preparing for workflow innovation	✓ Identify need for improvement ✓ Identify business cycles ✓ Introduce workflow management tool
2. Automate existing workflows	✓ Select process for improvement ✓ Define task component
3. Identify process improvements	✓ Consider customer requirements ✓ Reengineer the workflows

3.4 Prototype development for improved workflows and Implementation

The goal of this phase was to transform the improved workflows into a web based prototype with user interfaces for managing research projects. While paper based prototypes are quicker and cost less than online prototypes, web based (online) prototypes are easier to adapt into a final product (Laurie et al., 2002). A web based prototype which allowed for simulation equivalent user interfaces was developed.

Based on the demand for faster software development and because of many documented failures of traditional SDLC models, prototyping was developed as a better way to add functionality to an application. After quick requirements gathering phase, a prototype application is built and presented to the users. Feedback from the users provides a chance to improve or add functionality. This is illustrated in Figure 3-1.

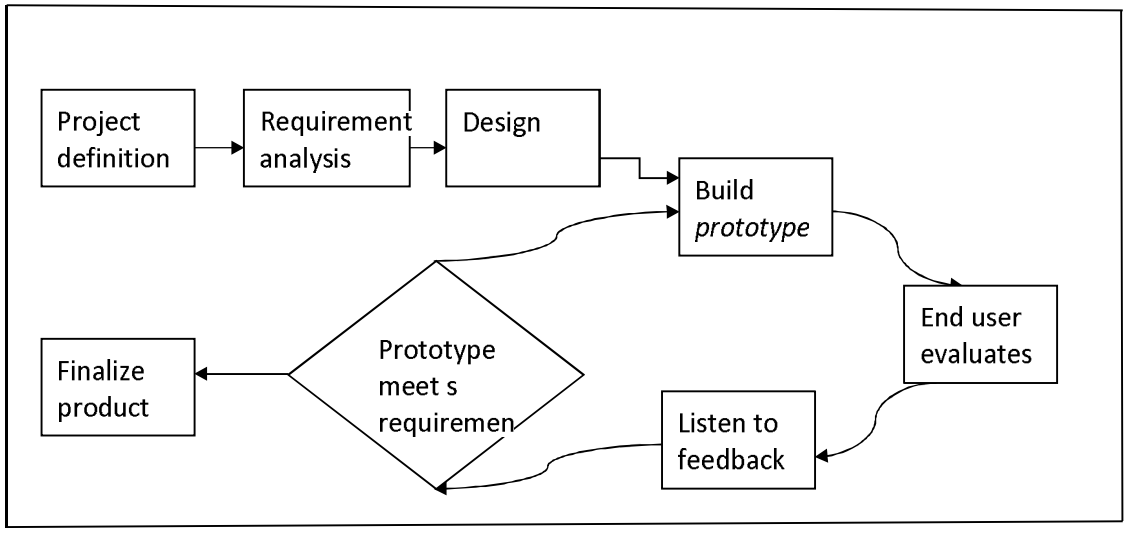

Figure 3-1: Prototyping model

Using prototyping does have a lot of benefits as well as drawbacks. These are discussed in Table 3.4.

Table 3-4: Benefits and drawbacks of Prototyping model

Benefits	Draw backs
Guarantees client satisfaction	Process is so quick, therefore proper testing (security) may be skipped.
Encourages and requires end user participation	If the requirements are not properly defined, the project timeline could be delayed and costs could increase.
Gives early capability in the project	Can encourage ill-advised shortcuts through the life cycle.
Users will be more responsive and helpful	Often leads to a premature commitment to a design.
Build and test as you go	A user and designer who view a prototype report can become entrenched in that design for the report, unable to see other options.
Gives users opportunity to provide direction for application design.	

For this dissertation, prototyping model was used because it is a method that allows one to build and test as the system is developed. Getting all the requirements on one occasion is unlikely hence multiple evaluations were used to flush out the remaining requirements. This method allows the end user to interact and review during the building phase to achieve the best possible product. Prototypes may demonstrate that a new model can indeed be implemented (proof of concept prototype).After proposing some new concept or a new model, a prototype may be used to prove that concept. Prove means demonstrating that the concept works. Prototypes may serve as a vehicle for experimentation; the construction of a prototype may provide more new insights into the prototyped model than those gained from the model alone. Finally one will present the prototype to make the statement "it is possible to implement this excellent concept in practice.

Prototypes may be used to eliminate risks such as uncertainty about system objectives and gaining user acceptance of the new system. In this phase a web-based prototype was built for project management. The prototype was developed using an open sources workflow tool called Processmaker. The prototype was built two related components. The prototype was then evaluated. Paper based prototypes are said to be quicker, easier to build and modify, cost less than online prototypes. Computer based prototypes provide a more realistic environment and are easier to adapt.

The researcher firstly developed processes for the prototype, which consisted of tasks, routing methods and assignment of tasks to users. Custom forms were developed for each task. The forms were developed to interface with users while running a case of a process.

The interface screens were developed from XML, with HTML available for the forms. JavaScript was used as a code for managing behaviours of forms by improving their usability and increasing functionalities. PHP was used to write triggers which performed calculations and gave added functionalities to the processes.

3.5 Prototype Evaluation

The goal of phase four was to evaluate the system functions and access whether they met the needs identify evaluate the designed prototype by identify usability issues of the web based prototype.

3.5.1 Usability inspection and heuristic evaluation

Usability is associated with positive effects, reduction in errors and enhanced accuracy. Usability is defined as the capacity to be used by humans easily and effectively. (Agarwal, 2002) Defined usability as a philosophy based on the needs and interests of the user. The ISO definition (ISO- 9241-11) contains three definitions; efficiency, effectiveness and satisfaction. Nielsen (1994) describes usability as an issue of system acceptability. He explains that usability of a system has the following attributes; learnability, efficiency, memorability, errors recovery and satisfaction. It is a quality that makes system easy to learn and use, which reduces workload in the system. Usability includes the consistency of the interface with other system, how the user can manipulate and navigate the system. Heuristic evaluation was used for the inspection. The evaluation factors are shown in Table 3.5.

Table 3-5: Heuristic Evaluation Factors

Usability Factor	**Definition**
Visibility and system status	The system should be able to keep users informed about what is going on, through relevant feedback within reasonable time
Match between system and real world	The system should speak user's language with words, phrases and concepts familiar to the user rather than system oriented terms. Follow real world conventions, making things appear in a natural.
User control and freedom	Users can choose functions by mistake and will need a clearly marked "exit button" to leave the unwanted state without having to go through an extended dialogue. Support undo

	and redo.
Consistency and standards	Users should not have to wonder whether different words, situations or actions mean the same thing. Follow platform convention.
Error prevention	Better than good error message is a careful design than prevents a problem from occurring in the first place.
Recognition rather than recall	Make objects, activities and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible.
Flexibility and efficiency of use	Accelerators- unseen or novice user- may often speed the interaction for the expert user such that the system can cater for inexperienced users
Aesthetic and minimalistic design	Dialogues should not contain information that is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishing its relative visibility
Help user recognize, diagnose and recover from errors	Error messages should be expressed in plain language (no codes), precisely indicate the problem and constructively suggest a solution.
Help and documentation	It may be better to provide help and documentation. Any such help should be easy to search and focused on the user's task

3.5.2 Perceived ease of use and Perceived usefulness

Perceived ease of a use is defines as the degree to which an individual believes that a particular system would be free of effort. Perceived usefulness is defined as the degree to which an individual believes that using a particular system would enhance his/her performance (Davis et al., 1989). The two principles are quite useful in finding out the user's attitude towards using a computer system. The more positive of perceived usefulness and perceived ease of use are the higher the probability of actually using the system. The questions in table 3.6 were used to gather feedback on perceived ease of use, while table 3.7 shows questions on perceived usefulness.

Table 3-6: Perceived ease of use questions

#	Item
1	I find the system easy to use.
2	Learning to operate the system is easy for me.
3	I find it easy for the system to do what I want it to do.
4	The system is flexible to interact with
5	I can easily remember how to perform tasks
6	My interaction with the system is clear and understandable

Table 3-7: Items for measuring perceived usefulness

1	The system would allow me to complete my tasks more quickly
2	Using the system would increase effectiveness of performing tasks
3	Using the system would give me more time over other issues than administrative task
4	Using the system would give me more visibility over my tasks
5	Using the system would reduce delays for the same amount of effort
6	I would find the system useful in the process for my research work

Chapter Four: Analysis of the research processes

A survey was carried out in the University of Botswana to see the current status of the students' research projects management. Six faculties (excluding health sciences) were examined their management procedures. For undergraduates courses most departments provided guidebooks on how they manage student's researches. It is clear that irrespective of field of study most of the researches undergo similar steps. For masters, MPhils and PhDs, department plays minor roles and the bulk of the work is done by the School of Graduate studies (SGS). Procedures are well-documented in the graduate handbooks for postgraduate theses and dissertations.

4.1 Current processes

For each of the faculties, the stakeholders were identified, marking criteria noted, milestones given to students were identified. This is detailed in Table 4.1

Table 4-1: Results from Departments

Faculty	Department	Name used	Stakeholders	Marking criteria	Milestones
Business	Accounting/ management /marketing/b usiness information systems	Research project	Faculty research coordinator, departmental research project coordinator, supervisor and student	Theoretical foundation methodology analysis of data, discussions and findings conclusions and recommendations	Supervision process, progress report
Social sciences	Social work	Research project	Student and supervisor	Proposal (title, introduction, literature review, methods, ethical issues, limitations project(title, introduction, literature review, methods, results and discussions, recommendations and conclusion	Supervision process, progress report
Social sciences	Economics	Project identificati on, proposal ,register	Programme coordinator, supervisor, student, department board	Introduction, review of economy literature review, theoretical framework and methodology, estimation and results, conclusions	Supervision process, progress report
Education	Physical education	Project	Student and supervisor	Introduction, review of literature, methods and procedure, presentation and discussion of results, summary	Supervision process, progress report
Engineeri ng	Mechanical and civil	Final year project	Students and supervisor, project coordinator, second examiner	Introduction, review of literature, methodology, data and various aspects of data analysis, interpretation and conclusion	Supervision process, progress report
Science	Chemistry	Final year project	Students and supervisors	Introduction, experimental, results, discussion and conclusion	Supervision process, progress report
Science	Computer science	Final year project	Students, supervisors, project coordinator, co-examiner	Introduction, literature review, requirement analysis and specification, system design specification, implementation summary, testing,	Project registration, initial proposal, detailed proposal, progress report, alpha and beta version, final report and project management sheets
Humaniti es	African languages and literature	Research project	Students, supervisors, departmental secretaries	Introduction, review of related literature, methodology, data analysis, conclusions and recommendation	Questionnaires, interview guide, recordings

4.1.1 Stakeholder identification

Seeking out and identifying stakeholders in any project is critical to its success. A stakeholder is anyone with a keen interest in the existing systems, new proposed system or anyone who controls the purse string on the budget. Lack of relevant stakeholders' identification can result to a project failure. For the proposed system, stakeholders were identified as students, who carry research and anybody who interact with the research project until it reaches the examinations point. This was captured from the study above, observations and other relevant documents.

Student

A student is a principal stakeholder. He initiates a research project and be allotted a supervisor. As a major beneficiary the student drives all the processes to the final stage of submission. A successful project, completed on time shows a thorough commitment and effort from the student's side. When a student quits the project, which is the point when the project can halt completely and eventually fails. Some of the duties include; milestones submission, research management, progress report controls, follows ethics of the research project and performs some presentations where necessary. The student is the heart and soul of the project.

Department coordinator

Appointed by the head of department, is in charge of monitoring research projects in a given department. S/he acts as a bridge between the student and supervisor. First he allocates a supervisor to a student. S/He takes care of meetings, deadlines and progress reports from students. For undergraduates courses the coordinator appoints co-examiners to carry examine the researches. S/He takes care of the problems that may occur during the course of the project and prepares marking scheme, presentation schedule and presents final marks to the head of department. The coordinator sits in the departmental committee for further implementation and planning

Supervisor

A supervisor can be any academic staff member with a keen interest in a particular area of research. For masters and PhD supervisors can be appointed from different department with the approval of the school of graduate studies. A supervisor can have many students to supervise. S/He might be assisted by a co-supervisor. S/He assigns tasks to students and keep records of all activities regarding research projects. S/He guides the student in issues like methods, design patters and any other duties deemed necessary. Regular visits and updates have to take place between the two parties and the meetings have to be recorded. S/He receives milestones from the student and he makes the final on whether the student

can take the project for examination. Minor amendments of the dissertation or the research essay are coordinated by the supervisor.

Head of department (HOD)

The head of department administers the whole process of students' research. As the head he appoints the project coordinator and account for any decisions made by the departmental board, he is the leader of the board. For undergraduates, the HOD to Senate for approval and the masters and PhD research are sent to the school of graduate for examination.

Dean of Faculties/School of graduate studies (SGS)

The dean is the most senior academic staff member who heads a group of department or the School of Graduate board. He receives reports from the examiners.

Internal examiner

He/she examines the student complete dissertation or thesis at the masters/PHF level and returns it with a signed report to the dean of graduate school giving feedback

External examiner

Appointed from outside the University and must have experience in the academic field. Takes part in examining dissertation/ thesis at the masters/PHD level and gives a feedback.

Departmental board/ department graduate board

The board chaired by the head of department. The department graduate board consists of department members at level of senior lecturers and above and those with PhD. The department board consists of all academic members. The department board makes some recommendations to higher committees. They can recommend students change of supervisors, appointment of internal and external examiner and recommend the award of the degree. The Department sometimes nominates up to two additional members who shall be Co-Supervisors, who with the Supervisor shall constitute a Supervision Committee

School of graduate studies board

The committee is led by the dean. The committee appoints examiners on the recommendation from the department and approves foreign supervisors and acting supervisors. The board can also approve the third examiner in case of conflicting report from internal and external examiners.

Co –examiner (UG)

A co-examiner normally examines along with the external examiner.

Deputy Vice chancellor Academic affairs (DVC)

The DVC has a keen interest on the students' researchers within the Universities in all the faculties. The DVC is interested in the in summaries of research and progress with graduate research, outputs from department and faculties.

Vice Chancellor

The VC also has a keen interest on the student's researchers within the University. The VC's interest is in summaries of research and progress with graduate research, outputs from department and faculties.

Research and development office

This offices mandate is to promote research within the University. It also does some funding of research. Its main interest will be in graduate research.

Library

Library catalogues all the completed researchers within the University

Finance

Students require some funds for their projects so the Finance office interest is on who is doing the research for funding purposes. Funds can be from sponsors or organizations.

4.1.2 Undergraduate research process flows

The major processes involved in undergraduate research process are highlighted below. These processes are put together in Figure 4.1.

Supervisor and project topic selection

There is no a standard way students select supervisors and topics. Lecturers can come up with project topics and give them to the coordinator or publish them on notice boards, students are also allowed to come up with theirs and seek for a supervisor. In most cases if a supervisor comes up with a topic he/she will be the one to supervise it. A meeting is normally held between students and the coordinator to discuss how they can get topics.

Project proposal

At the beginning of a project, students will prepare a project proposal with their supervisors and present copies to the coordinator. The coordinator will convene a board meeting to approve the project proposals. A topic gets approved in the board meeting when majority of staff feels the project is feasible. The coordinator will send or post the feedback on the proposals or students sometimes learn through their supervisors that their proposals were approved or not. If it is not approved the student will be forced to find a new topic. When approved the students will be required to write a detailed proposal and send the copies to the coordinator.

Research execution

Upon approval the student will work with the supervisor on the project. There will be several meetings between both the student and supervisor to check on the project progress. Any milestones to be submitted to the coordinator by the student will be through the supervisor.

Final submission and marking

At the stipulated time the students will be required to submit the final project. Students are asked to bring from one to three bound copies. Presentations are arranged by the coordinators and examiners are given students projects to mark and submit to the coordinator. Supervisors are also involved in marking. The examiners will then forward the marks coordinator who will compute some grades and send to the board for approval.

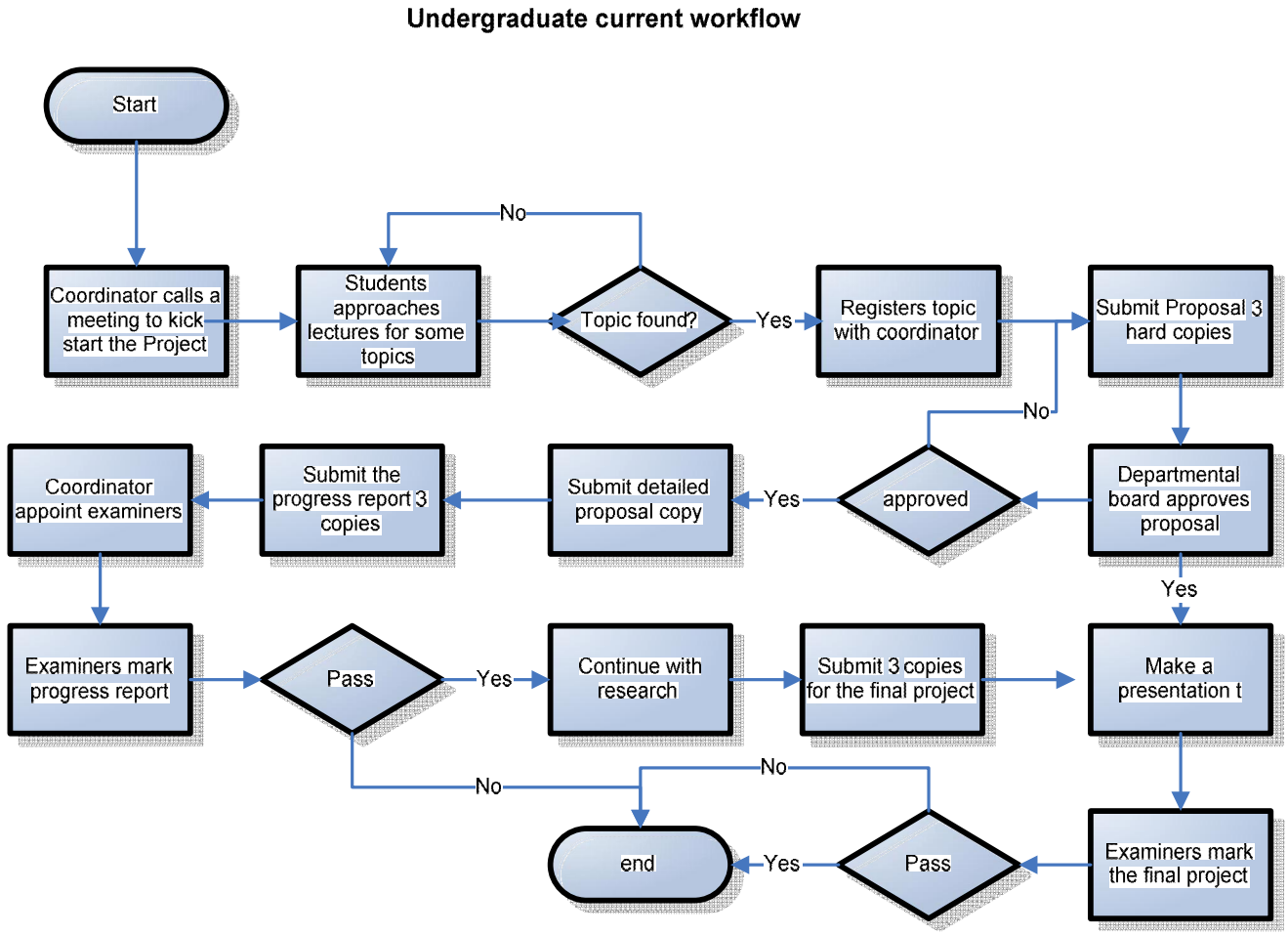

Figure 4-1: Undergraduate Current Workflow

4.1.3 Masters dissertation process flows

The major processes involved in masters' dissertation process are highlighted below. These processes are put together in Figure 4.2.

Preliminary work (Title and supervisor)

The Dissertation Supervisor is normally nominated by the Department before the completion of coursework. Such a supervisor shall normally be a member of academic staff in the department in the area which the researcher is pursuing the course. With the approval of the School of Graduate Studies, the Supervisor may be from another department or appropriate external institution. The Department nominates up to two additional members who shall be Co-Supervisors, who with the Supervisor constitutes a

Supervision Committee. In exceptional circumstances, a change of Supervisor may be requested by the student and/or recommended by the Departmental Board to the School of Graduate Studies Board. The Length of the Dissertation is between 20,000 to 40,000 words (excluding footnotes, tables and appendices).

Proposals

Most students are supposed to defend their proposals before the departmental board. The coordinator will convene a board as a panel during the defense of the proposal to give the student some input and direction into the work.

Dissertation execution

The student works with the supervisor until the dissertation is ready for examination by the school of graduate studies. At the end of each semester a progress report is sent to the school of graduate studies.

Final submission

The Dissertation is supposed to be submitted within two semesters for full-time students and four semesters for part-time students, after the semester during which course work is completed. A Student submits three loose-bound copies of the Dissertation/Research Essay, accompanied by a covering letter signed by the supervisor indicating his or her approval, or otherwise, to the School of Graduate Studies for examination by Internal and External Examiners; the Dean of the School of Graduate Studies shall retain one copy.

Dissertation examination

On the recommendation of the Departmental Board, the School of Graduate Studies appoints an internal examiner who is not the supervisor and an External Examiner (SGSCALENDAR, 2013). The Examiners shall each submit a signed report to the Dean of the School of Graduate Studies stating whether the Dissertation is;
a) Accepted and passed; b) Accepted pending minor amendments;
c) Referred for major amendments; or d) Failed.

The completion of required minor amendments to the Dissertation or Research Essay is coordinated by the Supervisor and certified by the Internal Examiner. If the Dissertation or Research Essay has been referred for major amendments, it is the responsibility of the Supervisor to determine that the candidate has made all the corrections recommended by

the Examiners. Major amendments are approved by the External Examiner. A Dissertation which has been referred for amendment can be resubmitted only once, and this must be done within a period of twelve months. A Research Essay which has been referred for amendment can be resubmitted only once, and this must be done within a period of six months. In the case of conflicting reports from Examiners or in borderline cases the Department may request and recommend a third Examiner to the School of Graduate Studies. Once the Dissertation or Research Essay has been accepted by the Examiners, the Department Board recommends the award of the degree. The recommendation, with the results of the coursework and Dissertation/Research Essay, are submitted by the Departmental Board to the School of Graduate Studies and Senate, and the decision of Senate communicated immediately to the student (SGS-CALENDAR, 2013).

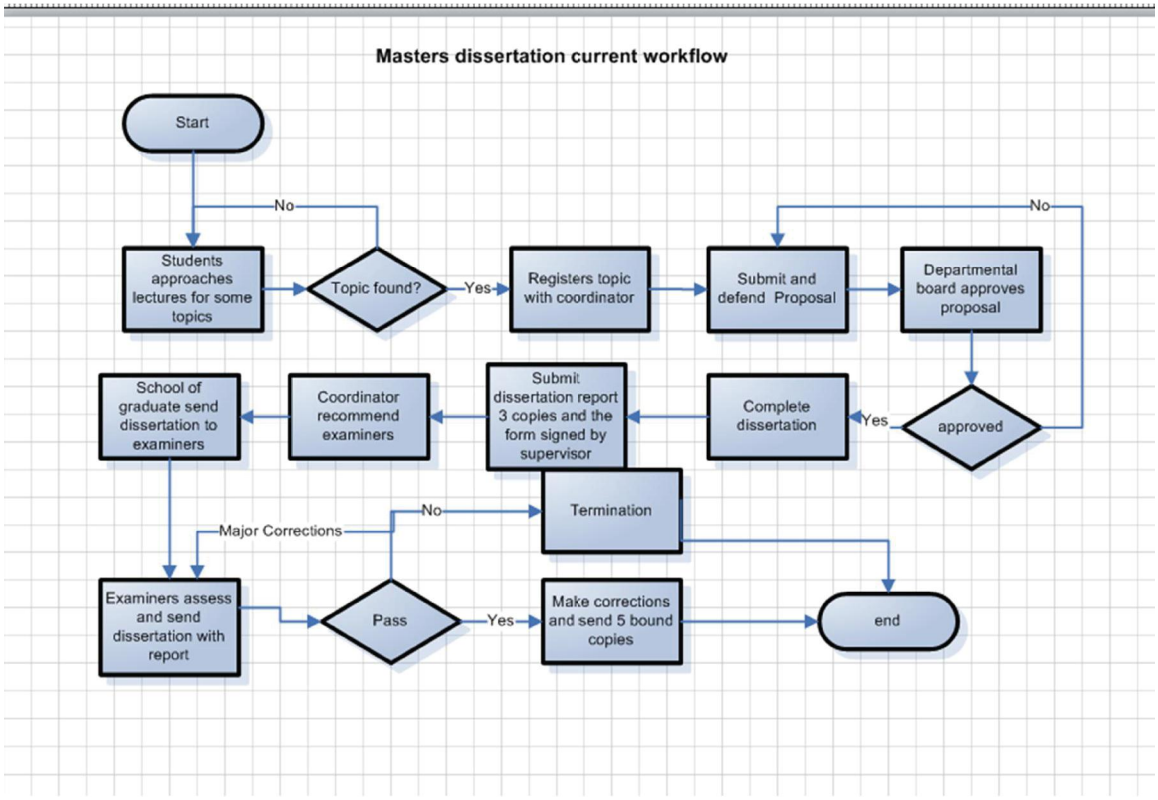

Figure 4-2: Masters current workflows

Analysis of current masters processes

4.1.4 MPhil and PhD process flows

The major processes involved in MPhil and PhD processes are highlighted below. These processes are put together in Figure 4.3.

Admission

On receipt of completed application forms and supporting documents, including an acceptable outline of the proposed research, the School of Graduate Studies sends one copy to the relevant Head of Department for review and recommendation. Acceptances/Rejections are considered by the School of Graduate Studies Board after receipt of the recommendation from the Departmental Board and verification that a qualified Supervisor is available. Each applicant shall be notified of the result of his/her application by the School of Graduate Studies. Successful applicants should then proceed with registration. A graduate student is expected to begin study for the MPhil or PhD degree within one calendar year from the date the application is approved (SGS-CALENDAR, 2013).

Proposal defence

The candidate presents their thesis proposal to the board. Once approved by the board the candidate will be able to continue with the thesis writing.

Submission of Title and Abstract of the Thesis
The title and abstract (not exceeding 500 words) of the Thesis is submitted through the Supervisor and the Departmental Board for approval by the School of Graduate Studies Board approximately three months before submission of the Thesis. After the title has been approved, it may not be changed except with the permission of the Department and the School of Graduate Studies Board. The abstract may be edited before the final submission of the thesis (SGSCALENDAR, 2013).

Submission of the Thesis for Examination
After completing the research/investigation, the candidate will be required to lodge with the Dean of School of Graduate Studies three loosely bound copies of the Thesis for examination.

Entry into the Examination
Application for entry to the examination must be made on the appropriate form obtainable from the Dean of School of Graduate Studies. The examination entry form is endorsed by the Supervisor, who satisfies himself/herself that the Thesis is in a form suitable for examination and, if items of coursework have been set, that the candidate has

satisfactorily completed them. The completed form must be returned to the School of Graduate Studies. The final submission of the Thesis for examination may follow at any time within the permitted time limit, but the candidate must immediately beforehand inform the Departmental Board and School of Graduate Studies Board in writing of the intention to do so, and also submit a signed statement from the Supervisor indicating his/her approval or otherwise, to the submission of the Thesis for examination (SGS-CALENDAR, 2013).

Appointment of Examiners and board of examiners

The examination crew for PhD theses comprise of an external examiner and one internal examiner are appointed by School of Graduate Studies Board on the recommendation of the Departmental Board. The Board of Examiners for the degree of MPhil and PhD comprise at least three members from the following, as recommended by the Departmental Board and approved by the School of Graduate Studies Board.
Internal Examiner: An academic member of staff who is competent in the area of the work to be examined. In the exceptional event that no suitable Internal Examiner is available from within the University, a Second External Examiner in lieu shall be appointed.
External Examiner: A Senior Academic from outside the University of Botswana. The person must be competent in the area of the work to be examined, and an experienced researcher. S/he shall not be a former member of UB unless at least three years have elapsed since leaving UB (SGS-CALENDAR, 2013).

The Oral Examination and results

There is an oral exam that finalises the whole process. It is chaired by a professor or a senior member academic member from a different department. The candidate presents and the board of make a recommendation which is then forwarded to the Senate

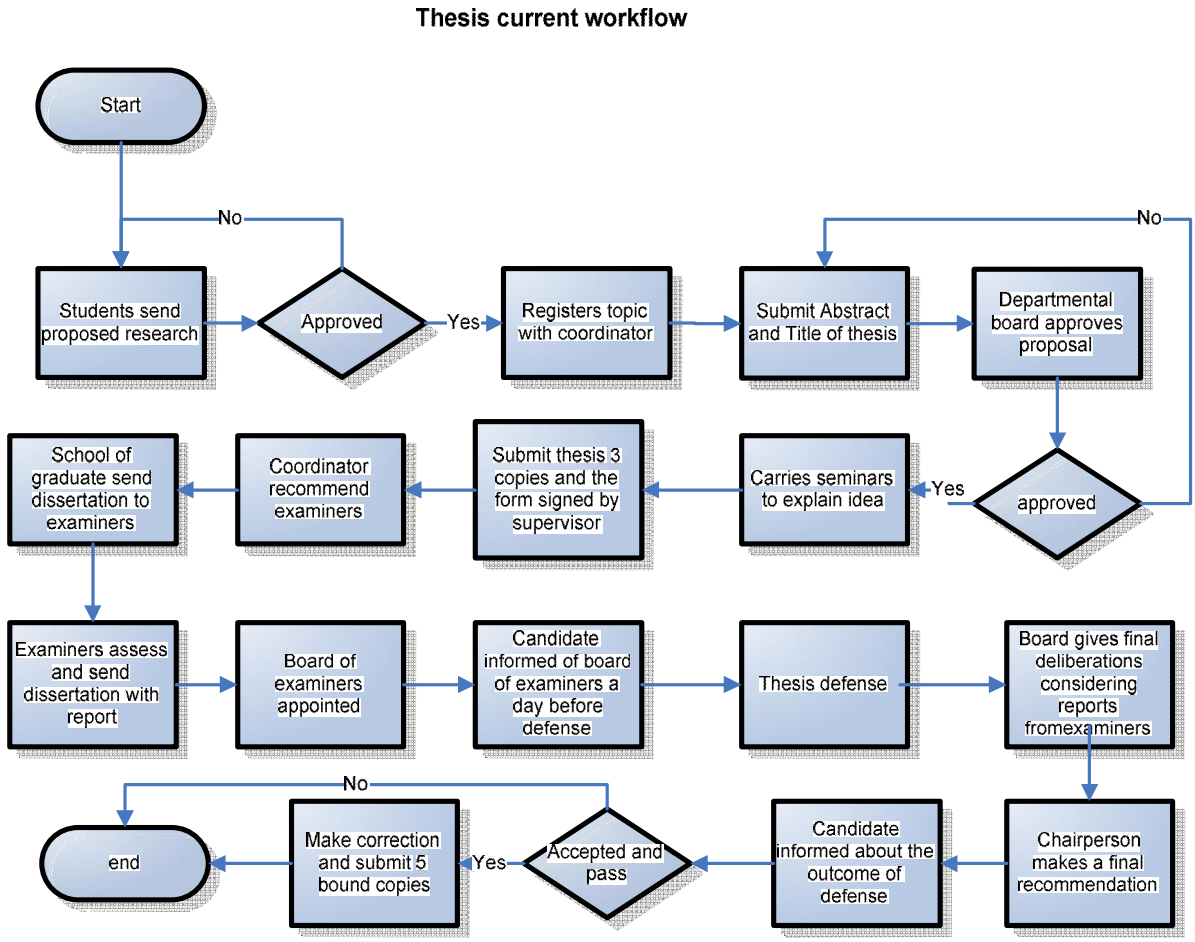

Figure 4-3: Theses current workflow

4.1.5 Analysis of current processes

With all the processes executed manually, there is so much inefficiency through the whole process. The delays are caused by processes depended on the human beings not following procedures. From the diagram in Figure 4.1, 4.2 and 4.3 most processes are controlled by the coordinator. Automating the current processes the way they are will mean the coordinator still controls the processes making the system semi-automated. After registration students will wait for the first meeting with the coordinator for them to start identifying the topics. Even lecturers take time to avail the topics to the students. Almost all processes are not efficient which prolong the completion time. The paper based processes come at some costs due to increasing prices of paper and cartridge. It is very difficult to monitor deadlines for all the stakeholders as they only rely on the coordinator to remind them. Due to lack of monitoring and communication, scheduled tasks are also postponed as students do not show up to see their supervisors. Some do

not even submit the milestones and it is therefore difficult to know the status of their projects. Other stakeholders may forget the deadlines or forget that the dissertation is with them. Examiners are given a month to bring the report but in some cases reports arrive after five months. There is no clear communication between the examiners and school of graduate studies. Reports dispatched through a courier may not even reach the examiner, and follow up is sometimes not done.

4.2 The re-engineered process

The constraints of the current processes of student project management system in UB were discussed. There is need for a spectrum of change to the current processes. The proposed system will not only automate the processes but radically redesign some processes and that is re-engineering. The reengineering comes for replacement of ineffective processes with the new ones and it is aimed at eliminating repetitive paper-intensive tasks therefore reducing costs. This section depicts some new processes which are re-engineered.

4.2.1 Undergraduate research process flows

The new undergraduate research flow is shown in this section. These processes are put together in Figure 4.4

Online Topic/Supervisor selection

Before students can select topics in the system, topics have to be submitted into the system by staff members. Each lecturer is required to submit at-least two topics into the system. Once the process of topic submission is completed, the coordinator gives access to the student to choose topics they want. If a student is interested he/she will make a request to the coordinator and if a student is not interested in any topic, he/she can submit their own topic to the coordinator. A topic is associated with a lecturer which means they assume supervisory roles to their topics. Lecturers with few students are given those students who submitted their own projects. Details of students registered for research projects were captured from the current University registration system and as well create accounts based on that information. When an account is created an email is generated to the students so that s/he can activate the account. They were required to activate their accounts by setting new passwords. After activation students will be taken to a page with a list of topics. The coordinator allocate the topics to students on first come, first serve basis. If the request is not accepted, students are allowed to request for another free topic. When the submission process has been completed, topics are forwarded to their respective cluster members for approval.

Project proposal online

Upon completing the student will upload the proposal in PDF format to the proposal link. The link will be available until the last day of submission. Meetings between the students and supervisor has to be recorded by the system; what was discussed, comments and time/date of the meeting.

Proposal assessment and approval

As each topic is uploaded for selection by the students, the coordinator assigns board/cluster to each topic. The board is made up of three to five lecturers. A lecturer can be in one or more boards. After all submissions have been made or deadline has elapsed, the coordinator activates the proposals for assessment to the board. Every board member is notified via email to start assessing the proposals. Board members will be required to look at the proposals and give feedback in a given time. Every board member is asked to indicate the final result of the proposal, approved or not approved. Upon completion the feedback will be sent to the coordinator together with the average result from the boards. The head of department will be provided with the reports. The student will get the result and all comments from the board.

Research execution

The project execution will involve more interactions between a student and the supervisor. The coordinator may come in only if there are pressing issues to attend to. Change of project title or the supervisor and financial assistance are some issues, which can be attended to by the coordinator during the course of the project. Meetings between student and supervisor are recorded in the system. Reminders for any work to be done or any submission will be communicated to the students via emails and all the activities will be noted in their calendars.

The coordinator will electronically schedule presentation and send to the students. The students and supervisor will have to respond to the schedule by indicating whether the student will make it to the presentation. A student who will not be able to attend has to give comments and reasons.

The submission of the final project has the same procedure for project proposal and progress report, while submitting the of hard copies and any other material, the coordinator has to indicate in the system the materials he/she received and an email will be sent to student to confirm receiving copies.

Marking and grading

After receiving all the projects from the students, the coordinator will assign co examiners to mark the research projects. The marking templates are sent to the supervisors and co-

examiners via email and the hard copies are delivered to them. Examiners would acknowledge receipts of hard copies online. The marking criteria used will be in line with the department guidelines. The coordinator can appoint co-examiners to do the marking. The supervisors and co-examiners will send the templates to the coordinator after marking. The coordinator will compute final grade and send to the board and head of department.

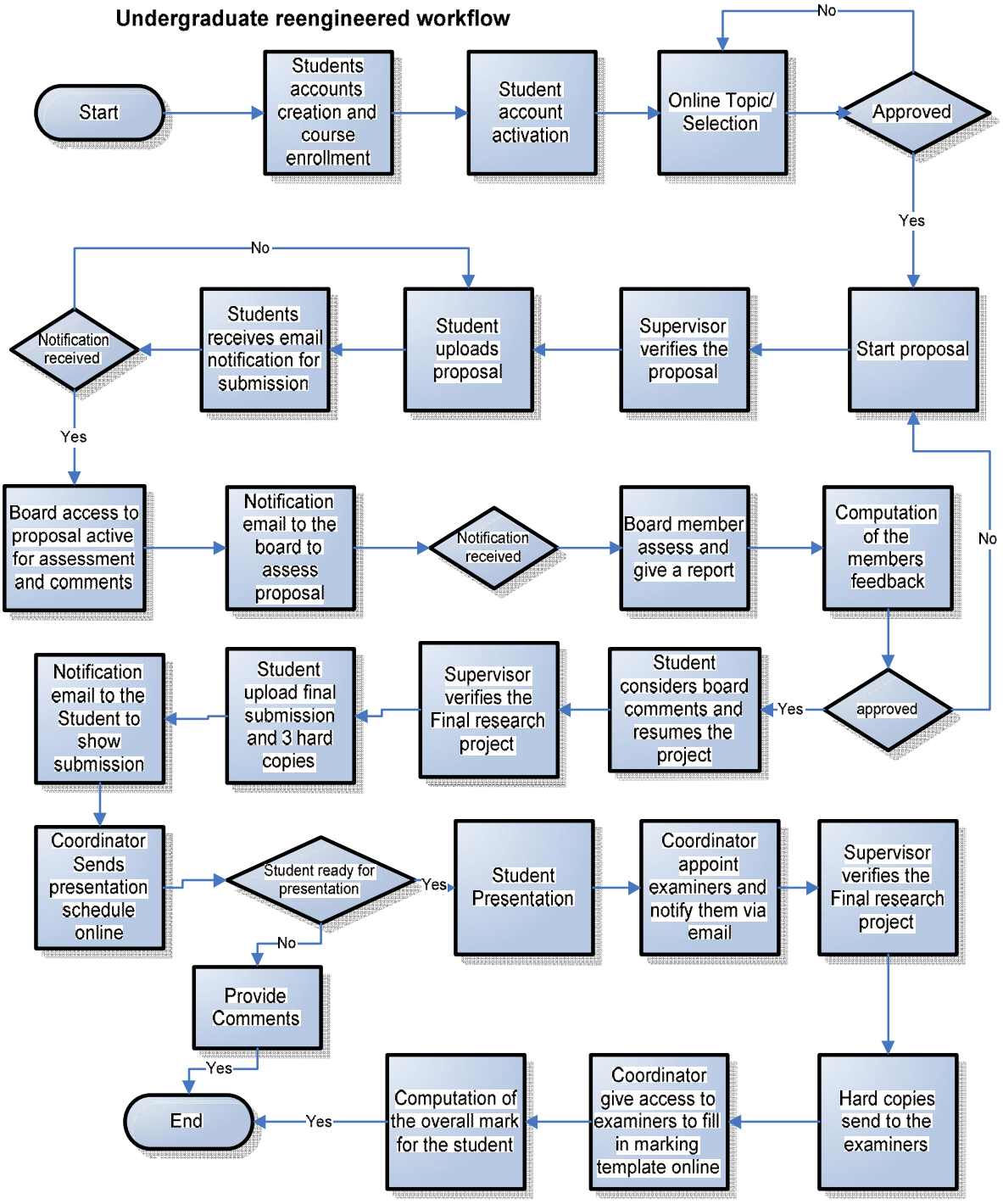

Figure 4-4: Re-engineered undergraduate workflow

After going through some workflow evaluation with the stakeholders the workflow was improved further. To avoid bottlenecks in workflows, four main processes were derived

from the above workflow. The processes were made to be as short as possible as said that long workflows can lead to inefficiencies in workflows. The steps are, Topic registration, Proposal writing, Project writing and Project examination. There were sub-processes designed to enhance the efficiency of the processes.

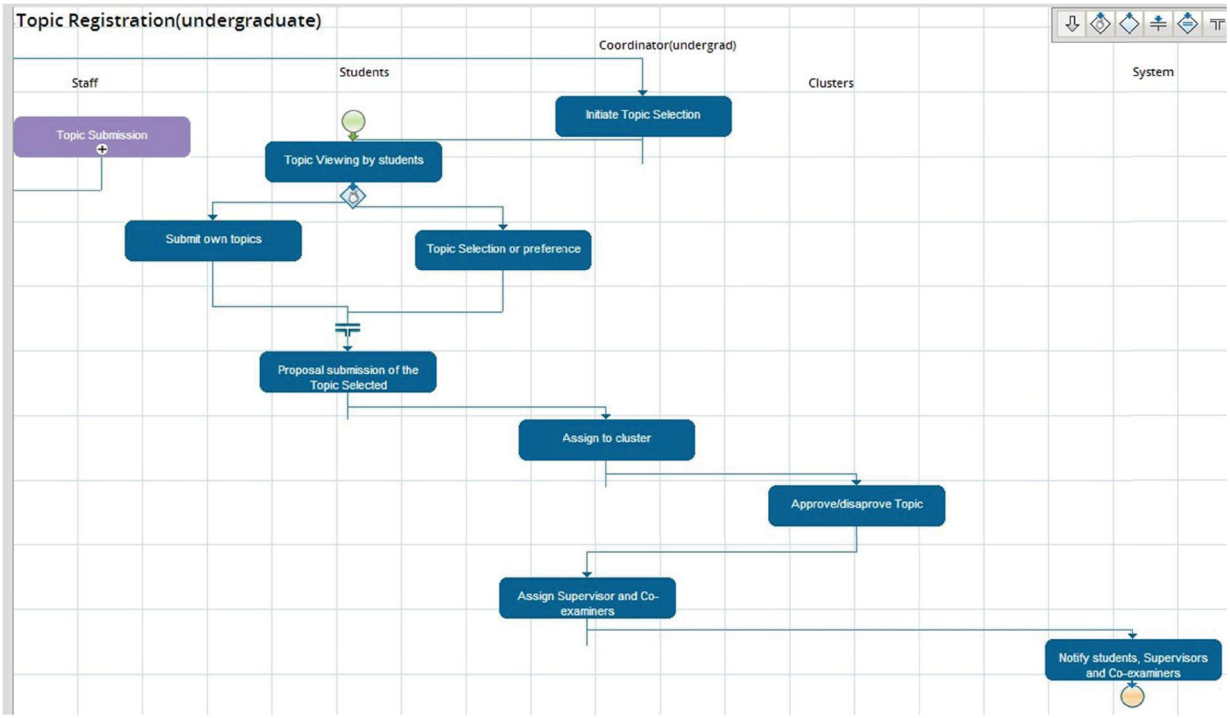

Figure 4-5: Undergraduate Topic registration Process

The figure 4.5 shows the topic registration process designed for undergraduate students. The process has a sub-topic called topic submission which is part of the processes.

The figure below is another process which follows after proposal writing. Project writing shows all the tasks done during the project. It also has a sub-process. Some of the processes are illustrated in the Appendix B.

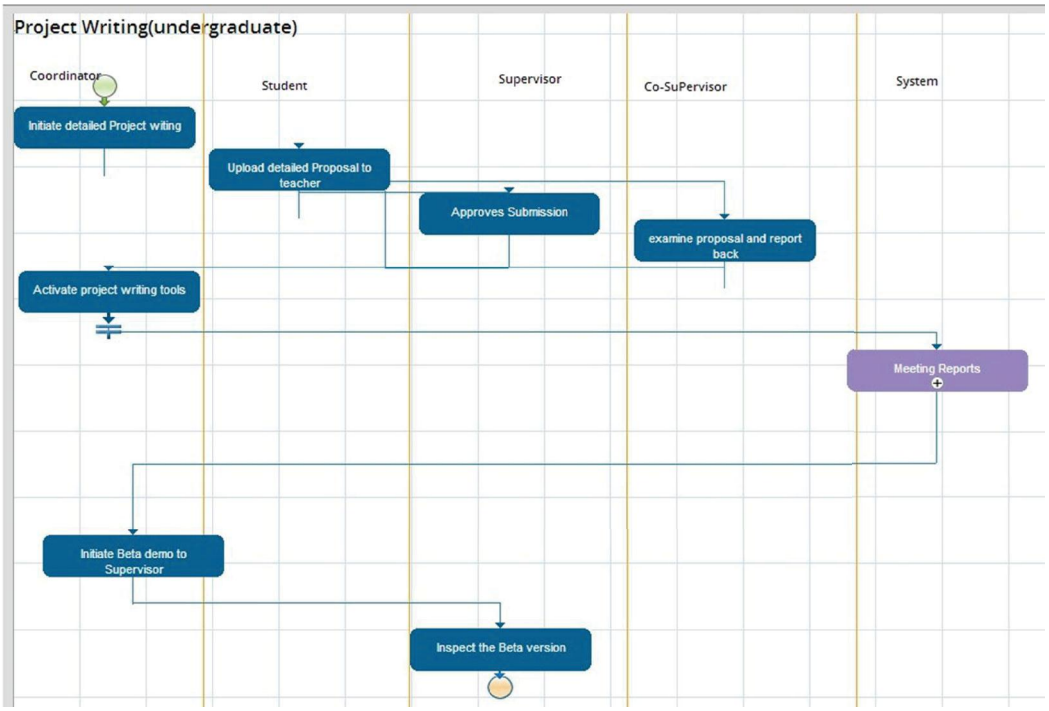

Figure 4-6: Undergraduates Process Writing

4.2.2 Masters dissertation process flows

Dissertation unlike the undergraduates researchers are controlled by the School of graduate studies together with the department. The Dissertation Supervisor shall normally be nominated by the Department before the completion of coursework. Such a supervisor shall normally be a member of academic staff in the department in which the research is pursuing, or with the approval of the School of Graduate Studies, the Supervisor may be from another department or appropriate external institution. This is illustrate in Figure 4.7

Supervisor/Topic selection

Masters students submit their own topics. During submission students select the lecturer they agreed with to be the supervisor. When the submission has been made, the lecturer selected will receive an email notifying him/her that he was appointed as a supervisor. The supervisor will have to confirm to that. Other processes are illustrated in Appendix B.

Dissertation examination

The coordinator will email names of the examiners to the school of graduate studies. The graduate studies will acknowledge the email and notify the coordinator of the date they

will send the dissertation to the examiners. More steps are outlined in the work flow diagram below up to a point the final recommendation is made.

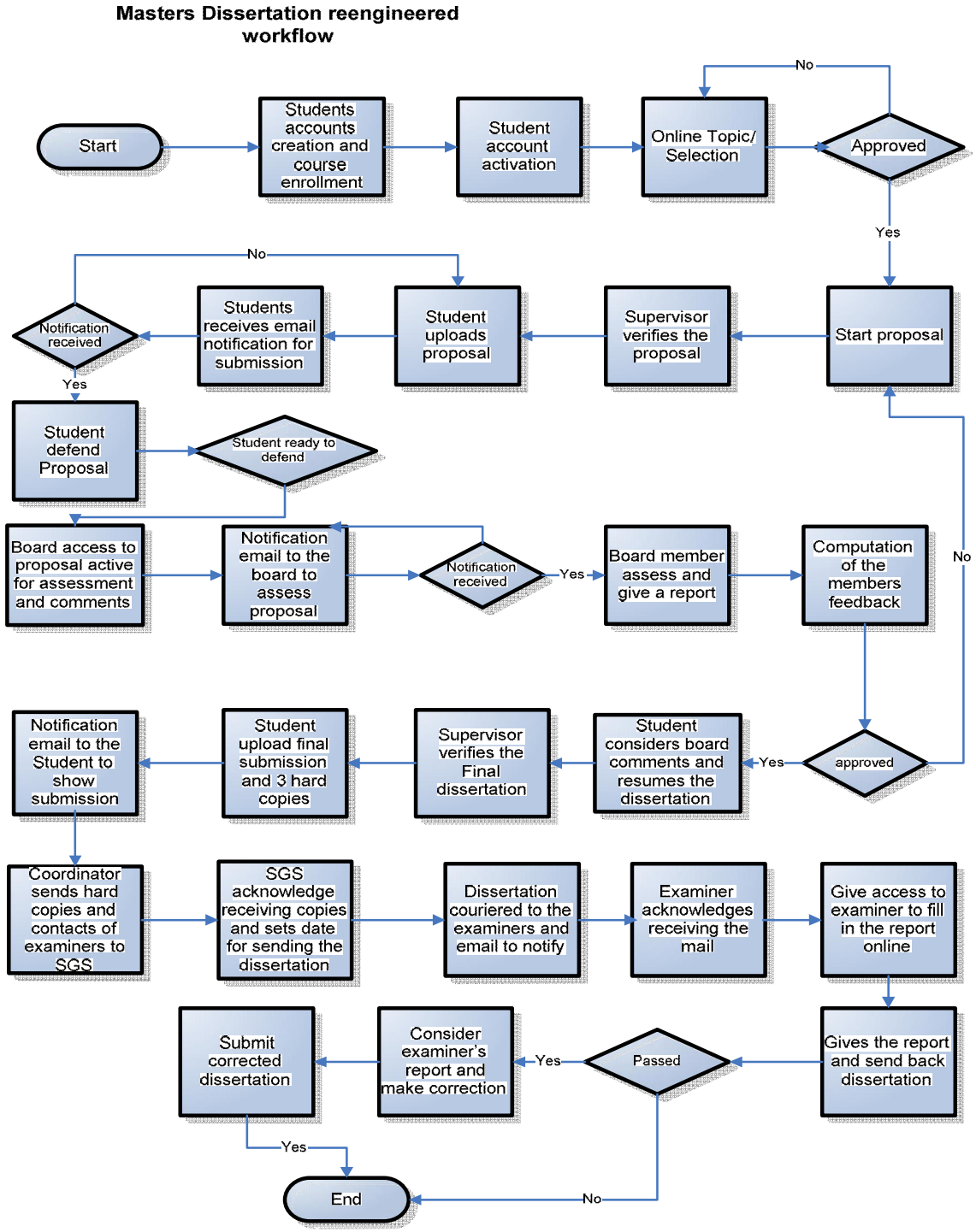

Figure 4-7: Re-engineered Masters Workflow

4.2.3 Degrees of master of philosophy (MPhil) and doctor of philosophy (PhD)

The MPhil and PhD degrees are graduate degrees carried out through supervised research. Research and supervisory arrangements will be determined in the Departments and require approval of the School of Graduate Studies Board. For the thesis most of steps are similar to that of the masters and undergraduate, the major difference is the thesis defence which is after examiners has assessed the thesis. The Board of examiners will sit to give the final recommendation after the defence with the consideration of reports by internal and external examiners. For details of the processes involved, the graph in Figure 4.8 provided the procedures. More improved procedures are depicted in Appendix B.

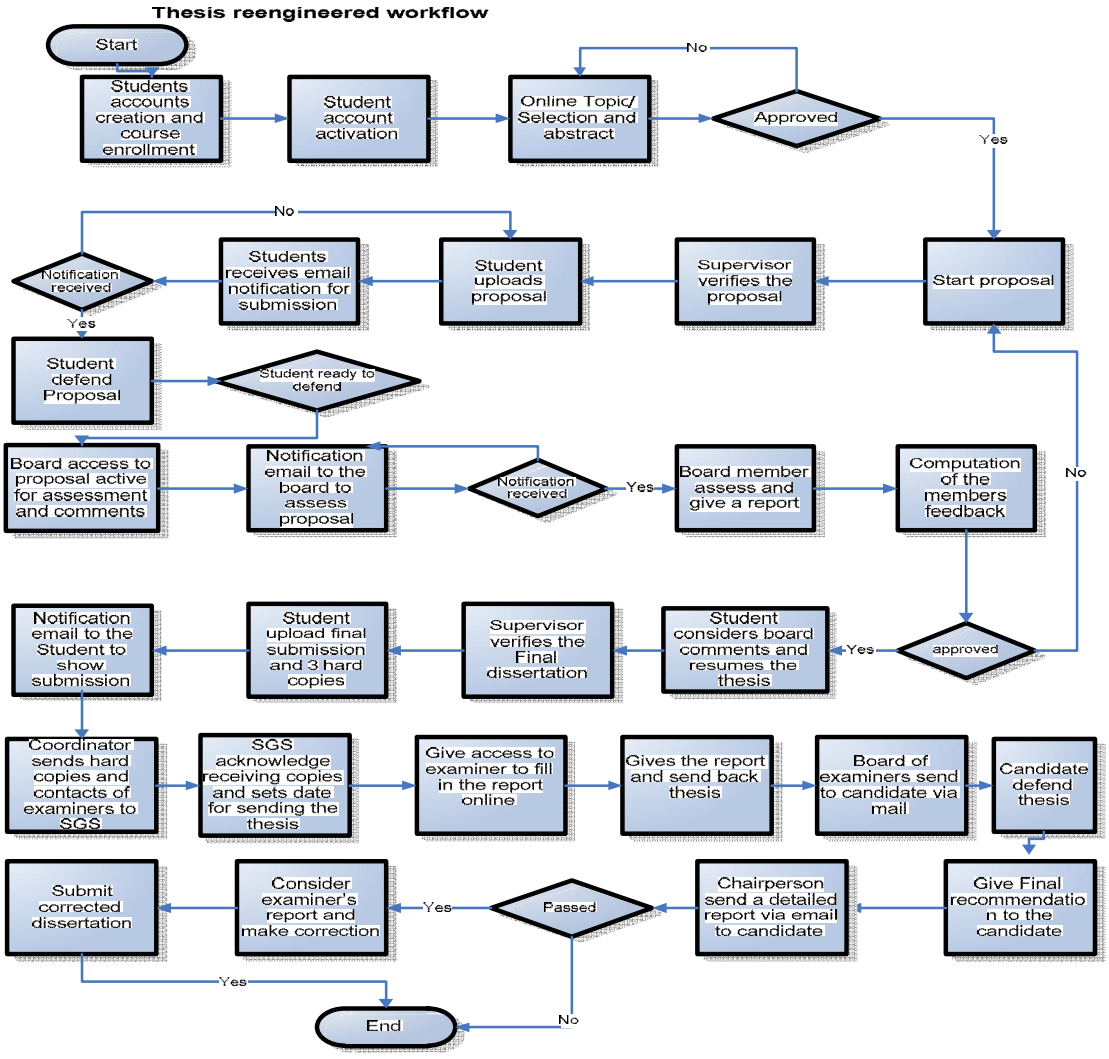

Figure 4-8: PhD re-engineered workflow

4.3 Reports

The integration system will be made up of undergraduate and post-graduate projects. These projects are carried out at different times. For post graduate it depends on the modes of study which are part time and full time. For example most undergraduate projects run for two semesters, master's programme run for one to two years and PhD for four to eight years. The system keeps a timeline for every project, for example in the case of a master's dissertation the timeline are shown in Table 4.2.

Table 4-2: Projects timeline

Event	Timeline: full time	Timeline: part-time
Enrolment	Start of registration	Start of registration
Records milestones	Monthly	6 weeks
Midterm monitoring	6 months	12 months
Final Submission	12 months	24 months

The system must keep on sending some reminders to students and for every event done a report will be sent to the student and supervisor. There are a number of reports from these system and they come at different levels. Not all reports can be accessed by everyone; only authenticated users within the system can view what is relevant to them. The timeline in Table 4.2 will be provided by years, department and faculty.

Some important reports identified are:

- Student project enrolment
- Milestone deliverables
- Board approvals
- Submissions
- Projects on examination

Other additional reports are:

- Dropouts
- Students who are to finish
- Projects behind schedule
- Reports on examination and defence

4.4 Comparison of current process with the reengineered processes

After improving the current manual a comparison was done between the old manual processes and the improved processes for research management for students' projects. Table 4.3 provides an overview of some comparisons.

Table 4-3: Comparison of systems

Features	**Current system**	**Improved system**
Prefill of data	Not available	Data filled using forms
Documents storage	Files, hard copies	Electronic databases
Documents sharing	Not available	Electronic sharing, enhanced retrieval of documents
Reminders to users	Sent by coordinators	Emails included in the system remind users of the pending tasks
Assignment of Tasks	Coordinator assigns users tasks	assignments
Tasks deadlines	Done by the administrators	Processes are have a validity period.
Reports	No reporting	Done by Management staff members

Chapter Five: Prototype Design and Development

5.1 Proposed solution strategy

The focus of this project was to model some workflows for the student's research management for the University of Botswana. The complementary goals include; reengineer process management workflows iteratively for the research projects to meet user's expectations and to integrate these workflows so that they are managed from a central point/system.

The Workflow was broken into components which will work together to allow different workflows to be integrated. The components are; data model, form editor, process manager and report manager. Each component was dependent one another one. Much of the information that needs to be collected for the system is available on student's registration system and staff personal system. Some integration with those systems will be crucial to get such information. When successfully implemented, the system can also feed library with digital theses.

5.1.1 Components

This section discusses the four components namely – Data Model, Form Editor, Process Manager and Reporting Manager

Data model

It is a collection of data relating to the research projects and the users. A data element can be a member of a data group which itself can be a member of another group. Any number of data models can be created and shared among many workflows. A data element has a source which indicates where the information stored should come from. These elements consist of;

Form editor

The form editor builds a user interface for data model. Each form is associated with a single data model. The form element is comprised of a name, description and object. The name is a label, the description is to help users understand what the form element does and object which corresponds to a data element from the form's associated data model. View object, is another form element, which is similar to a data object in that it displays data from a data mode element but the data is not editable. An email object is designed to provide a way for users to send out an email requesting something and confirms it when it

happens. For example, when sending a thesis to the examiners, an email is sent requesting them to confirm receiving the thesis.

Process Manager

The Process Manager is responsible for organizing all the forms, determining who they are displayed to. It allows the users to create any number of processes. The processes are built around stages. Example of stages includes "pre-submission, supervisor verification and post defence correction". Stages are ordered linearly and each stage is a collection of forms. The submission cannot progress to the next stage until all the forms have been completed and approved. A stage can also define an email to send out when a stage is completed. Each form has several options that can be configured. It includes which roles can edit the forms and which roles can see the form read only and which must approve.

Reporting Manager

This module is responsible for giving out reports to the relevant users. Reports do cut across all the departments to give out summaries of student's research projects. For example comparing completed research in a space of five years and gives the growth rate.

5.1.2 Application Design

The evaluation of workflow management systems, consideration was given to a web-based ProcessMaker open source system. Processmaker was chosen for this study because of its dynamic forms which interface well with workflows. Processmaker is richer in form fields' types required by current requirement of a form (Abdelgader et al., 2013). Prototype development was a consideration for this choice. The main functionalities and components available made it better than other systems. Open source systems have most of the components built which is of advantage, since it was possible to use it based on the needs. It also saved time since there was no need to develop the system from scratch. Processmaker is also user-friendly as it was indicated that users with no programming skills can use it.

Hardware and software requirements- Hardware requirements are based on the concurrent users, repository size and system configuration. Number of cases per day can determine the size of the server required. In developing the prototype (not considering live environments) we used 4GB RAM, 3.2Ghz Intel 2 Cores Duo CPU and 250 GB hard drives. Software requirements used include:

- Operating system (Linux – Debian) and Sendmail
- Web server- Apache 2.5.3 with the modules (deflate, expires, rewrite, vhost_alias)
- Database – MySQL 5.1.2
- PHP 5.6 with modules (MySQL, xml, mbstring, mcrypt, soap, ldap, gd , curl)

5.1.3 Design Security

Security of the system focuses on protecting data and giving access to the authorized users. ProcessMaker uses password, groups, departments and user-level security to secure the system.

5.1.4 Prototype design summary

ProcessMaker contains two main components: a design environment and a run-time engine. The designer environment includes tools to map processes, define business rules, create dynamic forms and add input and output documents. The run-time engine enables the cases to be started and run throughout the process. This engine turns the process map design into a fully-functioning application. Using SOAP, ProcessMaker can connect, through web services, to other systems, including but not limited to DMS and CRM systems, middleware, messaging, PM Mobile, etc. Using LDAP, ProcessMaker is able to manage high user authentication.
The Processmaker toolbox allowed for the creation of forms and map fully functional workflows. The web-based system made it entirely easy to integrate workflows across users in departments and organizations.

The system Implementation requires decision on appropriate data field types, collation and length, default value, input masks (correct data entry). The application created is based on Processmaker system which creates databases during installation. The system uses MYSQL database with three workspaces namely; wf_<workflow>, rb_<workflow>, rp_<workflow>.

Wf_workflow contains information about system's processes, cases, users and tables. wf_<workflow>, rb_workflow contains information about users to maintain role- based access control which is an approach to restrict system access to unauthorized users. On the other hand rb_workflow is designed to permit for external application to access data from the system cases. This workspace is not used in the system; we only utilize the two mentioned before. For our prototype another database was created to handle information about topics registered, student's information on projects, marks, reports and topics published. These databases can be easily accessed or modified on a graphical interface created by phpmyadmin on address 10.0.18.120/phpmyadmin. PM tables are meant for users who do not wish to go and create an external database. They are handy for quickly creating data to be used on forms and reports. Figure 5.1 shows the process architecture.

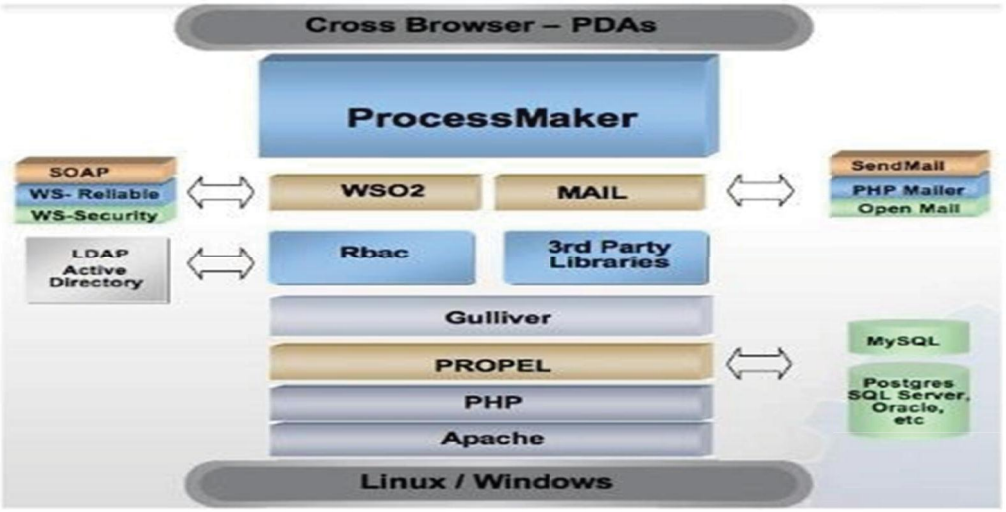

Figure 5-1: Process Architecture

5.2 Application structure design

Accessing of application has evolved from the traditional access of a single machine application with one user to a robust access when the network became more prevalent. Hence the need for shared resources arose. Data sharing spurred the development of a client/server application. The terms commonly used when involving application structure and implementation are,

- Presentation layer – contains the graphical and visual elements of the application named as the graphical user interface.
- Application logic – every business rules associated with application are stored here.
- Data layer – application data which is a database.
- Client – local computer used by the end user.
- Server - centralized services are stored here and shared among many end users. Once the server is down, end user machines will not receive services.

5.3 System Architecture

For the dissertation prototype, a web based application was created. With the web based application a client will use a browser to access services from the server. The method relieves the developer of the responsibilities of installing the application in every computer of an end user. The other benefit is that changes of the application logic and database happens in one place (on the server) and doesn't affect the end users machines.

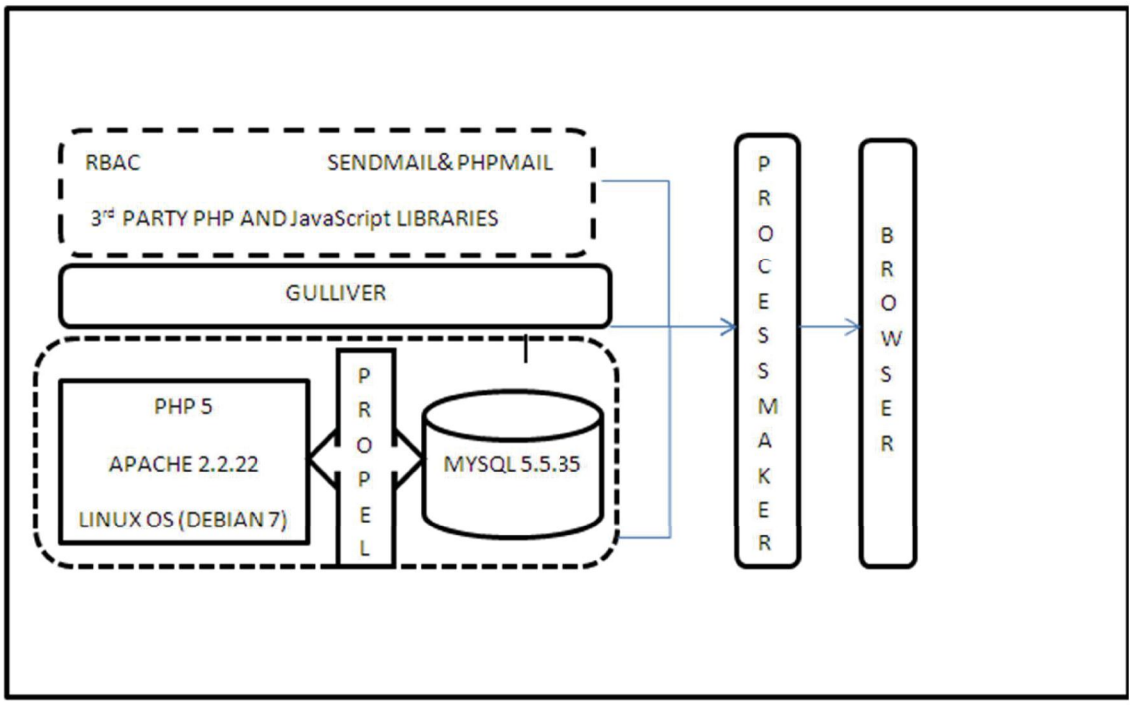

Figure 5-2: System architecture

5.4 Graphical user interface

Graphical user interface is the most ideal representation of the application. It reveals how end users accomplish their tasks. For this project, the open source Processmaker was customised to meet the needs of student's project management system. For the interfaces to be created, the system allows for the creation of the processes first. In Processmaker a process is a collection of tasks with inputs to create outputs that is of a value to the students doing research and end user within the University of Botswana institution. Some of the processes created are;

- Topic registration – recording and approving of topics.
- Proposal writing – carrying out the proposal work and submission.
- Project writing – carrying out the project.
- Project examination – marking of the project.

As major processes exist, there are some child processes created to ease the pressure on the processes. It is recommended to break large processes into separate master and child processes to reduce the complexity of the process map and give sub processes time to handle exceptional situation and activities. Functionalities of useful process can be hooked into another process. Some of the sub-processes include; topic submission (under topic registration process), meeting reports (under project writing), progress report and oral

examination. Sub processes are divided into synchronous and asynchronous. Synchronous sub-processes allow for the execution of child process, ceasing the master process to appoint where the sub-process is complete first before the master process resume where it stopped. Asynchronous sub processes does not pause the master process, no dependency on each other. All the sub-processes are synchronous.

5.5 User management

Processes created require users who will carry out the tasks to complete those processes. The system permits for the creation of users and groups. Groups are a way of simplifying the assignment of tasks to multiple users, for example the task of topic submission in the undergraduate workflow is the initial task assigned to staff members. In that way every staff member in a department can initiate the topic submission case. The system framework allows users to be created as shown in the figure 5.2. User information is mandatory when creating users accounts. The information required include; first and last name, userid, email, country, Replaced by, expiry date, status, role and password. Some fields are self-explanatory and others are clarified below.

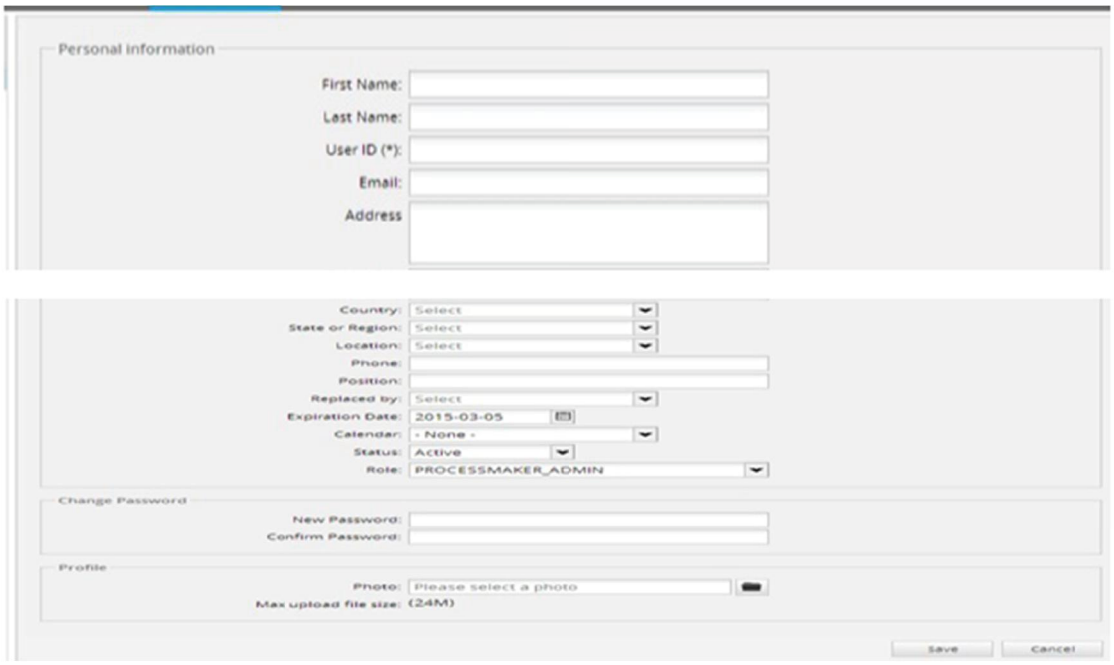

Figure 5-3 User Registration Form

- Replaced by – This gives an opportunity to select a user who will second the user created in case he/she becomes inactive. The user selected must be existing and active. An example can be the case of two coordinators being created. Under the

replaced by field we must select the other coordinator so that when one becomes inactive, may be on sabbatical the other one will assume the roles of the other. This field (replaced by) is only active for staff members only as students cannot be substituted in the field of learning.

- Expiry date – This field enable a time frame to be specified for a given user. When the time allocated to a user elapse the user account become inactive. For this project, students are given the time in which their project spans, for undergraduate students get twelve months, master 24 months and PhD students are given 4 years.
- The role field is the other critical field when creating users. The system gives 3 options to select from, namely; admin, manager and operator. Role is explained as a set of privileges to access certain functionalities of the system. An operator is given a role running cases after logging in. Students, supervisors, examiners, School of graduate and staff members were given the operator's rights. The role of manager is specifically for users who manage cases and oversee progress of the different workflows. University of Botswana Senior management (Vice chancellor, deputy vice chancellors, deans and heads of department) assumed the manager role. Lastly the admin role is for the system administrator of the system and the coordinators. Their roles include; processes designing, users and groups creation and any other functionalities of the system.
- The password field exists for the creation of the password. After that the user can login into the system to perform the task they have been assigned.

It is worth noting that manual creation of users becomes a cumbersome process when it involves a wide range of students, hence there is need for automatic bulk user creation. The implementation process, the project is open source system. There is bulky user profiles importation from LDAP and active directory. A plug-in is needed for the system to offer that automation of user profiles from other sources. Part of the impediment of the plug-in is that of cost and therefore will be difficult to incur due to in-adequate finances.

5.5.1 Groups

Groups organize users and simplify the assignment of tasks to multiple users. A task like register topics is assigned to group of staff members in department. It is quicker than assigning the task to each lecturer. Assigning tasks to individuals can be difficult to remember every user to a task, so groups eliminate such problems. However, individuals are assigned tasks there is no problem when a user's account is deactivated. Groups are more convenient in such a way that when there is change of personnel the changes can only be made in switching users to respective groups other than reassigning users to tasks. The system has a couple of groups; undergraduate students, master's students and PhD

students with each having 7 users per group. The students groups cannot have similar users meaning, every student should belong to exactly one group, no duplicates within or across groups. The students strictly belong to a single group because you cannot have a student pursuing bachelor's degree and PhD at the same time. Other groups are; coordinators, examiners, school of graduate, supervisors, Managers, Co-examiners, staff, library, clusters and research office. The clusters subgroups include information system, programming, Networking, systems and databases. Some of the groups can have duplicate users as their members, for example a lecturer can belong to one or more cluster and can be coordinator.
Lecturers can be examiners and supervisors.

5.6 Cases processes and Forms

Cases are an integral part of the system. A case in Processmaker as an instance of a process, where a process is a map of the work to be done. A case becomes a single time when the process is done. An example of a process can be topic registration (all the tasks performed until the topic is approved) and a case will be the single topic registered. When twelve users register 12 topics will have 12 cases. There are represented in a case list as shown in figure 5.4.

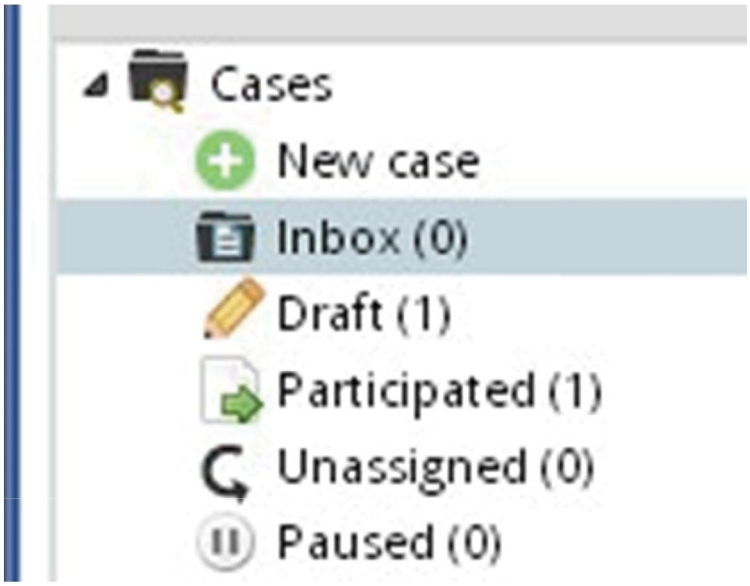

Figure 5-4: Case list

After login a user is presented with the case list as shown above. The options outlined under the case list are explained below;

- New case – it shows all the cases that a user is designated to start. Not every user is designated to start a process. Most of the processes are started by the coordinators so that they adhere to the right sequence of processes.
- Inbox – all the cases are designated to the logged in user. To do tasks are listed in the inbox and cases with expired time frame will have their due date in red.
- Draft – all cases in which the user is working and have not been forwarded to the next user are listed here.
- Participated- all the cases the user sent or participated are listed here.
- Unassigned – any case in which the user can assign to him or her.
- Paused – temporarily stopped tasks.

Forms

When a case designated to a particular user, it will appear in the inbox and the user have to open that case. When a case is opened a form will be presented. For every task that is performed by users most of the work is done on forms. Forms usage is categorized in three main areas: data entry, data retrieval and error checks and feedback.

5.7 Routing rules

Routing rules are known as derivation rules. Their sole purpose is to control workflow between tasks in a process. The first and last task is determined and how work move to the subsequent tasks until the last one. Conditions can also be evaluated to determine subsequent tasks.

Types of routing rules

 Sequential: when one task is completed, we move the workflow to the task that follows.

 Selection: the user assigned selects the subsequent task to follow.

 Evaluation: a condition (true or false expression) is evaluated to decide on the next task.

 Parallel by Evaluation: an evaluation routing rule uses conditions to decide whether to divide the workflow in two or more parallel tasks.

 Parallel (join): parallel tasks are united into one task. All parallel tasks must be completed before they are joined.

 End of Process: signal the end of the process where to terminate the workflow

 Starting task: Indicates the beginning of the process.

Chapter Six: Prototype Implementation

6.1 Introduction

The prototype focuses on Topic registration across all levels (undergraduate, masters and PhDs). From registration follows other processes like proposal writing, project writing and examination. The process workflow underwent several iterations to a point where the users felt satisfied with the workflows. Sub- processes were introduced as a measure of cutting down long workflows and eliminate inefficiency of the processes. Other prototypes experienced were the other stakeholders in the student's projects. Lecturers were given roles as examiners to award marks for the students work. Submission of documents was meant possible through the inputs documents. Report viewing was made possible as it one integral part of the system. The reports are needed by University of Botswana management pertaining research progress in the institution.

6.2 Undergraduate Processes

6.2.1 Topic Registration by staff

The Coordinator initiates the topics registration by staff members

To start on a new case click on "New case" and double click on the case "Topic registration and selection" as shown in figure 6.1.

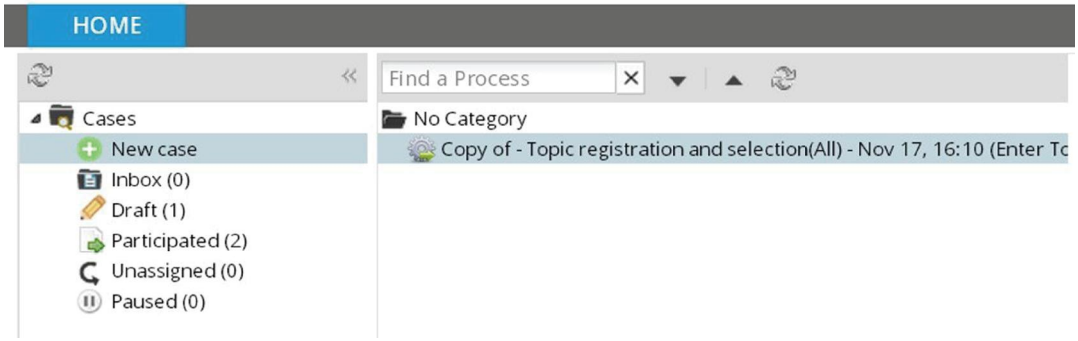

Figure 6-1 new case start

Figure 6.2 is an example of the form to be filled by the staff members. You have to fill in the required information and press submit. Staff members can submit at least 2 topics.

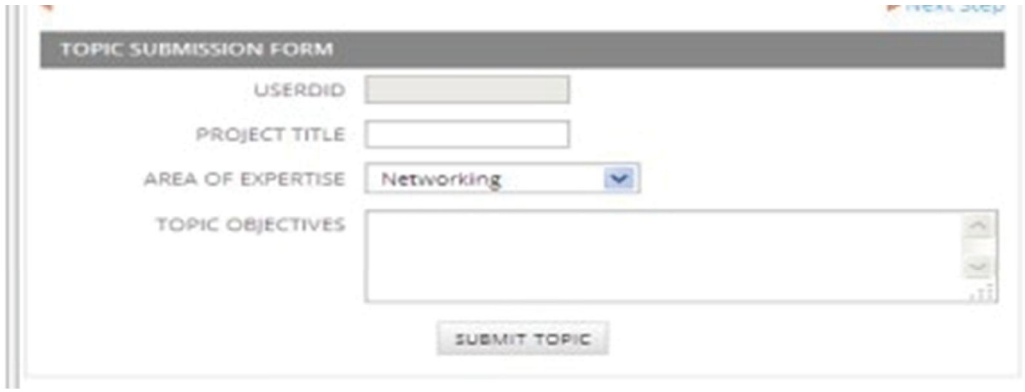

Figure 6-2 Topic Registration form

An email generated acknowledgement will be sent to every staff member who submits the topics. The sub-process will iterate up to a point where every staff member have registered their topics.

The coordinator gives students time to select amongst the submitted topic. The topic form to be used by student is in figure 6.3. You select the cluster to find out the topics they have registered in clusters and the search results will the objectives of the project.

Figure 6-3 Topic Search form

If you a interested in the topic you can select "yes" as above then the project selected in your form will be allocated to the logged in user otherwise a "no" a form to upload you own project. The form to be used by students for submission of own topics are shown in figure 6.4.

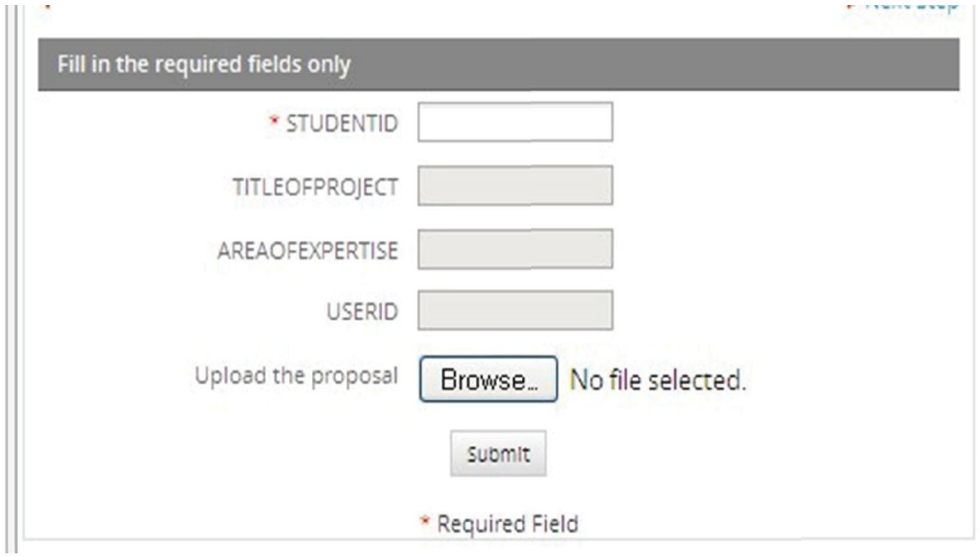

Figure 6-4: Students topic registration form

Based on the area of Expertise of the project the coordinator will route the topics with its brief proposal to the cluster members responsible. Figure 6.5 is a form to be completed by a coordinator indicating the time frame for assessing the topic.

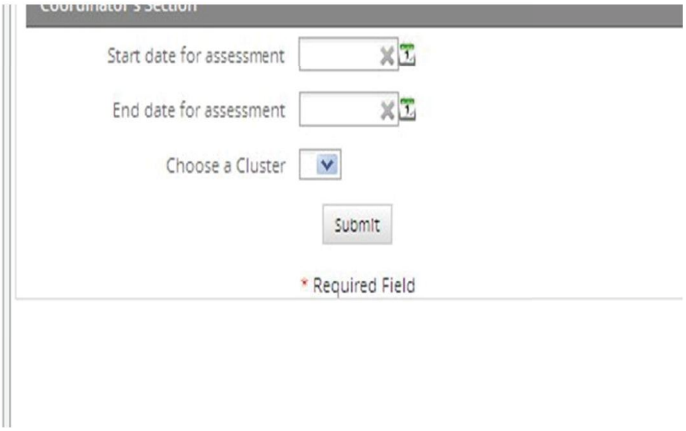

Figure 6-5: Student Topic form

In the process of assessing the topic staff members should indicate their wiliness to supervise a topic. The coordinator will assign each approved topic a supervisor, examiner and co-examiner as shown in figure 6-6.

Figure 6-6: Supervisor and examiners form

Finally the student will be notified via emails of the possible outcomes.

The message shown in figure 6.7 will appear showing who the form will be routed to a supervisor. Press "Continue" to send the form. If you do not press continue the form will be saved under drafts in which can be sent later by pressing "continue"

Figure 6-7: Routing Message

If the case is routed to you, the supervisor will receive an email notification of the task he/she is supposed to perform.

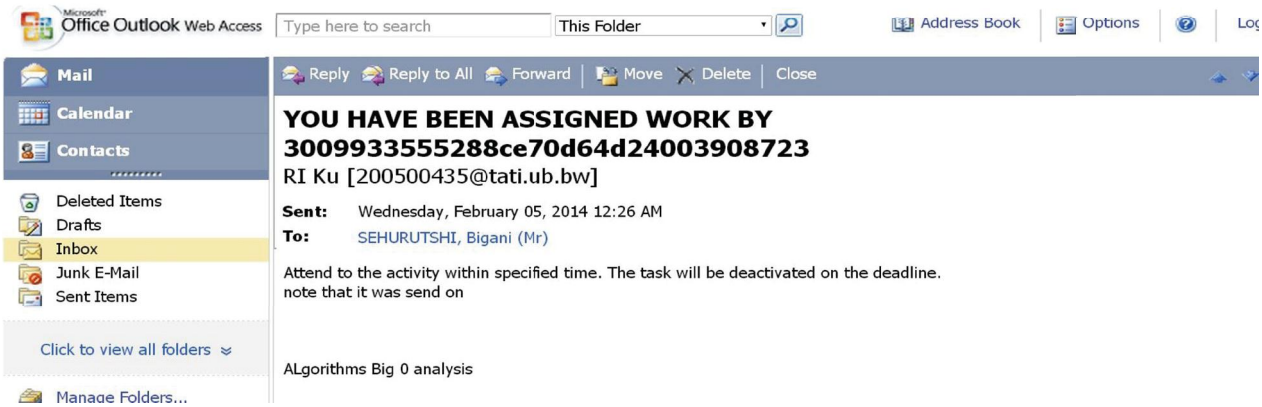

Figure 6-8 Email notification

As a Lecturer you will have the case routed to you will be shown in the Inbox. Click in the inbox and the form to fill will appear like. Indicate whether you recommend the topic and add some comments if any, then press "Submit"

6.3.2 Proposal writing (undergraduates)

Once students have the topics assigned the coordinator will initiate detailed proposal submission as shown in figure 6.9.
Enter the start and end date for students to submit the detailed proposal.

Figure 6-9: Detailed Proposal initiation Form

Student responds to the coordinator by uploading your detailed proposal in the form in figure 6.10.

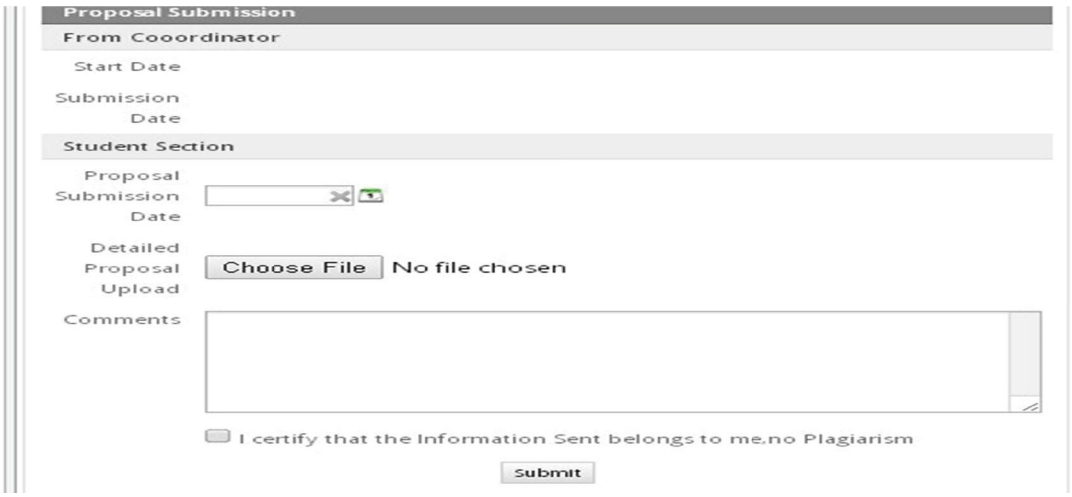

Figure 6-10: Detailed Proposal submission form

Coordinator forwards the proposal to the co-examiner who then marks it using the template in figure 6.11 and sends it to the coordinator.

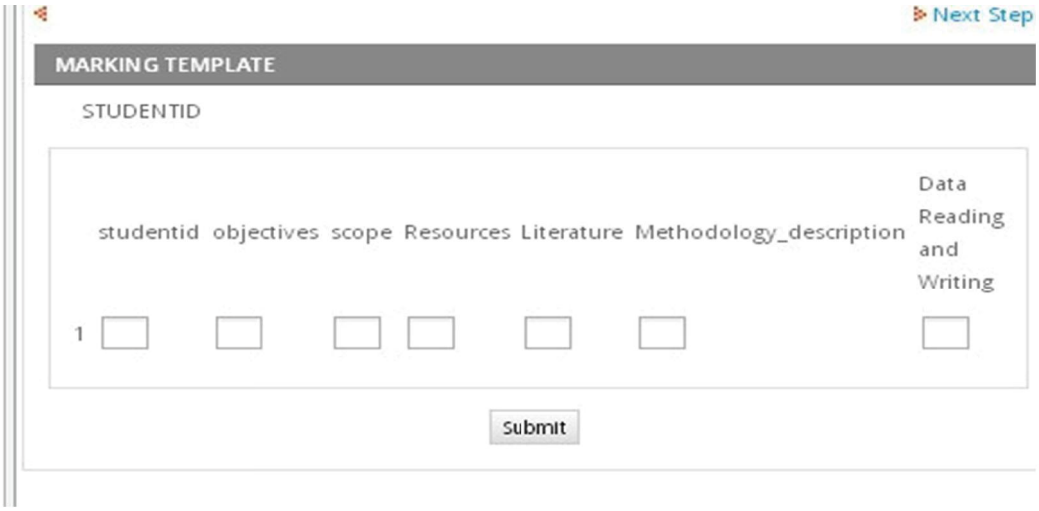

Figure 6-11: Detailed Proposal marking template

Proposal marks for each student are then saved in the database.

6.3.3 Project writing (undergraduate)

Project writing is initiated by the coordinator. The purpose of this initiation is to activate tools which will be used by the students during the course of the project.

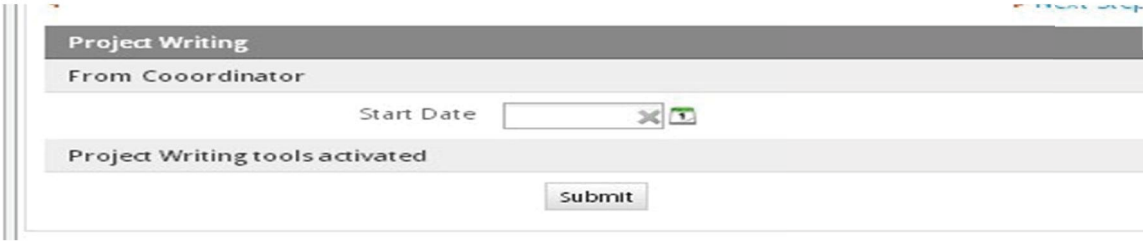

Figure 6-12: Project writing initiation Form

A tool used for recording every scheduled meeting between the supervisor and student. It starts off with the scheduling of the meeting. Student appoint with your supervisor by completing the form in figure 6.13.

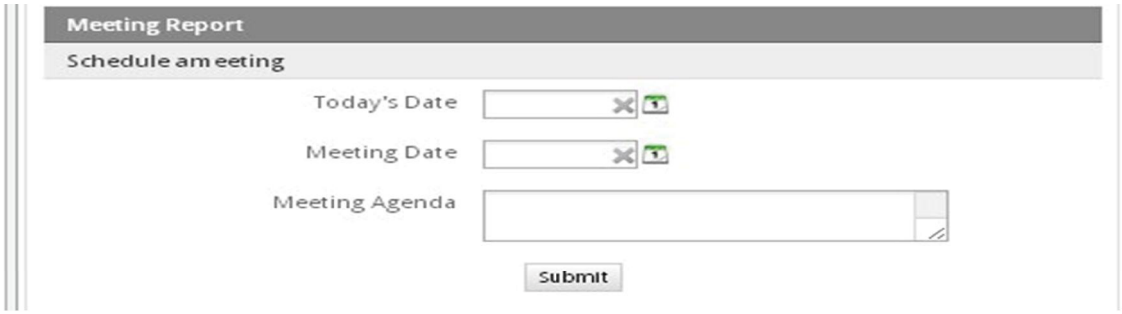

Figure 6-13: Meeting Schedule form

As the supervisor you are supposed to honour the appointment through a confirmation as shown in figure 6.14.

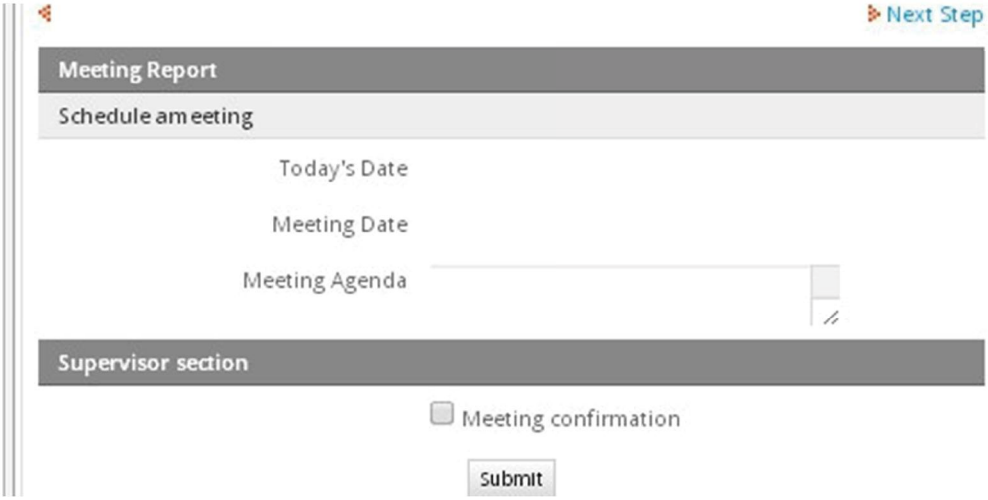

Figure 6-14: Appointment Acknowledgement Form

After the two have met then the student compiles the agenda of the meeting into a form similar to the one in figure 6.15.

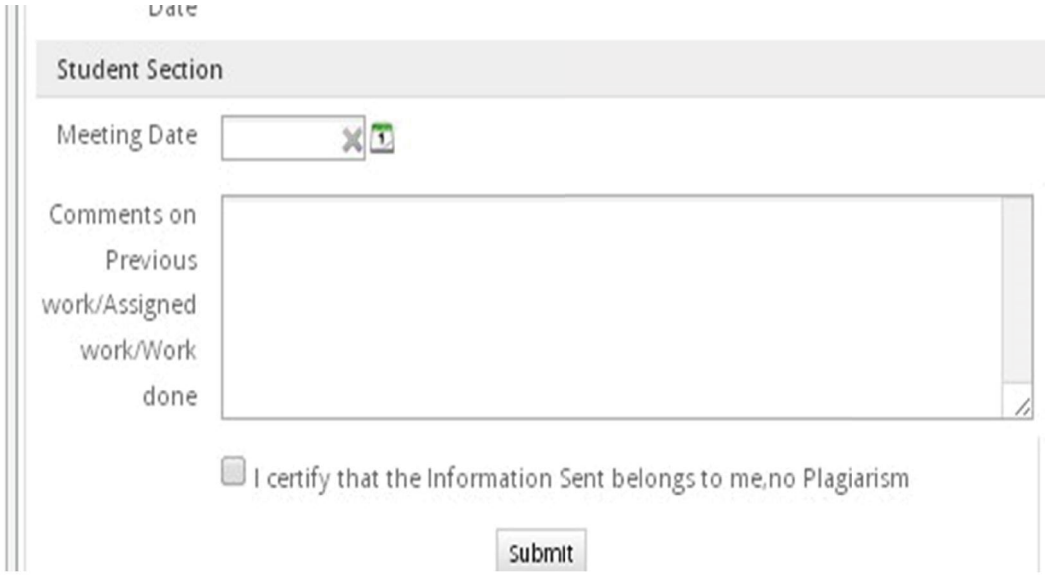

Figure 6-15: Student meeting logbook form

6.3.4 Project examination

The date for the examination is still determined by the coordinator, no flexibility in the submission. Student fills in the form in figure 6.16 below for the final submission.

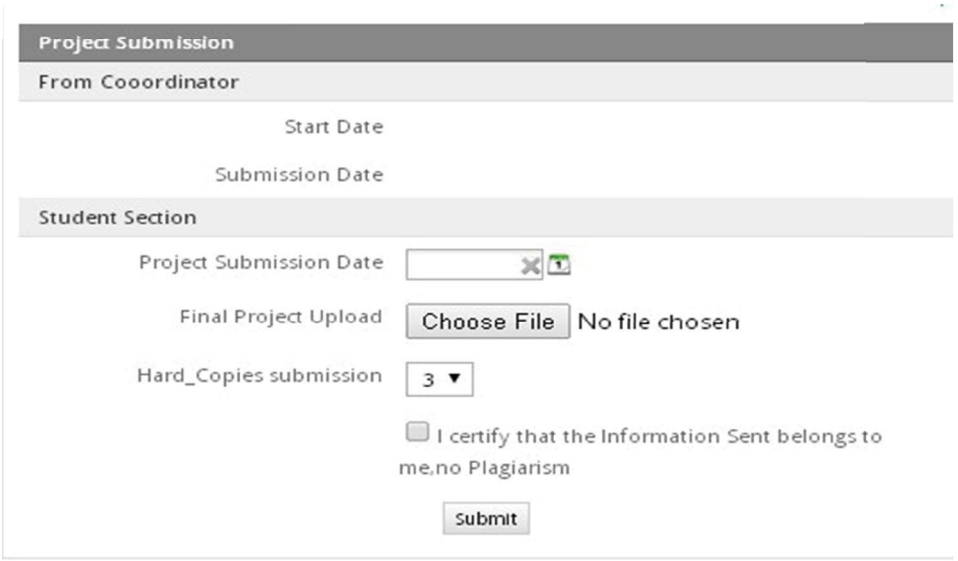

Figure 6-16: Student Submission form

The submission for the student is then routed to the supervisor who then approves the submission in the form shown in 6.17 and route to the coordinator.

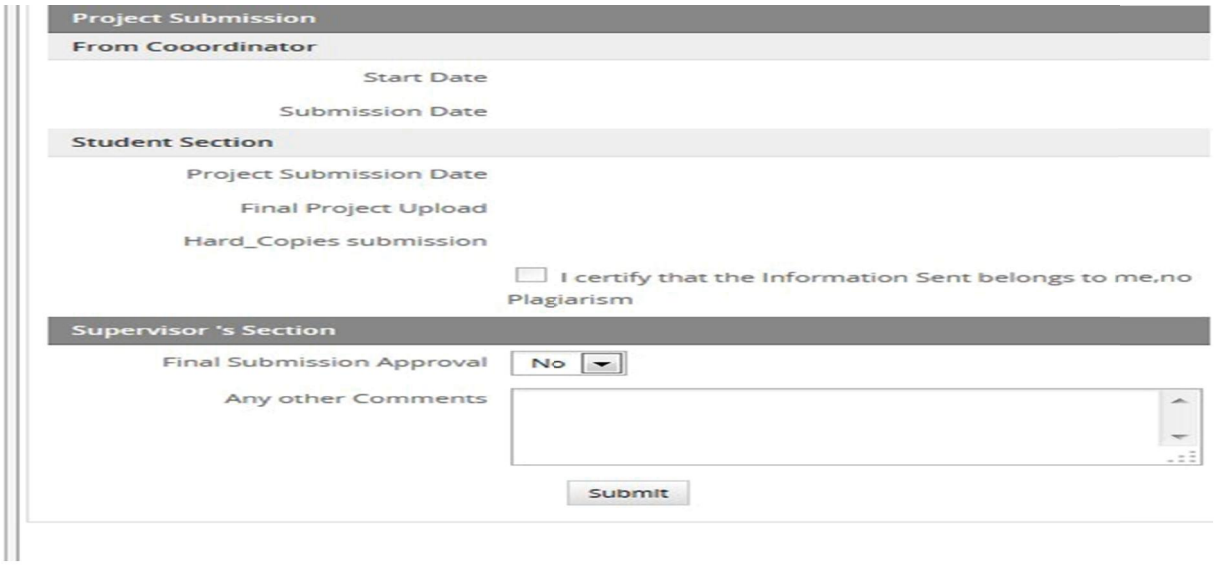

Figure 6-17: Submission Approval form

The coordinator receives the submission and should indicate the other material he/she received as shown in figure 6.18.

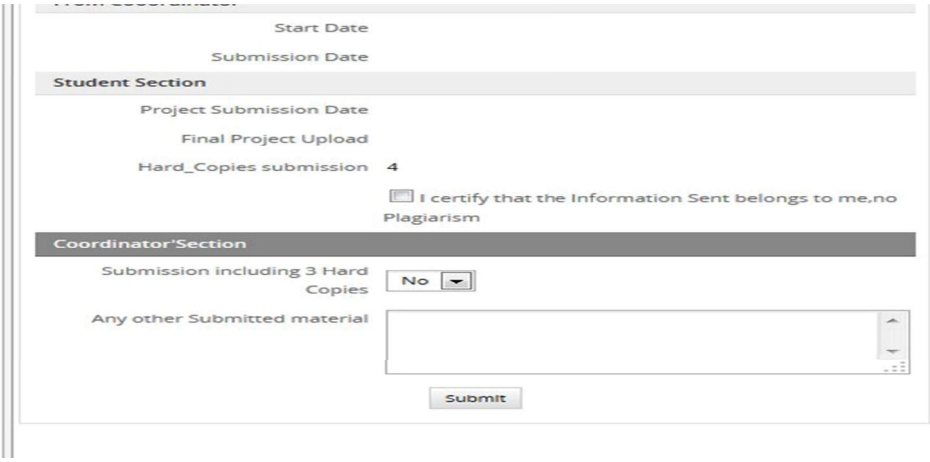

Figure 6-18: Submission Acknowledgement Form

After submissions are made the coordinator calls the students for presentations. The invitation starts by the coordinator issuing the schedule to the students as shown in figure 6.19.

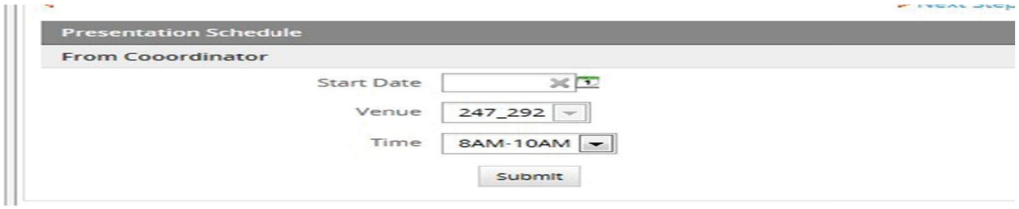

Figure 6-19: Presentation Schedule Forms

The students will respond to the invitation by filling in the form. Reasons for missing the presentation will be required before the presentation day.

After the presentation marks for the presentation will be entered into the system. The coordinator will then forward the projects to the examiners for marking.

The co-examiner will mark the student's project based on the template shown in figure 6.20. The marks will then be forwarded to the coordinator.

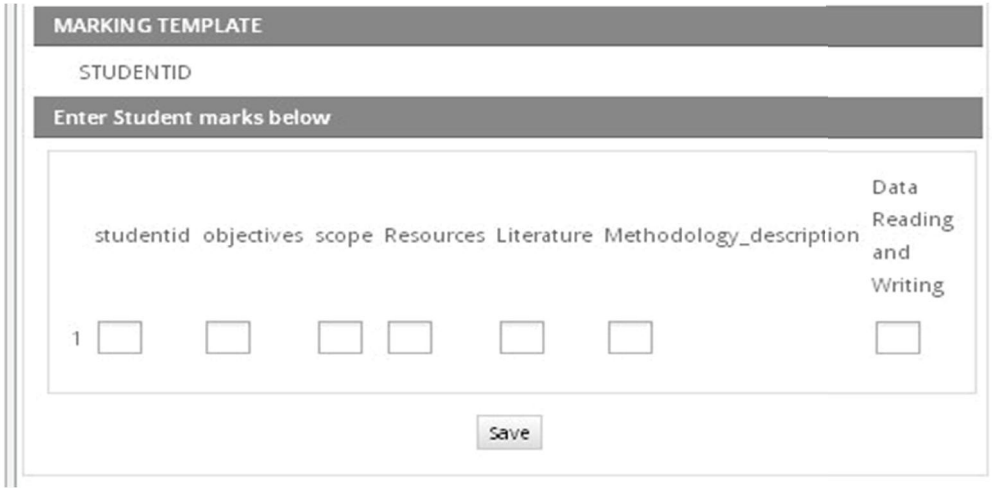

Figure 6-20: Marking Template

The coordinator will combine the marks for the student to generate the final mark for student as shown in figure 6.21.

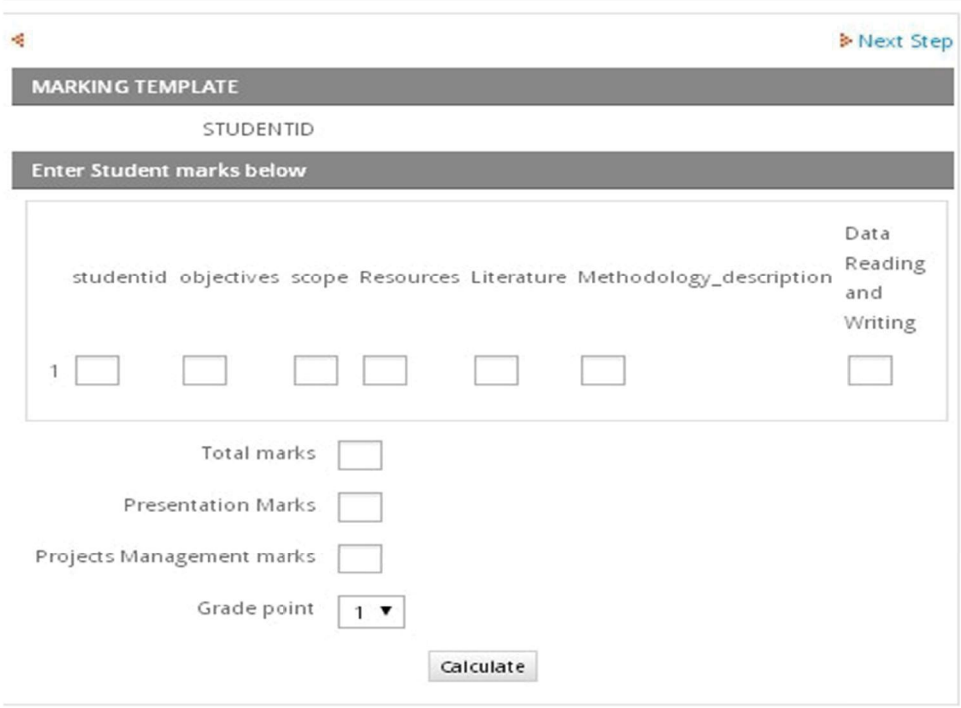

Figure 6-21: Grading Form

6.3 Postgraduate processes

6.3.1 Graduate project management Implementation

After logging in a masters student is presented with a screen below. Select case Topic registration

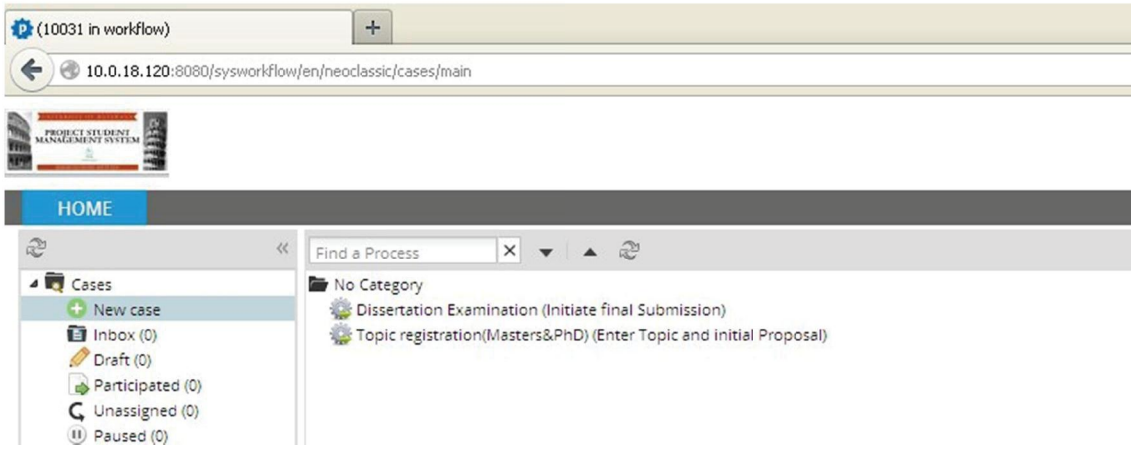

Figure 6-22: Graduate Topic case form

The student will be presented with a form as shown in 6.23 to register their own Graduate topic

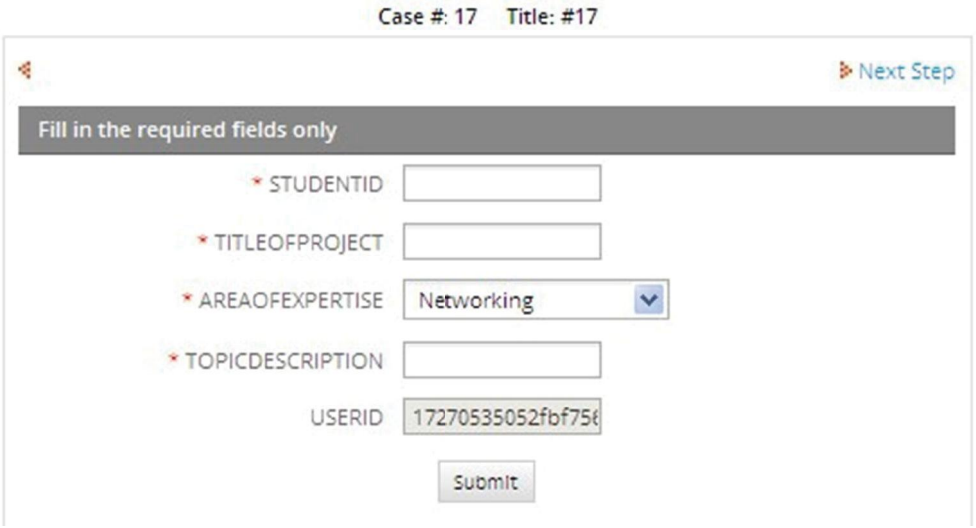

Figure 6-23: Topic Registration Form

Upon registering the topic you are presented with a screen to upload the proposal accompanying the topic you submitted. Any format can be uploaded but preferable in PDF format

Students are given a chance to select the lecturer they approached for supervision. Select the one you approached. The lecturer selected will indicate that he/she will supervise. If there are comments add them and submit.

From the supervisor the task will be routed to the coordinator where he/she will forward the topic to the board for assessment. Each board member will fill in the form to indicate your preferred choice for the topic.

6.3.2 Graduate Proposal writing

After topic registration the next task is proposal writing and defense as initiated by the coordinator. The students will be presented with a form in figure 6.24 to submit their proposal for presentation. Attach the documents.

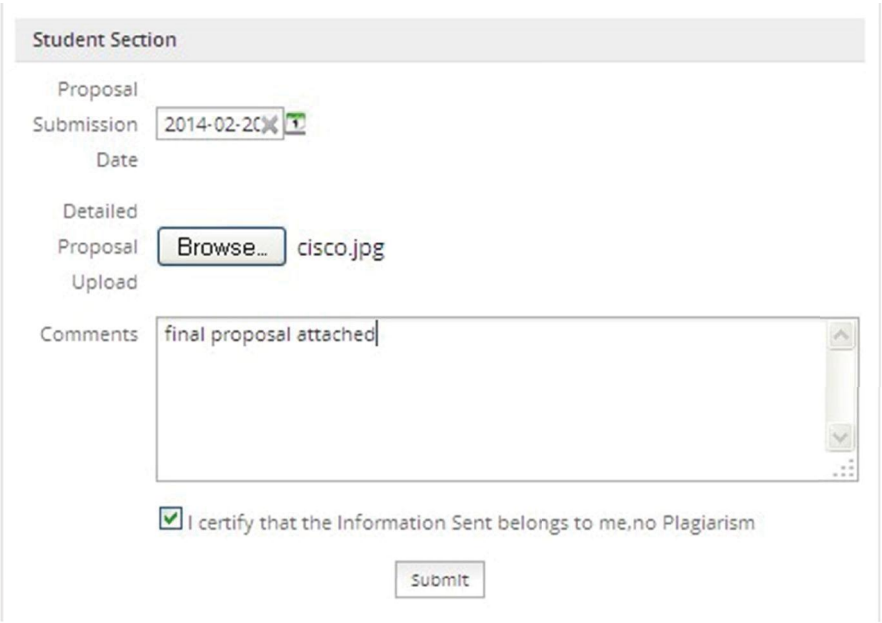

Figure 6-24: Proposal Submission

As a supervisor for the student above, indicate your support for the submission in screen-shot in figure 6.25.

Figure 6-25: Supervisor Acceptance Form

Coordinator sends out the proposal defense date and venue to the students. The screenshot in figure 6.26 assumes the presentations were carried out and the boards' records defence reports in the following form.

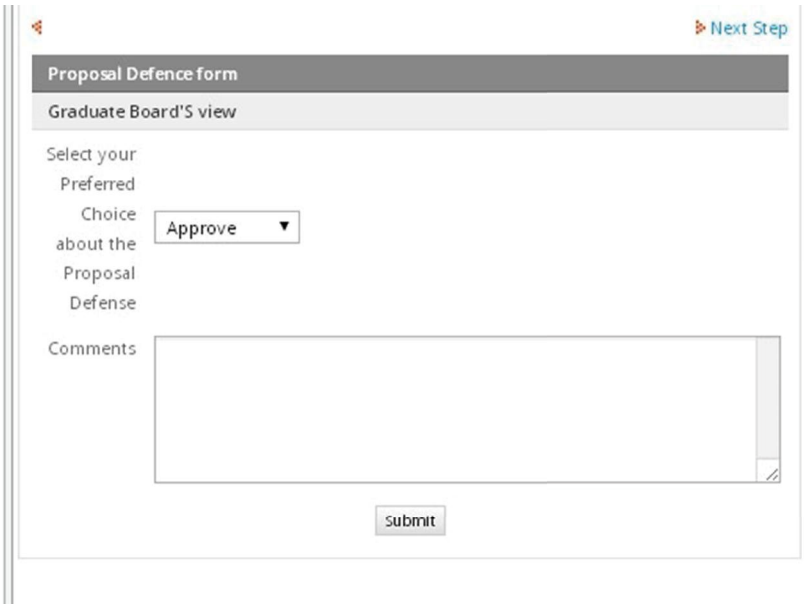

Figure 6-26: Proposal Assessment Form

The student will be notified of the outcome of the proposal defense and the action they are to take.

6.3.3 Project writing for Graduate

After the project proposal has been submitted the student can go ahead and start doing the real project. Different projects require a different time this phases does not have an exact time period. Depending on the individuals the completion time for the process will be flexible but it will be of need to keep track of the initial date. The case dwells in project management aspects of the entire dissertation. In the middle of the project the student will be required to submit a report. Figure 6.27 shows the form to be filled by students and sent it to the supervisor.

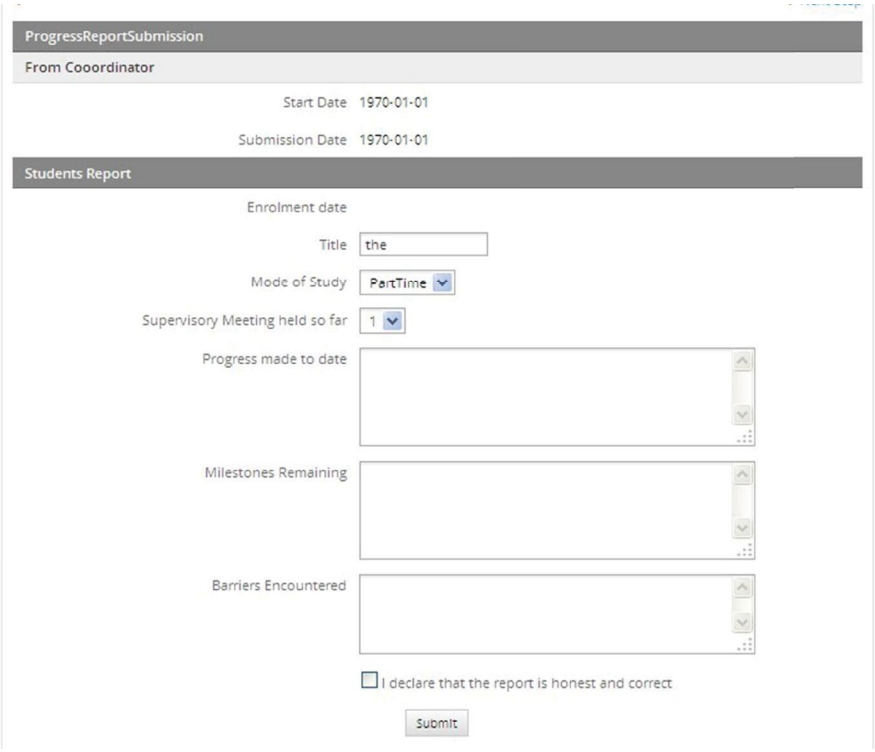

Figure 6-27: Students Report Form

The coordinator is required to fill part of the report as shown in figure 6.28. The report helps in knowing the progress of the project.

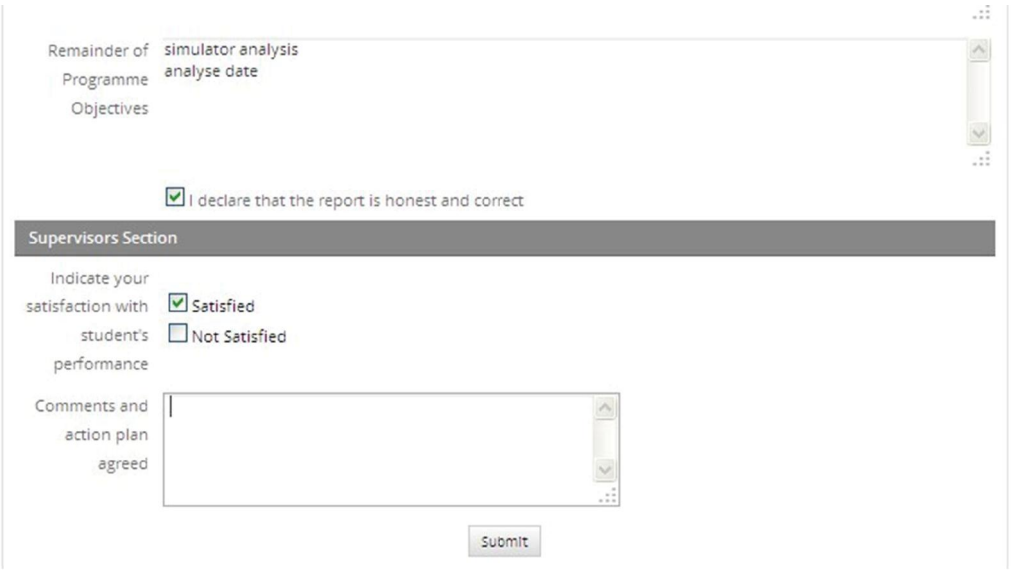

Figure 6-28: Supervisor Report Form

When the student is almost complete he sends the draft dissertation to the supervisor. You upload your report in a pdf format and specify the date. The supervisor after going through the report sends back the report with corrections.

6.3.4 Dissertation Examination

The dissertation examination starts with the students making an indication that they are ready to submit. Fill in the date and make a request to the coordinator. Request form is shown in figure 6.29.

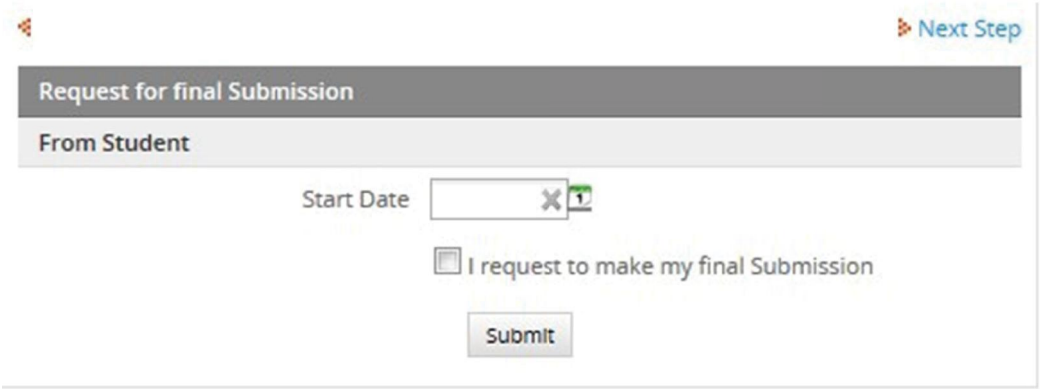

Figure 6-29: Request for Submission form

The coordinator will then open the submission for students who made request. The student will upload his/her work and sent as specified in the figure 6.30.

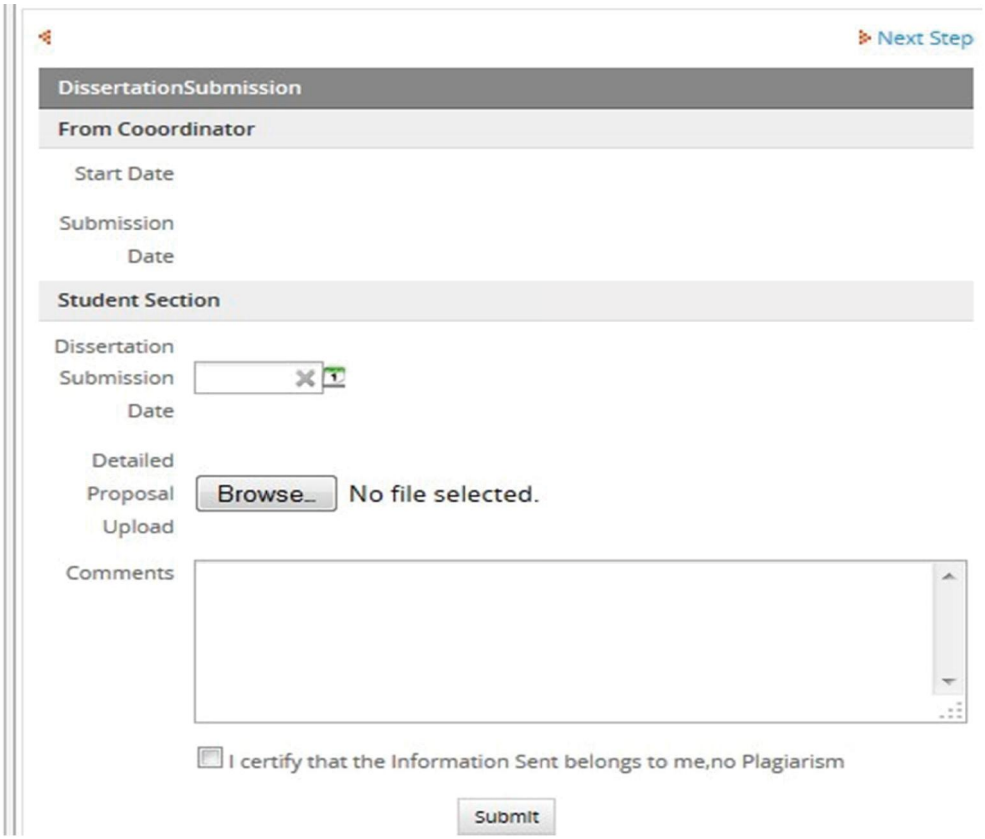

Figure 6-30: Student Submission

The submission by student is routed to the supervisor. Supervisor indicates that he/she approves the submission and adds comments if any to the coordinator. The coordinator will indicate that he/she is satisfied with student submission and send to the school of graduate studies. The SGS accepts the submission and indicate the number of hard copies you received from the student. When you send the dissertation to the examiners indicate the date you sent it. Indicate to the examiners the date they are supposed to have sent the report back. Figure 6.31 is declaration form supposed to be filling as an examiner after receiving the dissertation.

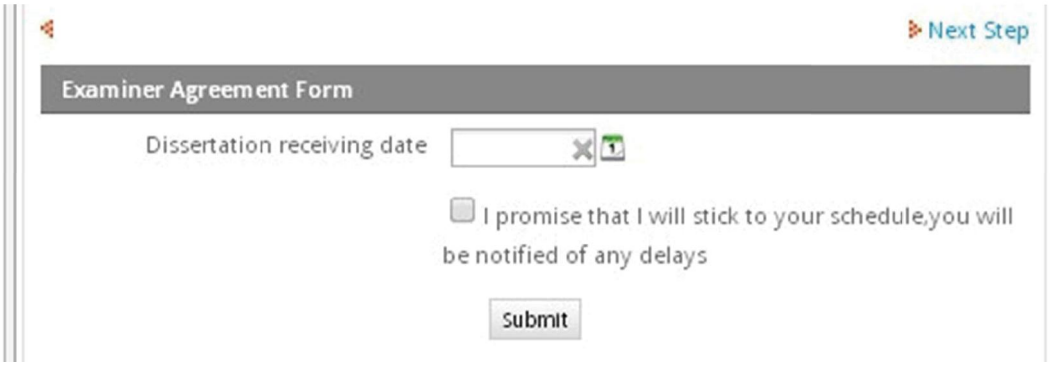

Figure 6-31: Examiners Agreement Form

After finishing he/she fills in the form by indicating the date couriered the report and some feedback on the report. The Form is depicted in figure 6.32.

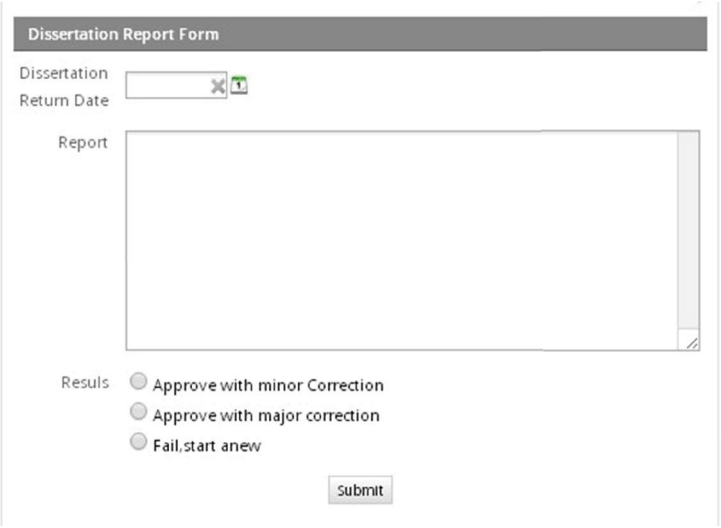

Figure 6-32: Examination Report Form

When the report arrives the SGS notifies the coordinator of the report from the examiners and indicate the duration. The coordinator prepares a brief report to the student not going into confidential information. Inform the student that the reports are ready for collection. When the student receives a report, he/she work on the corrections and send back the corrected version to the supervisor. The supervisor will indicate the approval of the submission of the corrected project. Indicate that all the necessary corrections are taken into consideration. Route to the examiners. The examiners indicate as to whether they are satisfied with the correction and indicate the final result of the student's work. The SGS will then notify the coordinator and student of the outcome and post examination submissions will be made.

6.3.5 Theses examination

The first steps of theses examination are similar to the ones above for the dissertation examination. Oral examination is the only missing step performed in this workflow.

Oral examination starts off after the examiners have submitted the reports to the coordinator. The coordinator initiates it by inviting the concerned to the examination as shown in figure 6.33.

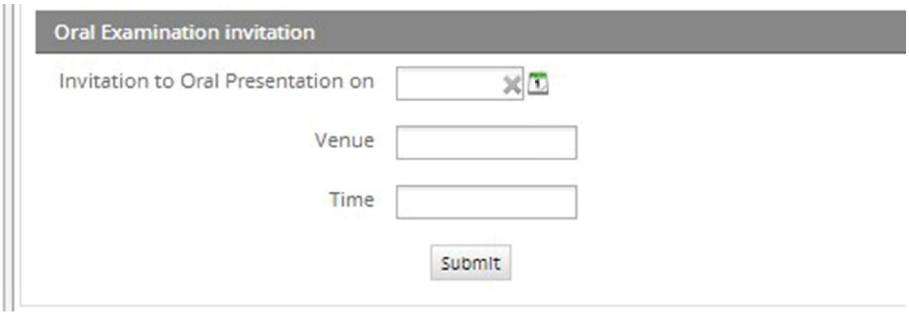

Figure 6-33: Oral Invitation Form

After the oral presentation the successful projects will be archived for future use

6.4 Reports

6.4.1 Reports through Case tracking by users

Every user who partakes in the cases has the opportunity to track the progress. Go to the participated folder and click the case you want to track as indicated in figure 6.34. This is a very useful tool for users who have submitted their work to know the whereabouts of their work.

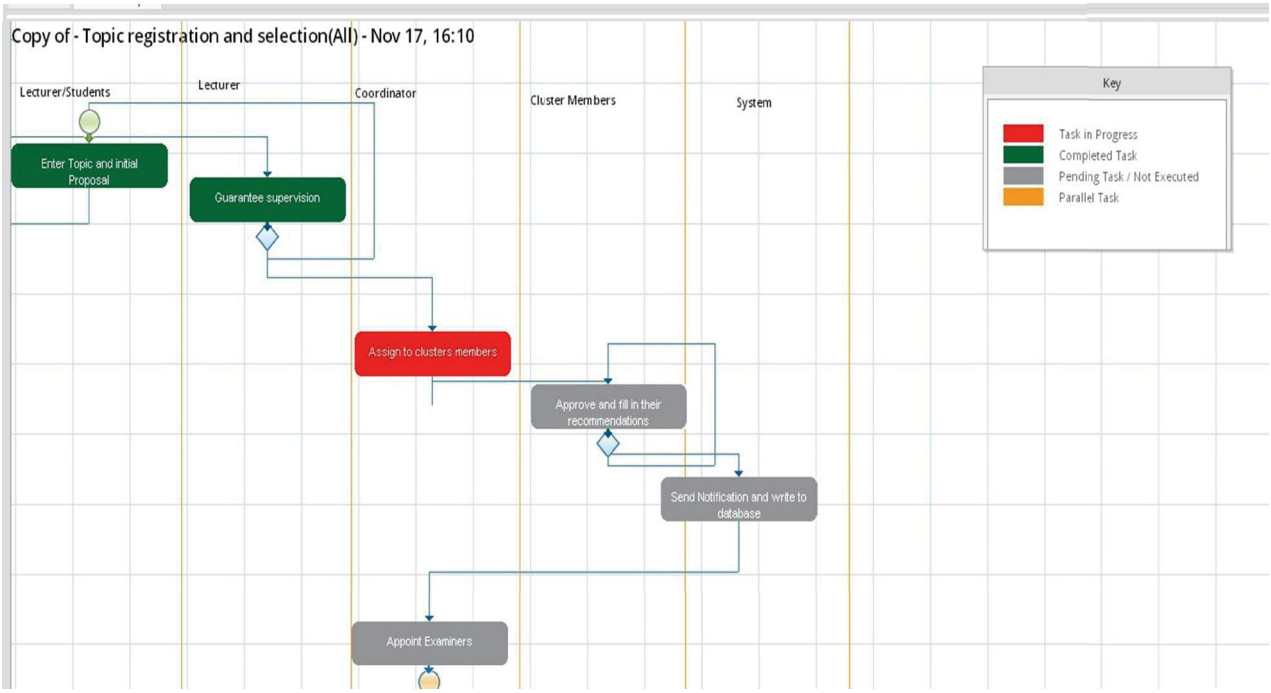

Figure 6-34: Case tracking Window

Tracking using the task information which indicate the start date and due date as shown in figure 6.35

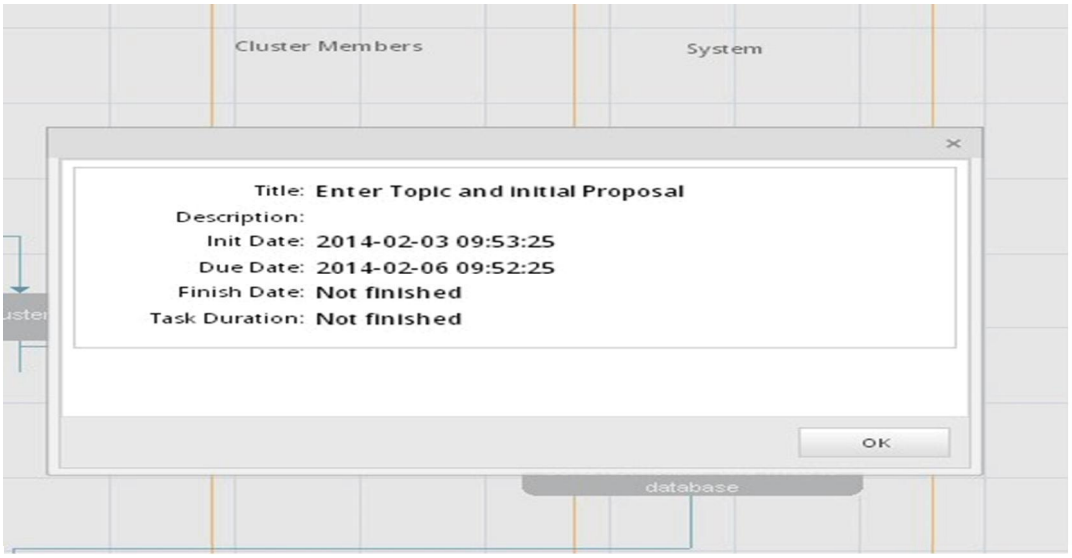

Figure 6-35: Detailed Task Report

6.4.3 Process Managing

Calendar – A calendar is one important element in the project. Calendars are only accessed by the admin for calculation of due dates, allow working days and rest or holidays to be specified. Figure 6.36 is a showcase of setting up the Calendar for the Topic Registration process

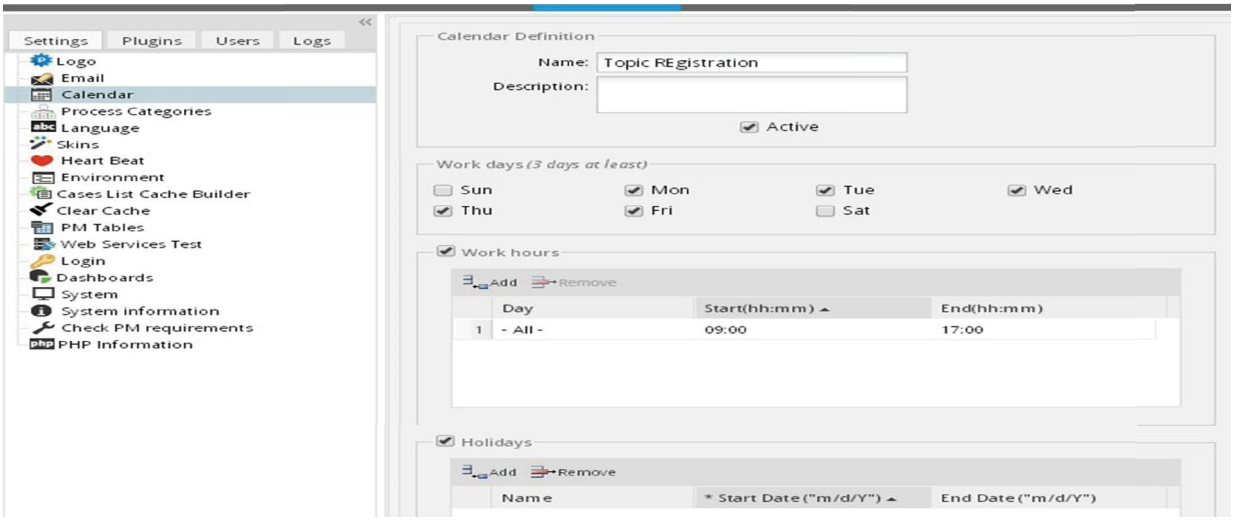

Figure 6-36: Topic Registration Calendar

- Name – a label to identify the calendar
- Work days - this shows the working days, in the project is Monday to Friday
- Active - Select whether active or not
- Holidays – defines the holidays of the calendar which will be excluded from the calendar

The calendar created will be crucial when tasks are created in the processes. The task created in figure 6.37 will be given a duration of 3 days in which it will it uses the calendar days of Calendar Topic Registration.

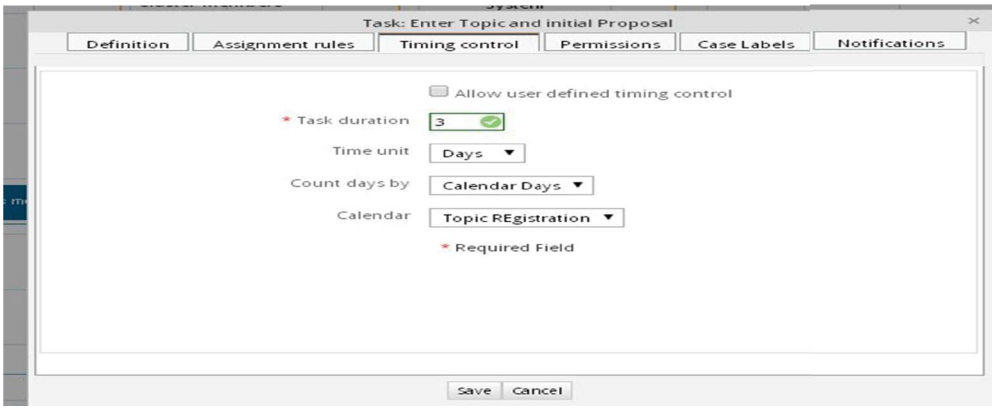

Figure 6-37: Timing Control

6.4.4 Management views

One of most fundamentals functions of the system is to be provide some information to the management of the University like heads, Deans and the vice and deputy chancellors.. The search fields;

- Delegated date from
- To
- Category
- Process
- Status
- User

6.4.5 Projects reports

The system dashboard provides real-time monitoring of the efficiency and productivity of processes and users executing those processes. Managers and supervisors can use the dashboard to check up on the productivity of employees and measure how well departments are functioning. The dashlet can be calculated over a defined period of time, say today, yesterday, this week, previous week, previous month, this year and previous year. This time periods will help the management to measure efficiency of projects in the University across faculties.

The admin will be the one to create the dashlets and make them available to the University management for which the dashboard will be available. Figure 6.38 is a screen shot for creating the dashlets. The following fields are mandatory:

- Title - name of the dashlet
- Dashlet - open cases VS Completed cases will be displayed
- Assign To - an individual who will be assigned a dashboard. It can be a user, department or a group
- Name – the actual individual to see the dashboard, in this case, it will be the management

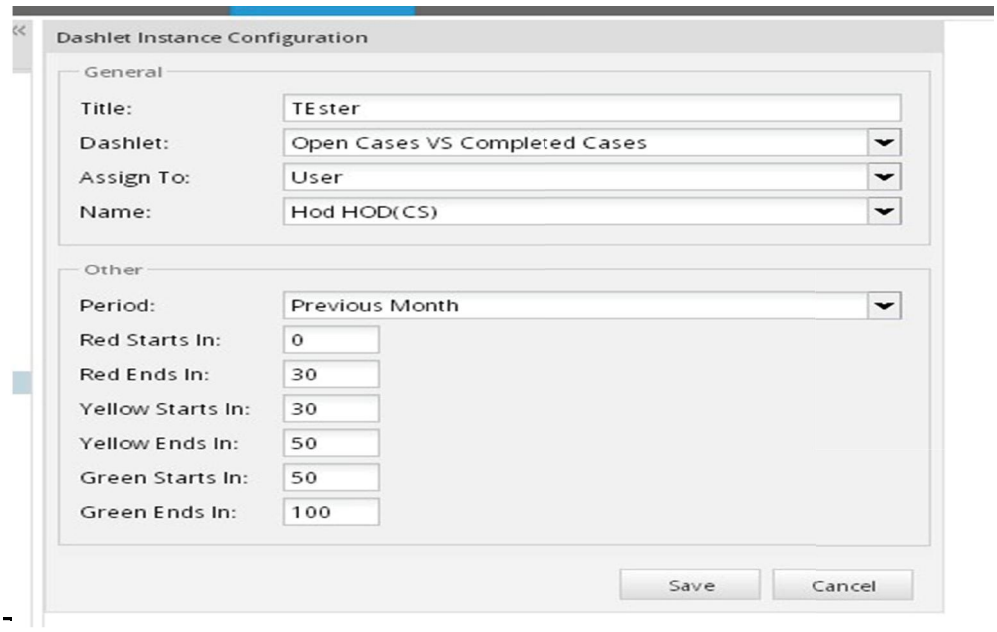

Figure 6-38: Dashlets Creation

Once the dashlet is created the user will be able to see the report under their dashboards.

The colour codes in the dashboards are

Red - shows the number of cases which are open and need to be worked on

Orange - shows the number cases open

Green – shows the number cases completed

Chapter Seven: Prototype Evaluation

Three types of evaluation were done to test the prototype system. They were usability and heuristic evaluation, perceived ease of use and perceived usefulness. This section presents a discussion on the evaluation.

7.1 Usability and Heuristic Evaluation

Nielsen(1994) recommends that three to five evaluators be used for heuristic evaluation. In this research, evaluators were selected based on the distinct levels. The evaluators were:

- ✓ Three final year undergraduates students
- ✓ Three Masters students(final year)
- ✓ Three PhD students(Library and Information Studies)
- ✓ Four Computer Science Lecturers

In total, thirteen evaluators from department of Computer Science and department of Library and Information Studies performed heuristic evaluation in December 2014. This was mainly based on convenience sampling -those who were willing and available to evaluate the system with some experience in the usability and heuristic evaluation of prototypes. The questions are detailed in Appendix A. Evaluator's response to questions that determine whether the prototype supported each of the usability factors or not. The positive response "yes" means that the system supported the usability and the factor was not violated. The negative answer "No" means that the system violated the usability factor. Of the eight factors evaluated, six scored more than half the number of positive responses and two factors scored more "no" than "yes". The summary is shown in Table 7.1. Also in the overall scores for heuristics are between 0 (no usability problem) and 5(Usability Catastrophe), the evaluators agreed that visibility, error prevention, recognition and minimal design were clear and consistent. This is shown in Table 7.2. In further analysis of the result, percentage of violation was calculated. Table 7.3 shows the result. This was presented as a chart in Figure 7.1. The problems that identified from the analysis were mainly user control and consistency with standards.

Table 7-1: Summary Heuristic Evaluation results

Usability factor	Positive(Y)	Negative(N)	Not Applicable (NA)
Visibility of the system status	64	1	0
Match between system and real world	31	8	0
User control and Freedom	25	38	3
Consistency and standards	23	39	5
Error Prevention	36	16	0
Recognition and Recall	54	15	9
Aesthetic and Minimal design	26	13	1
Help users recognise, diagnose and recover from errors	21	5	0

Table 7.2: Heuristic Evaluation results

Usability factor	No Usability problem	Cosmetic Problem only	Minor Usability problem	Major usability problem	Usability Catastrophere
Visibility of the system status	11	2	0	0	0
Match between system and real world	9	4	0	0	0
User control and Freedom	5	5	3	0	0
Consistency and standards	3	7	4	0	0
Error Prevention	8	5	0	0	0
Recognition and Recall	9	2	2	0	0
Aesthetic and Minimal design	11	2	0	0	0
Help users recognise, diagnose and recover from errors	10	3	0	0	0

Table 7.3: Heuristic Violations

Usability factor	No of violations	Total number of ratings	Percentage of violation (%)
Visibility of the system status	1	65	1.5
Match between system and real world	8	39	20.5
User control and Freedom	38	65	58.5
Consistency and standards	39	65	60.0
Error Prevention	16	52	30.8
Recognition and Recall	15	78	19.2
Aesthetic and Minimal design	13	39	33.3
Help users recognise, diagnose and recover from errors	5	26	19.2

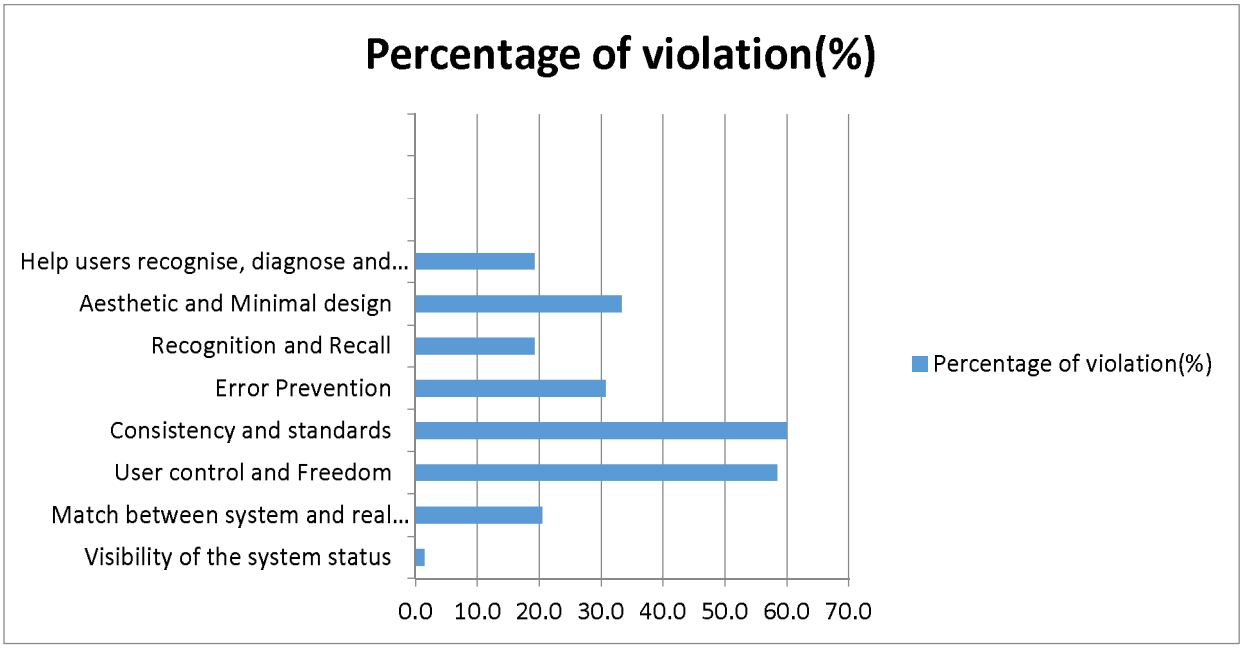

Figure 7-1: Chart for Heuristics violations

The problems that were listed by the evaluators are listed in Table 7.4. The evaluators also recommended the following:

- ✓ Specifying the labels and button names
- ✓ Titles for pop-up messages
- ✓ Training users

The design solutions to the problems as implemented in the prototype design are also shown in Table 7.4. Not all problems could be addressed in this prototype design.

Table 7.4: Usability problems and design solutions

Usability problem	**Design solution**
Ambiguous words like "Area of expertise, cluster"	Used combo-box to list the areas
What is the difference between userID and StudentId	userID changed to username
Date format not clear in date field	Fix date format
No cancel in all forms, only submit buttons	Cancel buttons created
No clear title for form of coordinator receiving submission from students	Title created
No undo and redo buttons	Solution not implemented
No option of using keyboard instead of mouse	Solution not implemented
No defaults values for data values	Default values added
No dots used to indicate length	Solution not implemented

7.2 Perceived Ease of Use

Six questions on perceived ease of use of the prototype were added as part of the evaluation. The same thirteen who did the Usability and Heuristic Evaluation did the evaluation. The evaluators responded to the six questions and the responses are summarised in table 7.5. The responses were between "strongly agree" and "strongly disagree".

Table 7.5 Percentage summary of perceived ease of use

	SA*	A*	N*	DA*	SDA*	Total%(N)
I find the system easy to use.	46.2	46.2	7.7	0	0	100(13)
Learning to operate the system is easy for me.	15.4	76.9	7.7	0	0	100(13)
I find it easy for the system to do what I want it to do.	23.1	46.2	31	0	0	100(13)
The system is flexible to interact with	23.1	53.8	23	0	0	100(13)
I can easily remember how to perform tasks	23.1	61.5	15	0	0	100(13)
My interaction with the system is clear and understandable	15.4	46.2	39	0	0	100(13)

SA – Strongly Agree; A – Agree, N- Neutral; DA- Disagree and SDA –Strongly Disagree

It can be seen from Table 7.5 that users found the system easy to use, flexible as well as easy to remember the process of performing tasks. Responses ranged between 77% and 92%. However lower percentages between 61% and 69% were obtained in system doing what uses want clarity. There is high possibility that this rating is also due to the usability problems which have been attended to.

7.3 Perceived Potential Usefulness

The perceived potential usefulness was measured using six items with a 5-point scales ranging from strongly agree to strongly disagree. The scale was 1= strongly disagree, 2-disagree, 3-neutral, 4-agree and 5-strongly agree. Twenty participants completed the questionnaires across different departments. The respondents came from mostly the Faculty of Science. The participants were walked-through the online prototype. Of the 20 participants, 85% were from Faculty of Science and 15% were other Faculties. Within Faculty of Science 71% of participants were from Department of Computer Science. From the participants 20% were graduate students and 75% came from undergraduate students. This was mainly based on convenience sampling - those who were willing and available to evaluate the system. As shown in able 7.5, over 80% of the evaluators responded with either "agree" or "strongly agree" in all the items related to the perceived usefulness. Overall, all evaluators felt the system will be useful. None of them disagreed or strongly disagreed. In terms of reducing delays, all participants agreed. This really buttresses the fact that the system will indeed reduce delays and improve efficiency.

Table 7.5 Percentage summary of perceived potential usefulness

	SA	A	N	DA	SDA	Total%(N)
The system would allow me to complete my tasks more quickly	25	55	20	0	0	100(20)
Using the system would increase effectiveness of performing tasks	40	45	15	0	0	100(20)
Using the system would give me more time over other issues than administrative task	55	35	10	0	0	100(20)
Using the system would give me more visibility over my tasks	45	40	15	0	0	100(20)
Using the system would reduce delays for the same amount of effort	45	55	0	0	0	100(20)
I would find the system useful in the process for my research work	40	45	15	0	0	100(20)

Participants perceived that the prototype system as very useful. The prototype appeared to meet participant's need for a research projects management system. The evaluators' narrative comments also support the potential usefulness of the system. Details of the comments are reported below.

E1: "The system helps the management and students to achieve a durable solution towards progress"

E2: "The system brings a very important aspect of dates in the interfaces for both students and supervisors. This will address the problem of staying with documents for a long period of time without acting. Every that is done should be accompanied by a date stamp."

E3: "The system should also combine process and document workflows with both cloud based storage and collaborative tools. The system should allow for anonymity of process-incomplete work and allow for privacy preserving data mining. The system should allow for data-sharing of not only documents but even data collected"

E4: "Good for managing my project"

E5: "Such a system would be perfect for students because it will minimize delays. We normally start our projects late. We wait for projects titles to be approved so such a system would make it easier to get responses on time."

E6: "IT helps improve the communication between students and lecturers and time management of the overall project"

E7: "The system actually account for delays and track progress"

E8: "The system helps me keep track of my project and my supervisor"

E9: "Such a system helps with delays and meeting arrangement with supervisors"

E10: "Scheduling of project can be overviewed and rearrangement can be efficiently dealt with"

E11: "The prototype is beneficial to all stakeholders because such a system it ensures that there are no delays when a student undertakes a research project. It ensures that there is proper communication between supervisors and students"

E12: "The system addresses issues of concern to with the student's research projects. Improvements will be noted if the system can be put in place."

E13: "The system help with approval of topics, which delays our project development since one cannot develop a project without approval. Scheduling for appointment is done on time with this system and become helpful with a supervisor having many students to supervise"

E14: "The system saves a lot of time but more time is needed to do consultation with supervisors. The system should promote transparency concerning marking."

E15: "Not all administrative tasks should be automated. Students should meet physical with the supervisors to check progress thereafter the discussion should be recorded in the system. The prototype caters for that very well."

E16: "The system should include forums where one can make discussions with their supervisors and not meet physically with the supervisor"

E17: "The system saves a lot of time. E.g. assigning supervisors to students"

Chapter 8: Summary of study, Recommendation and Conclusion

This chapter consists of summary of the study, limitations, recommendation and conclusion

8.1 Summary of study

The broad goal of the study was to analyse the current processes and model a better workflow and a prototype for the whole process of students' project management from the point of registering topics to the final submission of the projects.

The specific objectives of the study were to:

1) Assess the current state of operations for student research project management in the University
2) Model a workflow to make it more efficient.
3) Design, develop and evaluate prototype system based on the workflow

The study has been done in five phases. In the first phase, the sufficient information involving students' research management at the University of Botswana were identified. The information included stakeholders, project milestones and projects phases. The survey was carried out in twelve departments. Problems related to research projects management were identified by coordinators representing lecturers.

In the second phase, the study focused on modelling of the current processes relating to research projects. The first phase helped with user requirements which were used in this phase to model the current workflows. The workflows were categorised into undergraduate level, Masters Level and PhD level. The workflows designed were modelled for the requirements gathered from Computer Science department.

In the third phase we explored the potential of improving the workflows built in the second phase. Workflow reengineering methodology was used to help reengineer efficient workflows. The first three phases for WFS were used being; preparing for workflow innovation, automating existing workflows (this was done in the second phase of the study) and preparing workflows for improvement. Some workflow techniques were further used which divided the workflows into four main processes, which are; topic registration, proposal writing, project writing and project examination. The idea behind formation of these workflows was to improve efficiency of the workflows. The long processes created in phase two were reduced into short manageable workflows.

The prototype system was designed using Processmaker. A web based prototype was designed with a database, mail server, forms, users and workspaces.

A system can only be said to be effective and efficient if it meets usability criteria for specific types of user's carrying out specific tasks (Agarwal.R, 2002). Usability is associated with positive effects, including errors reduction, enhanced accuracy and positive attitude towards users. If a systems passes usability testing we can say it is effective and efficient. In the last phase of the study, the prototype system was evaluated using heuristic evaluation and end user evaluation. Heuristic evaluation is considered a practical, inexpensive method of identifying usability problems and assisting in refinement of system design (Laurie et al., 2002). Thirteen usability evaluators from department of Computer Science and department of Library and Information studies evaluated the prototype using heuristic evaluation. Eight usability factors were applicable to my study. As a result only two usability factors; user control and freedom and consistency with standards violated heuristics by scoring negative responses but their overall severity score were between "no usability problems to minor usability problem". Some of the problems included; complex wording, no cancel buttons, no default values in the data fields, no undo buttons and others. The overall severity rating ranged between, no usability problems, cosmetic problem and minor usability problem, which suggested that the prototype was very usable hence efficient and effective. Most of the comments were problems that were resolved.

In addition to the heuristic evaluation, evaluators were given six questions on perceived ease of use and perceived usefulness of the prototype. On the whole, the evaluators perceived the prototype system as easy to use and a useful tool to the management of research tasks.

8.2 Contribution of the Work

Current work flow requires a lot of human effort to manage and maintain while managing students' project through the prototype make things more systematic and convenient. Information about the student project and progress are all organised from one point. Students, Supervisors and other stakeholders can always refer to information in the system when they need the information and will help all stakeholders manage their tasks effectively. Reports are also available at any point they are required.
The following are the main contributions of this dissertation;

- Capturing and modelling the current manual system into workflows.
- Reengineer workflows to eliminate bottlenecks.
- Convert improved workflows into an automated prototype.
- Analysis of the improved workflows and the prototype.

8.3 Limitation of the research

The study was confined to undergraduate, masters and PhD thesis. There are however other forms of work within the University such as mini research essays, diploma etc. which are not part of his research. There are several causes of delays such as humans and system but the

research focus is mainly those caused administrative inefficiencies that can easily be dealt with using proper process flows and reminders. The work also tries to look for commonalities across department; however, it is not possible to cater for all details particular to each department.

8.4 Recommendation for further study

The study is based on a first prototype design and therefore there is room for further work on refining the workflow and developing more efficient system.

Any future work on this prototype should focus on the improving the integration with the other systems. The system should be able to allow users to have a single point of login across all the three systems. The case now is that a user has to login in every system. Providing a single point of entry into the three; Moodle, research system and ETD-db system will improve efficiency and productivity.

Currently, the system allows submission of hard-copies for the student's projects. Examiners would read manual scripts for projects and enter marks/reports into the system. In future an online marking tool can be merged to the prototype and make users move away from manual work. Students would be able to upload their work online for examiners to mark or give feedback.

8.4 Conclusion

Students' research is a capstone in the study process at the University of Botswana. This study looked at the current setup and proposed a better workflow system to improve the process. The process led to the development of a prototype for a students' projects management system for University of Botswana. Five phases were followed in the developing of the prototype. The end of the first phase resulted in gathering of information about the current state of students' research projects. The second phase used the information gathered in the first phase to model the current processes. The third phase improved the processes designed in the second phase by providing a new workflow. The last two phases were the prototype development and the evaluation. The results of these two phases proved the concept was viable. The completion of this dissertation as a whole, demonstrated a viable concept of project research management system which met the users' expectations. The prototype will be quite useful in the effective processes of monitoring, supervising and managing students' research projects; therefore, in future developments of the institution, the issues of student research workflow should be incorporated into the system.

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Appendix A: Heuristic evaluation form

1. Visibility of the System Status – The system should be able to keep the user about what is going on through appropriate feedback

#	Usability Factor	Response	Comments
1.1	Does every screen have title or header?	Yes No NA	
1.2	Is there visual feedback or dialog boxes	Yes No NA	
1.3	Is there clear indication of the current location	Yes No NA	
1.4	Is the menu-naming consistent with the user's task domain	Yes No NA	
1.5	Does the system provide visibility, can the user tell the state of the system.	Yes No NA	

No usability Problem	**Cosmetic Problem only**	**Minor Usability problem**	**Major Usability Problem**	**Usability Catastrophe**
0	1	2	3	4

2. Match between the System and the real world- Words, phrases and concepts should be the language of the user not system- oriented terms. Make information appear in a natural and logical order.

#	Usability Factor	Response	Comments
2.1	Are the headings and sub-headings ordered in a in a logical way	Yes No NA	
2.2	Is there a natural sequence to the menu choices for data item	Yes No NA	
2.3	Are all the words used in the system known to users	Yes No NA	

No usability Problem	**Cosmetic Problem only**	**Minor Usability problem**	**Major Usability Problem**	**Usability Catastrophe**
0	1	2	3	4

3. **User Control and Freedom**-Users should be able to select tasks. Users should make their own decisions rather than having a system do that for them.

# Usability Factor	Usability Factor	Response	Comments
3.1	Is there a clear exit on each screen?	Yes No NA	
3.2	Are all screens	Yes	

	accessible across the system?	No NA	
3.3	Is there an undo function?	Yes No NA	
3.4	Does users have option of clicking on a menu with a mouse or a keyboard	Yes No NA	
3.5	Can users easily move forward?	Yes No NA	

No usability Problem	**Cosmetic Problem only**	**Minor Usability problem**	**Major Usability Problem**	**Usability Catastrophe**
0	1	2	3	4

4. **Consistency and Standards-** Users should not wonder whether different words or actions mean the same thing.

# Usability Factor	Usability Factor	Response	Comments
4.1	Have the forward standard been followed consistently?	Yes No NA	
4.2	Are abbreviations clearly explained?	Yes	

		No NA	
4.3	Is vertically scrolling possible?	Yes No NA	
4.4	Are the no more than four to seven colors, and are they far apart?	Yes No NA	
4.5	Are names consistent, both within each tab and across the system?	Yes No NA	

No usability Problem	**Cosmetic Problem only**	**Minor Usability problem**	**Major Usability Problem**	**Usability Catastrophe**
0	1	2	3	4

5. Error prevention- Are they good error messages which prevents a problem from occurring.

# Usability Factor	Usability Factor	Response	Comments
5.1	Does the dots or underscore been used to indicate field length?	Yes No NA	
5.2	Is navigation between screens simple and	Yes	

	visible?	No NA	
5.3	Does Field in the data entry screens contain default values?	Yes No NA	
5.4	Does the system prevent users from making errors in the data entry field?	Yes No NA	

No usability Problem	**Cosmetic Problem only**	**Minor Usability problem**	**Major Usability Problem**	**Usability Catastrophe**
0	1	2	3	4

6. Recognition than Recall- Make objects, actions and options visible. The user should not have to remember dialogue from the previous dialogue. Instruction should be visible.

# Usability Factor	Usability Factor	Response	Comments
6.1	Are messages and prompts placed in a place where the eye can pick them	Yes No NA	
6.2	Have items be grouped into logical zones and headings being used for the zones.	Yes No NA	
6.3	Are optional data	Yes	

	entry fields clearly marked?	No NA	
6.4	Is color highlighting used to get user's attention?	Yes No NA	
6.5	Is color highlighting to indicate that an item has been selected	Yes No NA	
6.6	Can the user easily locate data?	Yes No NA	

No usability Problem	**Cosmetic Problem only**	**Minor Usability problem**	**Major Usability Problem**	**Usability Catastrophe**
0	1	2	3	4

7.0 Flexibility and Ease of use

# Usability Factor	Usability Factor	Response	Comments
7.1	Are messages and prompts placed in a place where the eye can pick them	Yes No NA	
7.2	Have items be grouped into logical zones and headings being used for the	Yes No NA	

	zones.		
7.3			

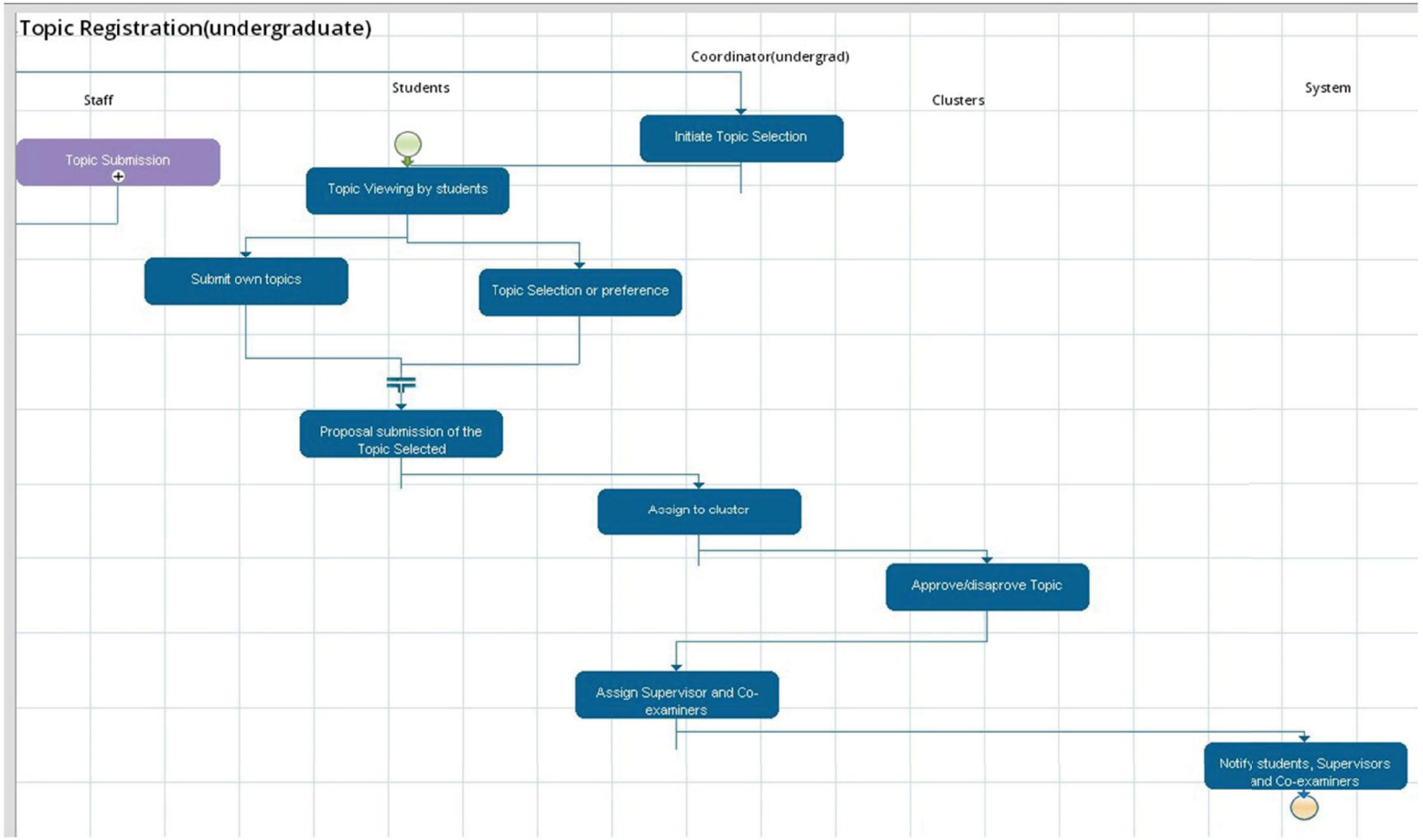
No usability Problem	**Cosmetic Problem only**	**Minor Usability problem**	**Major Usability Problem**	**Usability Catastrophe**
0	1	2	3	4

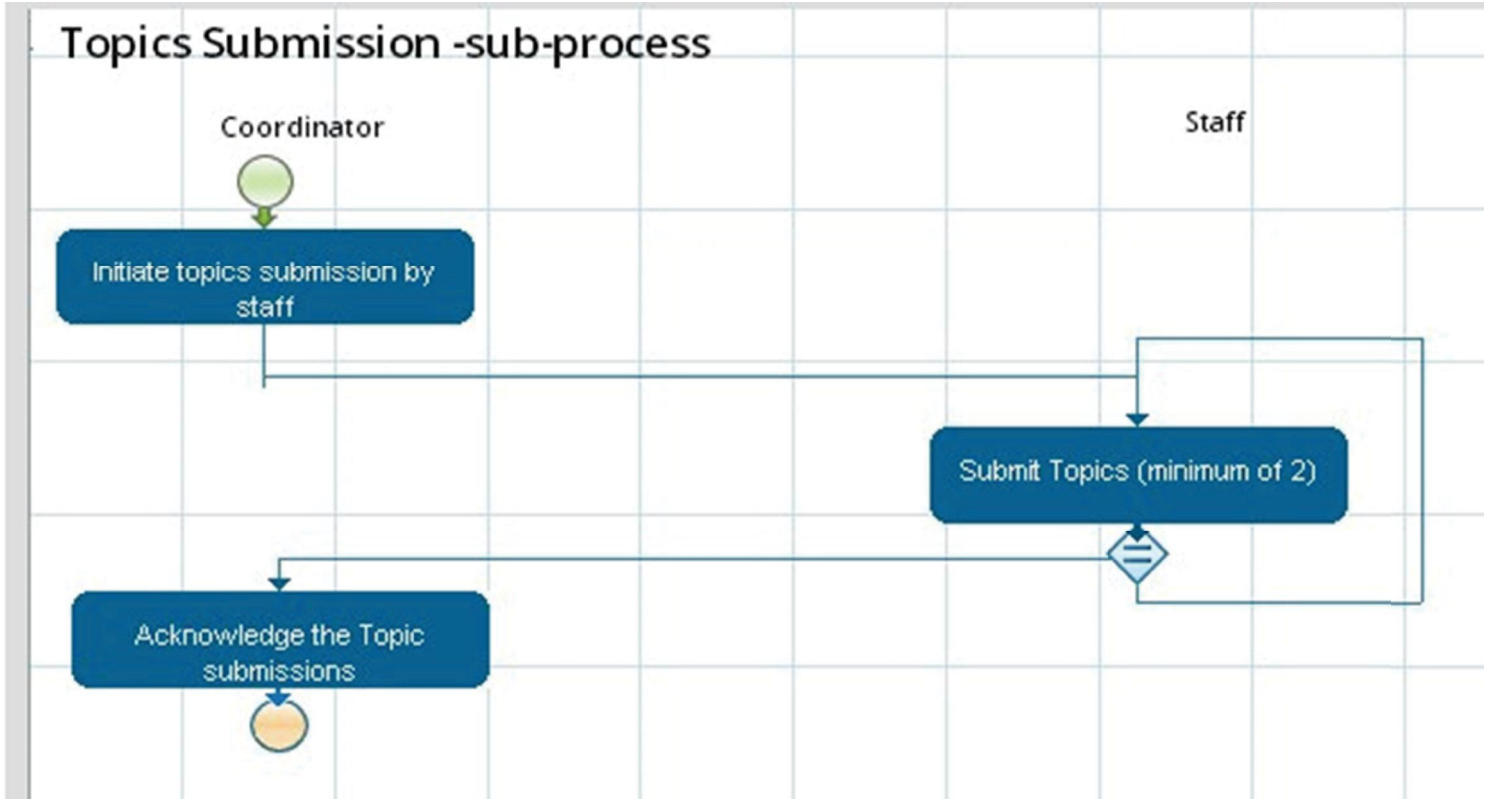
8.0 Aesthetic and Minimalistic Design- Dialogues should not contain information which is irrelevant.

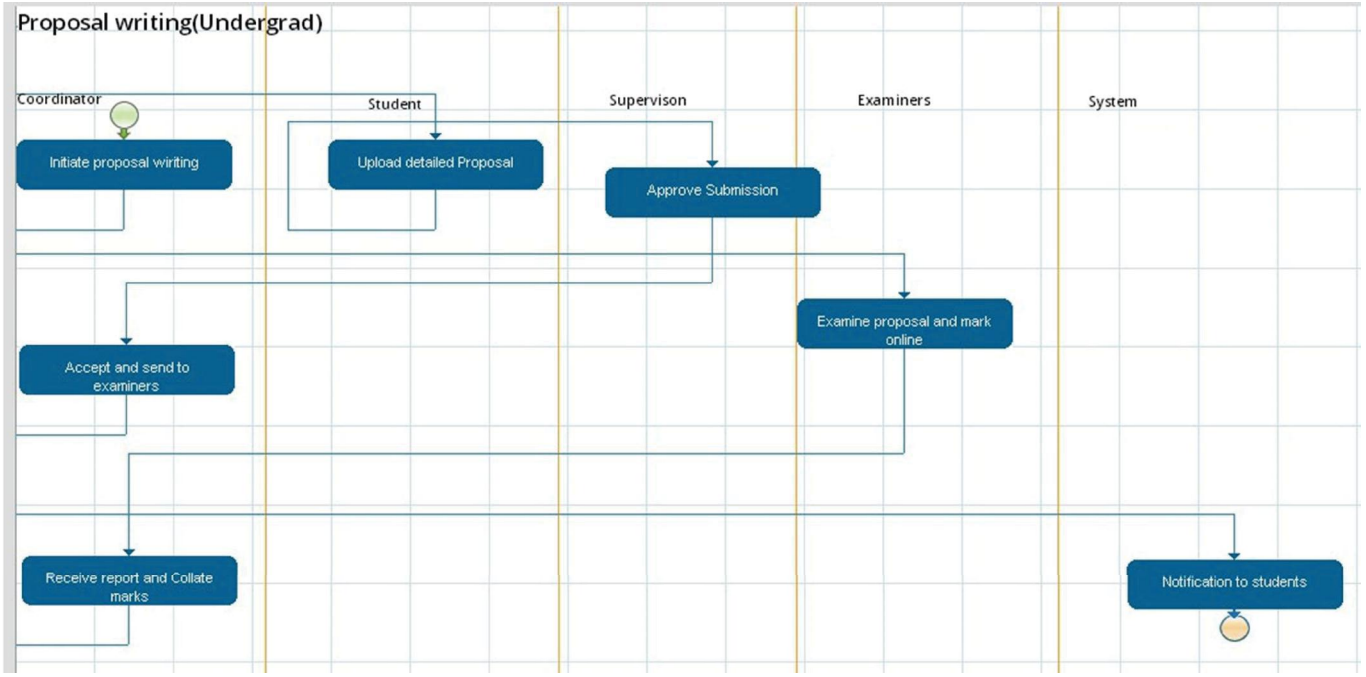
# Usability Factor	Usability Factor	Response	Comments
8.1	Are messages and prompts placed in a place where the eye can pick them	Yes No NA	
8.2	Have items be grouped into logical zones and headings being used for the zones.	Yes No NA	

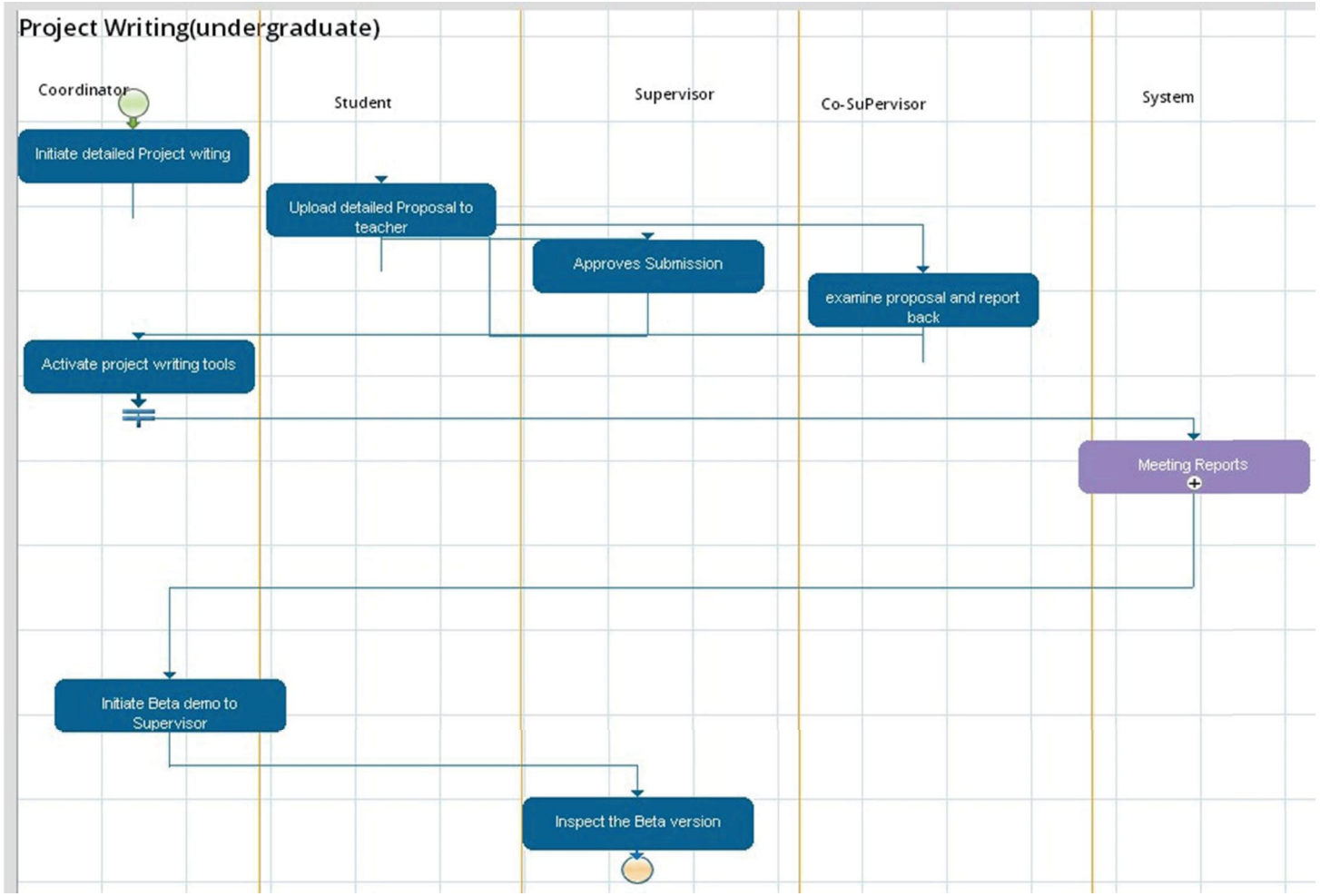
No usability Problem	**Cosmetic Problem only**	**Minor Usability problem**	**Major Usability Problem**	**Usability Catastrophe**
0	1	2	3	4

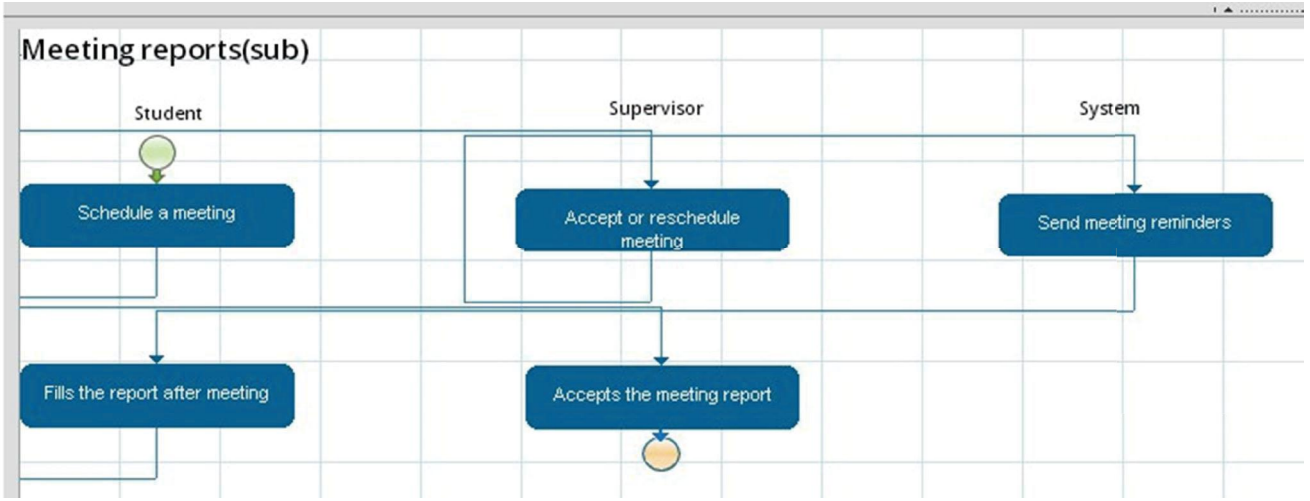
Appendix B: Reengineered processes

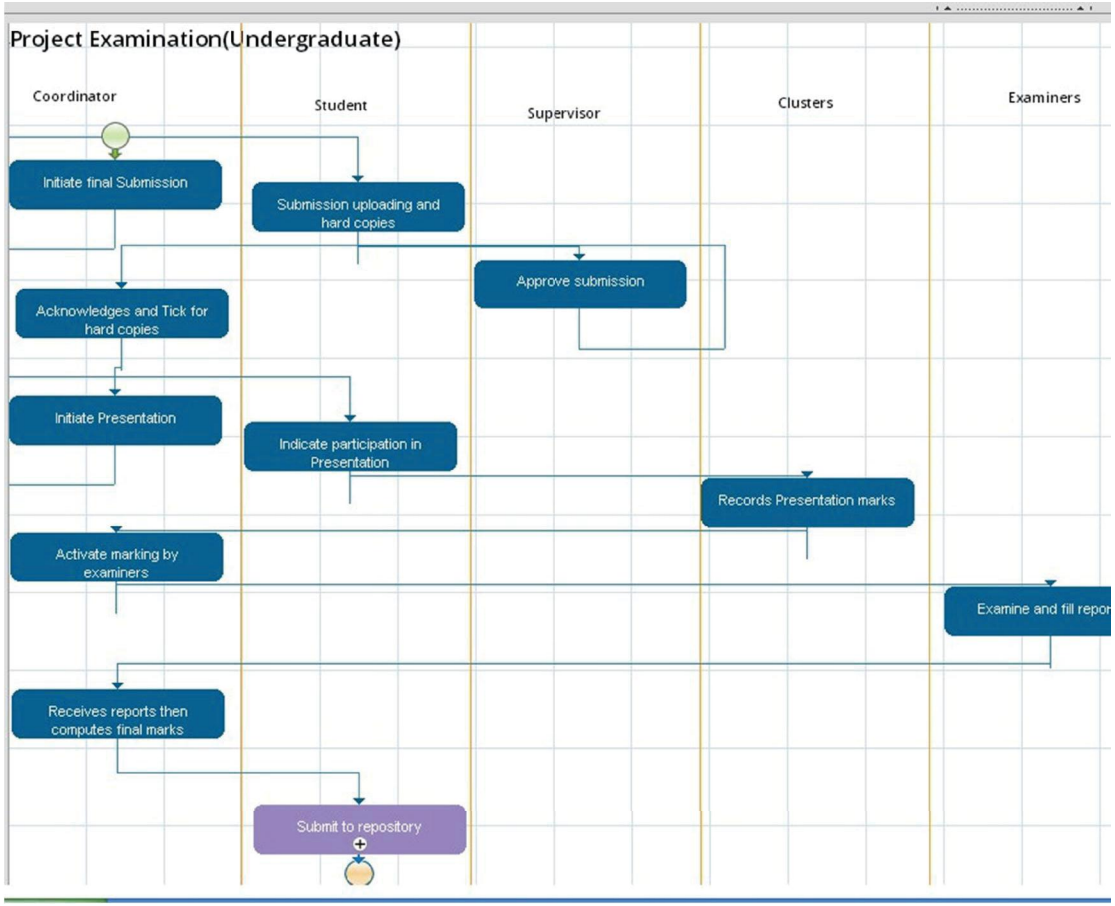


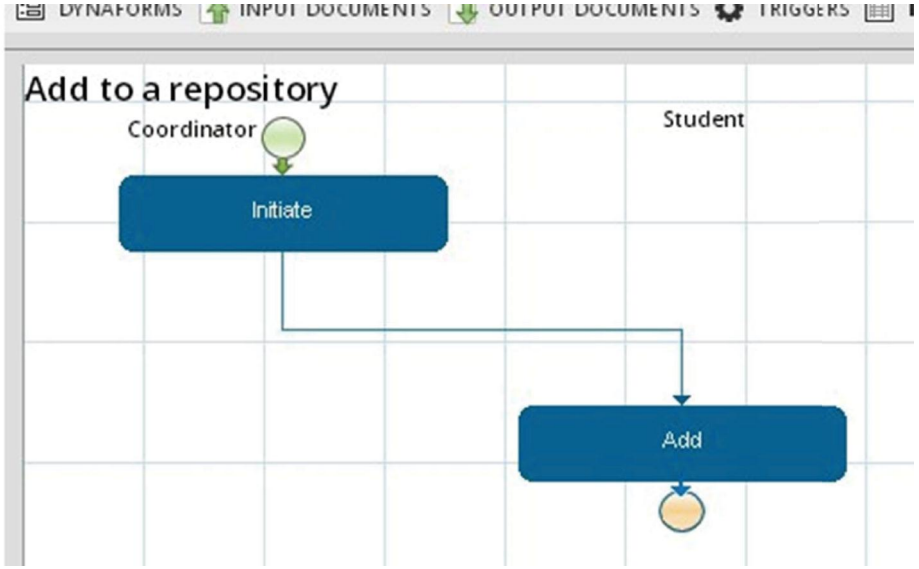

Topics Submission -sub-process
Coordinator
Staff
Initiate topics submission by staff
Submit Topics (minimum of 2)
Acknowledge the Topic submissions


Proposal writing(Undergrad)
Coordinator
Student
Supervison
Examiners
System
Initiate proposal wiriting
Upload detailed Proposal
Approve Submission
Examine proposal and mark online
Accept and send to examiners
Receive report and Collate marks
Notification to students

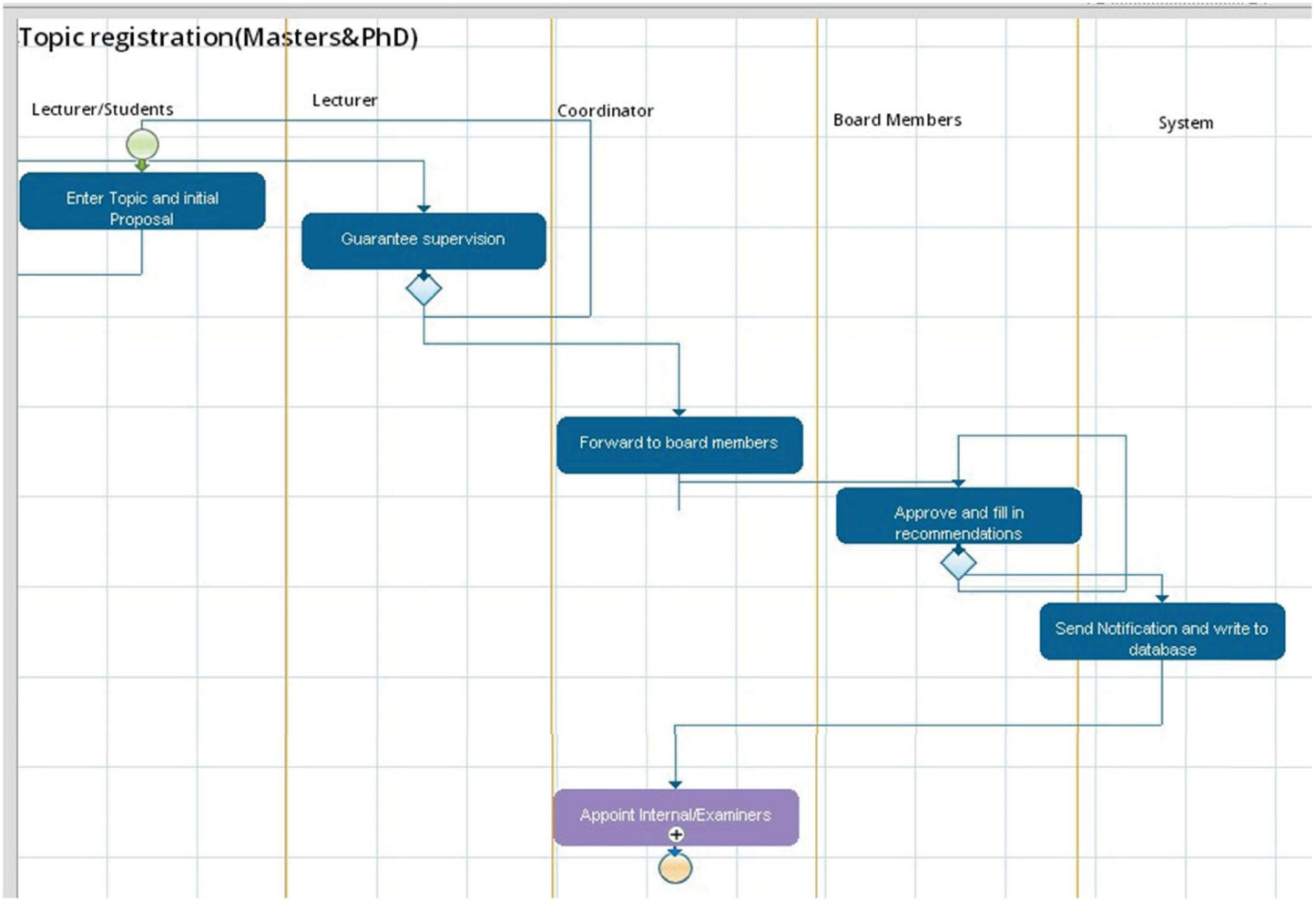

Project Writing(undergraduate)
Coordinator
Student
Supervisor
Co-SuPervisor
System
Initiate detailed Project witing
Upload detailed Proposal to teacher
Approves Submission
examine proposal and report back
Activate project writing tools
Meeting Reports
Initiate Beta demo to Supervisor
Inspect the Beta version

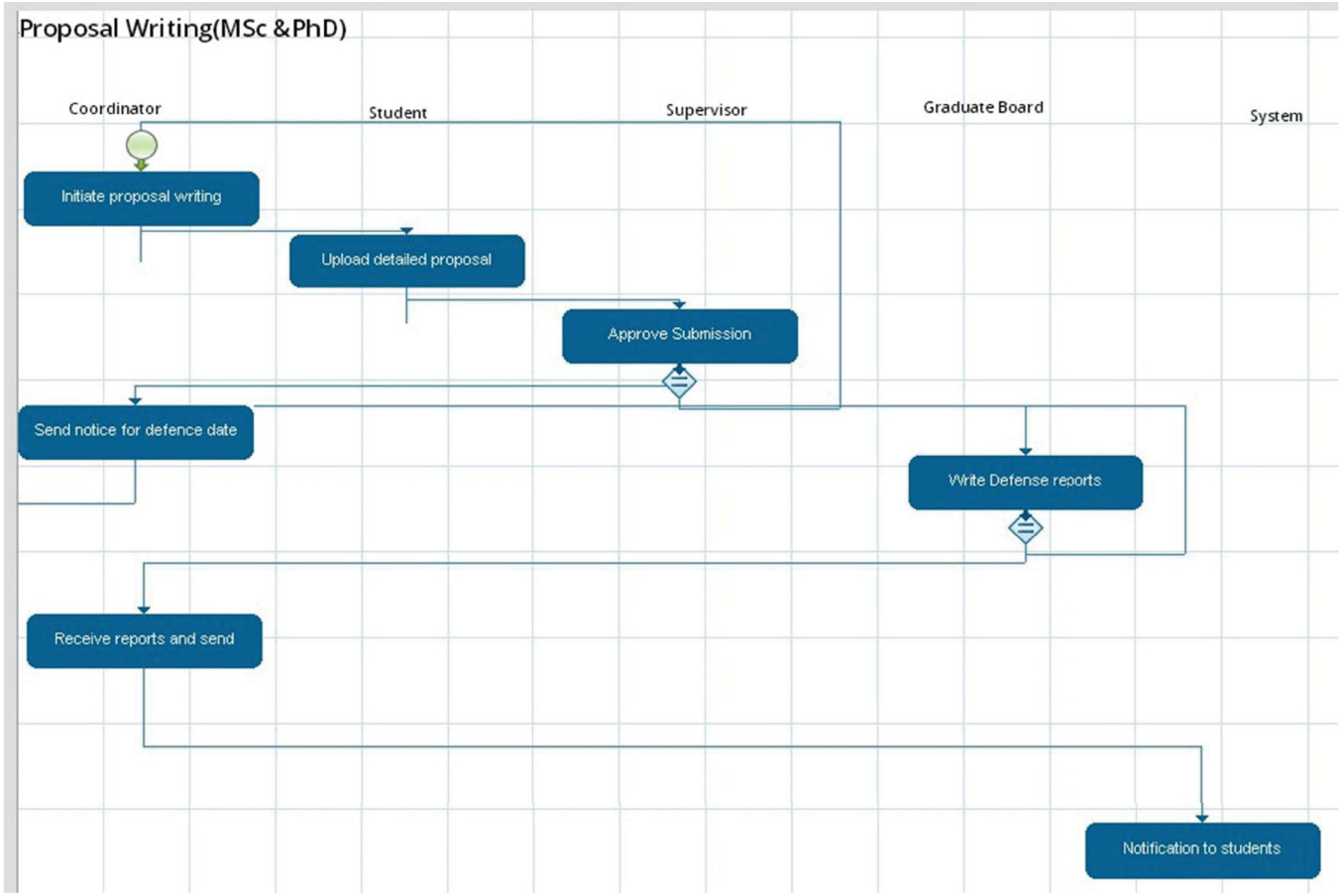

Meeting reports(sub)
Student
Supervisor
System
Schedule a meeting
Accept or reschedule meeting
Send meeting reminders
Fills the report after meeting
Accepts the meeting report

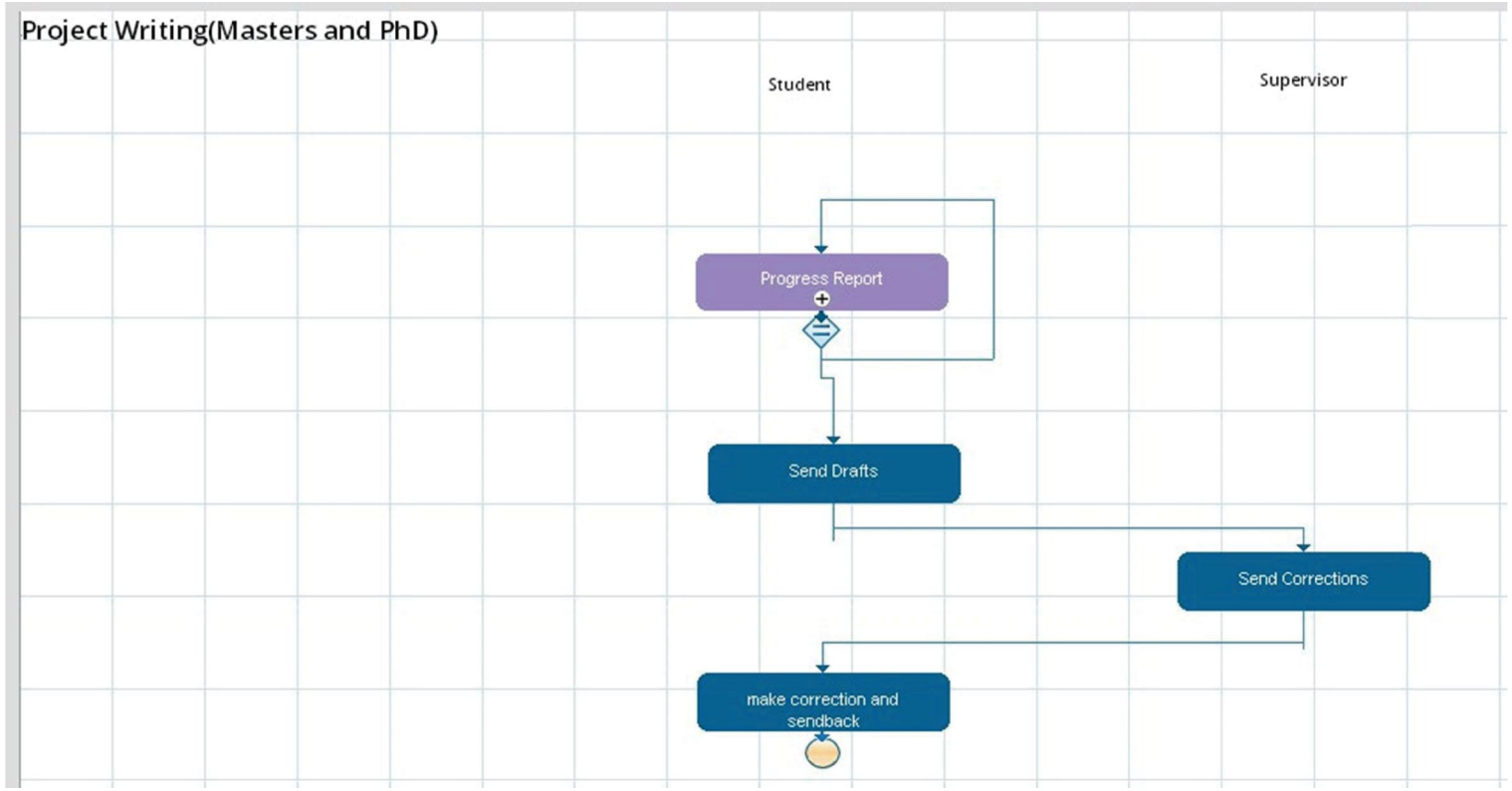

Project Examination(Undergraduate)
Coordinator
Student
Supervisor
Clusters
Examiners
Initiate final Submission
Submission uploading and hard copies
Approve submission
Acknowledges and Tick for hard copies
Initiate Presentation
Indicate participation in Presentation
Records Presentation marks
Activate marking by examiners
Examine and fill repor
Receives reports then computes final marks
Submit to repository

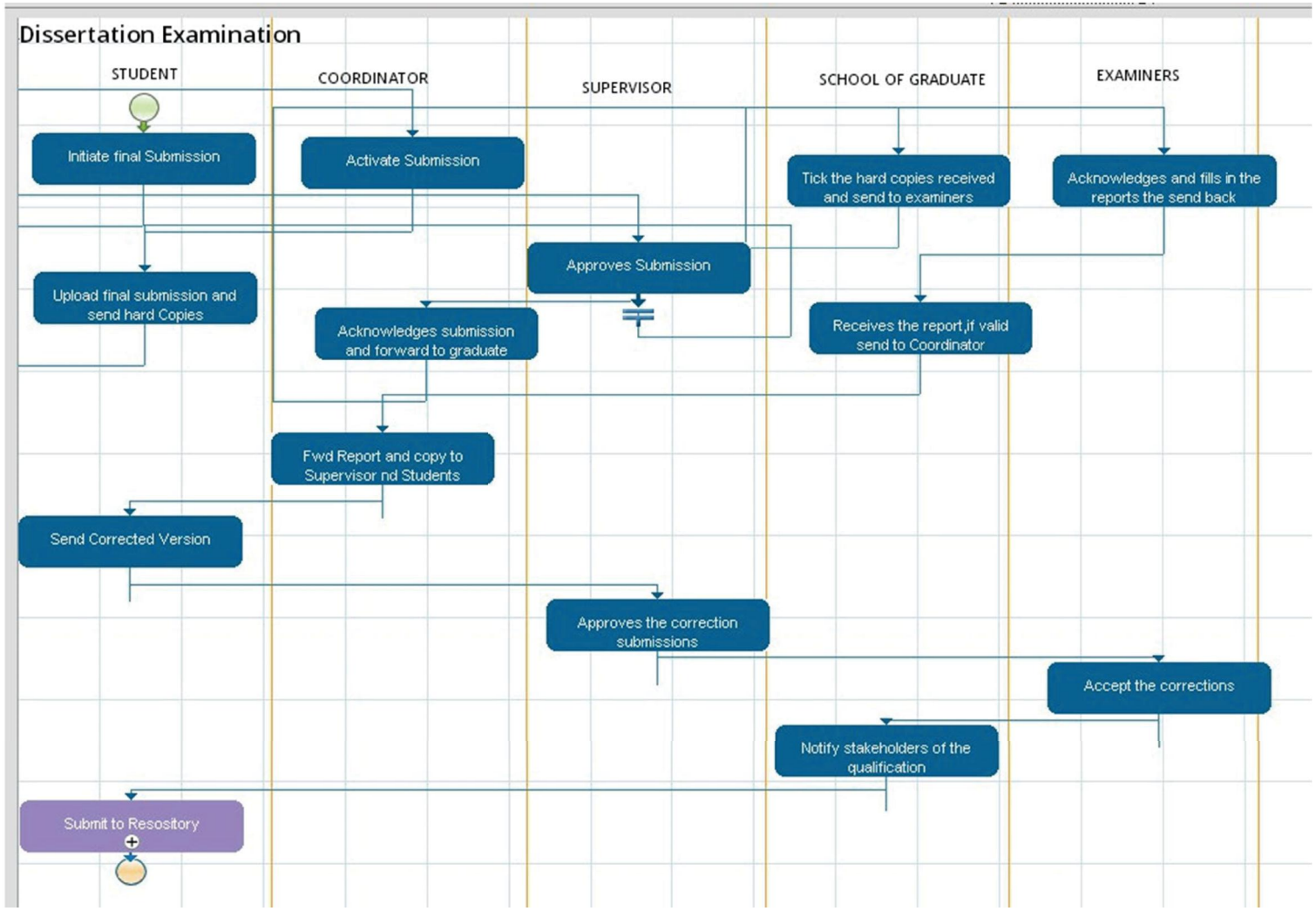

DYNAFORMS
INPUT DOCUMENTS
OUTPUT DOCUMENTS
TRIGGERS
Add to a repository
Coordinator
Student
Initiate
Add

Masters and PhD

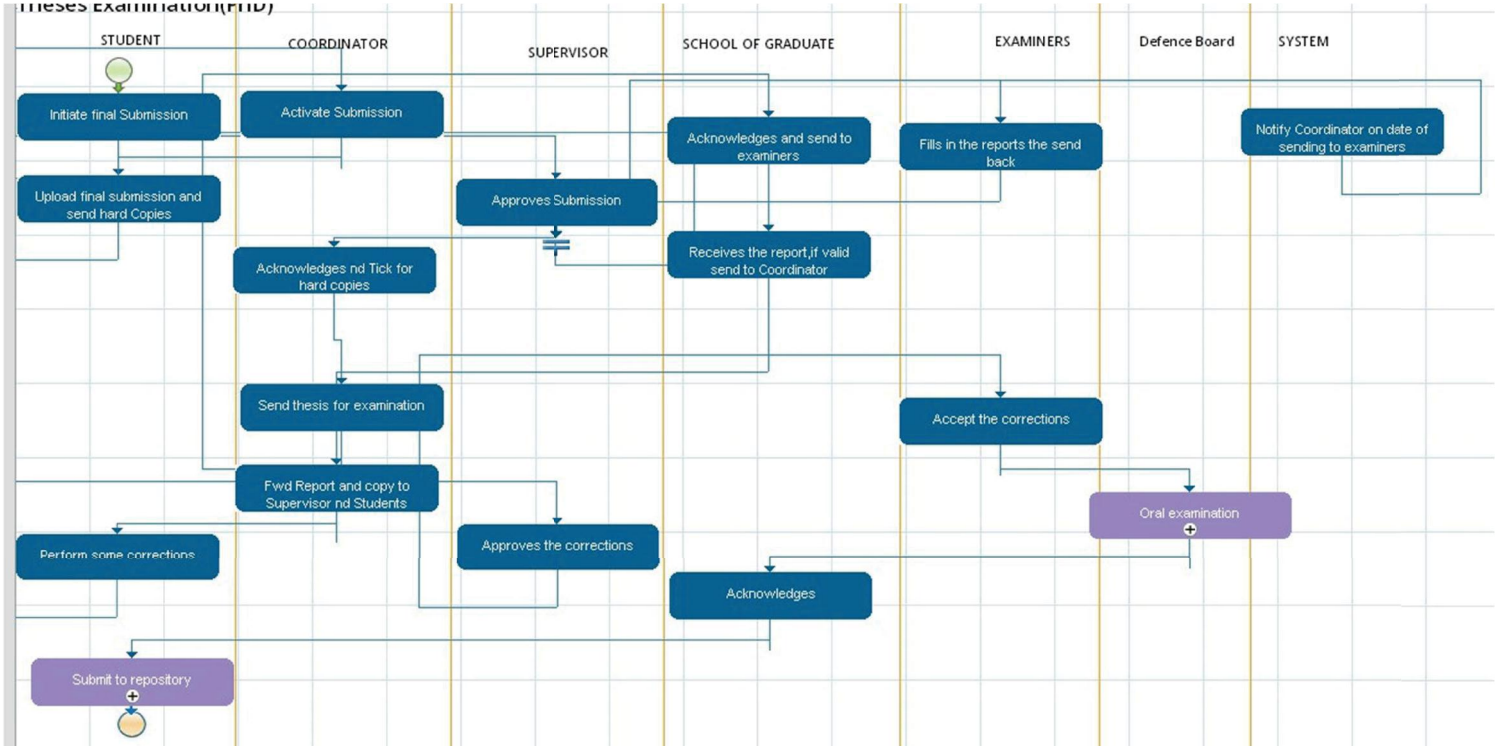


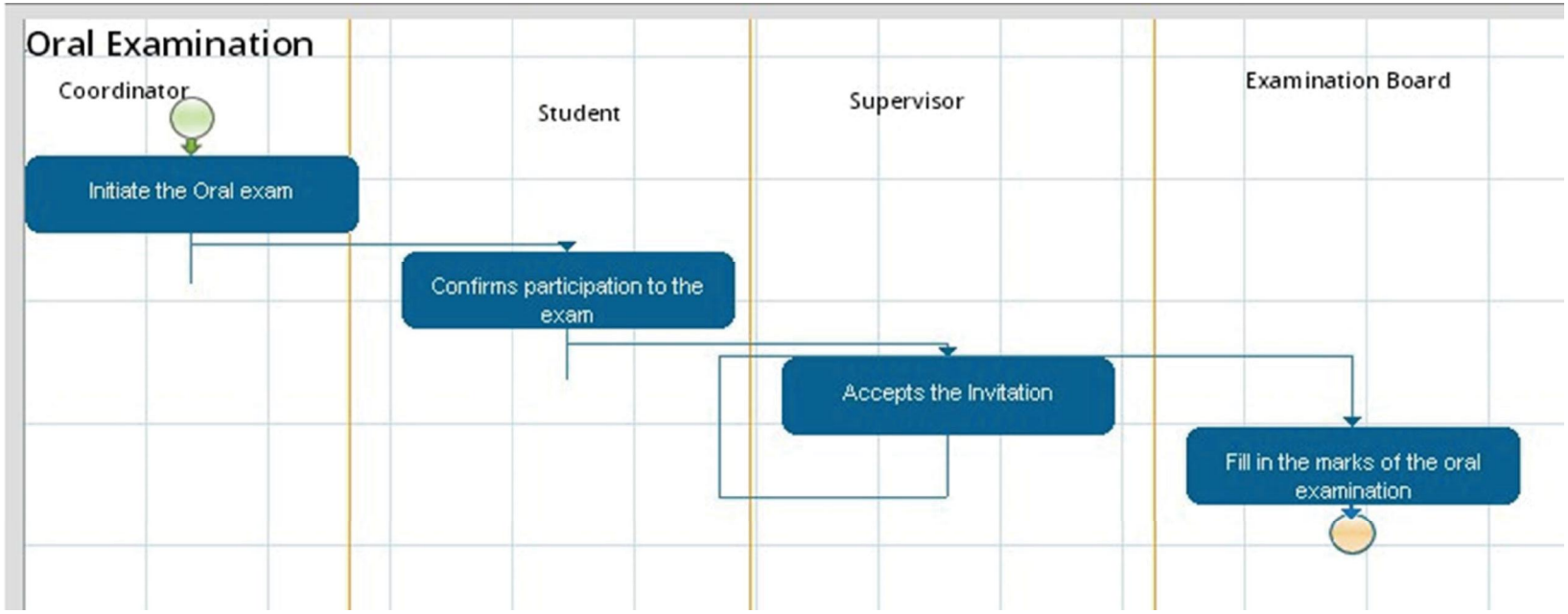

Proposal Writing(MSc &PhD)
Coordinator
Student
Supervisor
Graduate Board
System
Initiate proposal writing
Upload detailed proposal
Approve Submission
Send notice for defence date
Write Defense reports
Receive reports and send
Notification to students


Project Writing(Masters and PhD)
Student
Supervisor
Progress Report
Send Drafts
Send Corrections
make correction and sendback


Dissertation Examination
STUDENT
COORDINATOR
SUPERVISOR
SCHOOL OF GRADUATE
EXAMINERS
Initiate final Submission
Activate Submission
Tick the hard copies received and send to examiners
Acknowledges and fills in the reports the send back
Approves Submission
Upload final submission and send hard Copies
Acknowledges submission and forward to graduate
Receives the report,if valid send to Coordinator
Fwd Report and copy to Supervisor nd Students
Send Corrected Version
Approves the correction submissions
Accept the corrections
Notify stakeholders of the qualification
Submit to Resository

Thesis Examination




Oral Examination
Coordinator
Student
Supervisor
Examination Board
Initiate the Oral exam
Confirms participation to the exam
Accepts the Invitation
Fill in the marks of the oral examination