A SECURE COLLABORATIVE MANUSCRIPT MANAGEMENT SYSTEM FOR NATIONAL EXAMINATIONS, A CASE STUDY OF THE KENYA NATIONAL EXAMINATIONS COUNCIL

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DECLARATION

This project as presented in this report is my original work and has not been presented for any other University Award.

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The project report has been submitted as partial fulfilment of requirements for the Masters of Science in Computer Science of the University of Nairobi with my approval as University supervisor.

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The Kenya National Examinations Council (KNEC) did declare the use of ICT in all its operations as one of its main objectives for its development. In this line, KNEC has in the recent past embraced ICT even while interacting with its clients and stakeholders. One major such innovation was the introduction of online registration of candidates for national examinations in particular, Kenya Certificate of Secondary Education (KCSE) and Kenya Certificate of Primary Education (KCPE) starting 2011.

The secure collaborative manuscript management system project is intended to take advantage of the advancements in ICT and recent KNEC innovations to re-engineer the management of examinations manuscripts process, which is currently costly, time consuming and insecure. This was done by investigating the gaps of the current – heavily manual oriented process used at KNEC, and then designing a secure and collaborative manuscript management system (SCMMS), to replace the current. The main purpose of the SCMMS is to manage the national examination process, from setting of the manuscript from learning institutions, electronic sending to KNEC, verification, moderation, storage in a paper bank and random selection for an examination. The SCMMS when tested promoted a more paperless system that significantly reduces delays in all aspects of the examinations cycle, while promoting collaboration among various actors in examination management, and in a secure environment. Though the initial cost of coming up with the system might be high due to the purchase of hardware-server, software and training or sensitisation of personnel, in long run it would be cheaper and more efficient.
DEDICATION

I dedicate this work to my family, my Wife and child for their perseverance. This work took a lot of time that would have been spent with them. They all understood and wished me well without reservation.

To my employer, the Kenya National Examinations Council, who allowed me to carry out this project using its resources, it would have been very expensive if i were to look for the resources all by myself.

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To my very close friends who had to live and do a number of things without my input due to my commitments to this project work-I do dedicate this work to them, may God bless them all.
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ABBREVIATIONS AND ACRONYMNS

1. SCMMS: Secure Collaborative Manuscript Management System
2. ICT: Information and Communication Technology.
5. KCPE: Kenya Certificate of Primary Education
6. KCSE: Kenya Certificate of Secondary Education
7. REC: REVISTA ESPAÑOLA DE CARDIOLOGÍA
8. EMM: Electronic Manuscript Management
9. IMS: web-based Item Management System
10. SDLC: System Development Life Cycle
11. SRS: Software Requirement and Specification document
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CHAPTER ONE: INTRODUCTION

1.1 Background

The Kenya National Examination Council was established in 1980 under the KNEC Act Cap 225A of the laws of Kenya, with the purpose of managing national examinations; both school and post school examinations. National examinations involve registering candidates, setting, administering, processing and certification of examinations.

This project was about setting the examination, which involves managing the manuscript from invitation of setters and coming up with the possible examinations questions and answers, validation, moderation, subject panel approval and printing of the exam papers.

The current process is heavily manual, resulting to higher costs, long working hours and cases of insecurity among others. For example when KNEC cancels results of candidates due to irregularities, it is always blamed on its staff. Ali Mazrui (2010) stated that “there are loopholes in the way the Kenya National Examinations Council handles setting, printing, marking and distribution of the examination papers”. He continued to say that” there is a possibility that some of the people invited to set the examinations share the questions with candidates”. Such kinds of suspicions are normal, given the nature of the current manuscript management process, which has lots of human intervention.

In this thesis, i proposed to solve these problems by computerising the process and introducing an electronic and a secure collaborative manuscript management system.

1.2 Problem statement

The use of a manual process in managing of manuscripts for national examinations has resulted to a number of problems, which continues to increase every year, with the increase in candidature for these examinations. Insecurity poses one of the major challenges in KNEC, where examination papers are stolen during transportation and storage at examinations distribution centres. This distribution centres are not manned by KNEC officers, but Police officers, who at times collude with unscrupulous persons to steal the papers. This has resulted to examination irregularities, like cheating, hence unfair competition and a half-baked high school graduates, who once admitted to institutions of higher learning are not able to perform as expected, and hence the high dropout ratio.

Higher administrative costs in hiring of those who set the exams, payment of their travelling, accommodation and procurement of stationeries are also associated with the manual system. In most of the cases, getting the examiners or other professionals together to set a paper has proven to be a very
difficult task, given that they are not KNEC employees and so are not bound to KNEC code of conduct. So much time is wasted in finding them to set a paper, validate, typeset and \ or moderate.

1.3 Main Objective

The main objective of this project was to study the current manuscript management process at KNEC, and to develop a secure, collaborative and cost effective manuscript management system for managing national examinations.

1.4 Objectives

The specific objectives of this project were:

1. To analyse the current manuscript management process at KNEC.
2. To design and implement a collaborative manuscript Management System based on the current process at KNEC
3. To design and implement a secure Manuscript Management System based on the current process at KNEC
4. To develop and test a manuscript management system that will reduce on cost, time and errors associated with the current manuscript management process

1.5 Research Questions

1. Which are the steps in coming up with an examination paper
2. What factors must be put in consideration while developing a paper
3. Which items or activities have high overhead costs and
4. Which items or activities are seen to consume more time
5. Which are the Items or activities in the manuscript management process that are seen to pose examination security threats

1.6 Significance of the Project

Success in enhancing manuscript management process is assured if the SCMMS is successfully implemented and therefore provide an efficient and secure manuscripts management method to be used by any person setting national exams, any time and from any part of the country. The setters will become more enthusiastic and get opportunities to set examinations and at the comfort of their work places, home or anywhere, for that matter, provided they have access to internet.
The examination council will also save on cost, including typesetting cost and that of accommodating the contracted professional. The system, if fully developed and implemented will serve to assure confidence to the stakeholders and reduce examination irregularities that arise from the examination setters, through the paper banking (a module for storing completely developed papers securely, to await administration of examination) component of the proposed manuscript management system and by automatic selection of examination papers.

When the system is availed to KNEC and its stakeholders, it will cause all the work previously done manually go digital and improve the general efficiency in examination management, enhance security and in the long run, save a lot in terms of finances and time.

1.7 Limitations and scope of the project

This research project studied the current manuscript management process at KNEC and as a result developed a secure collaborative manuscript management system, but which was limited to only KCPE subjects.

It covered the manuscript, not only from the point of submission by the examination setter but from the training and recruitment of contracted professional up-to and until the manuscript is randomly selected as an examination paper.

1.8 Assumption

This research project assumed that the current manuscript management process at KNEC was similar in all other national examination bodies, and that the solution developed, could be used by any other examination body across the country.

It also assumed that since the solution was limited to KCPE manuscripts only, it can perfectly fit to be used in other examinations e.g. KCSE, teacher examinations etc

1.9 Project deliverable

The deliverables of this project was a design, functional system and test results of a secure collaborative manuscript management system with a recruitment and paper banking facility that cuts on cost and time associated with the manual process, while ensuring security of manuscripts at examination bodies.

A project report was also delivered describing the manual process, its shortcomings and how the new system was developed.
1.10 Definition of Terms

1. Manuscript: an examination paper in its original form, from a setter.
2. Setter: a person, in many cases a teacher, who has been contracted by KNEC to be part of a team to set an examination paper
3. Paper: a set of questions, following a KNEC prescribed format and weighting, that is ready to be sat by candidates
5. Moderator: a person, who has been contracted by KNEC to look and amend a manuscript based on the difficulty levels and coverage of the syllabus.
6. Proof reader: a person, who has been contracted by KNEC to check on the grammatical and spelling errors of a manuscript.
7. Subject Officer: a KNEC employee in charge of a given examination subject
8. School examinations: KCPE and KCSE examinations
9. Post School examinations: tertiary level examinations apart from University examinations

1.11 Summary

This chapter dealt with the core areas of the research that was carried out. The background, statement of the problem, purpose of the study and objectives were explained. Research questions, significance of the study, limitations and assumption plus the deliverable in this study were clearly outlined.
CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of existing work in the area of manuscript management processes. It involves examination of documents such as journals, magazines and books that have a bearing on this study. The review provided the researcher with insight into what has already been done pinpointing its strength and weaknesses.

It can be noted that studies and systems have been done in the area of Electronic Manuscript Management systems, but rarely in connection with National Examinations, hence the gap.

My study aimed at zeroing down to national examinations, and development of an Electronic manuscript system that can be used to enhance national examination process.

2.2 Manual Manuscript Management Process

It is important to note that majority of examinations bodies especially in Africa are still using the traditional system, which is heavily-manual oriented. For example at West Africa Examination Council-WAEC and Joint Admission and Matriculations Board- JAMB of Nigeria, the process of initiating a manuscript involves inviting seasoned experts in various subjects. The experts are given the teaching and examination syllabuses and requested to set questions, which are later compiled for subsequent scrutiny. A second set of experts are then invited to examine the questions set critically and allowed to make modifications to make them conform to the acceptable standard. The result of the said exercise is a set of polished and mostly unambiguous questions that are said to be fair to those that are to be examined. The questions are then securely stored. (http://lagosbooksclub.wordpress.com)

This process at WAEC and JAMB are replicated across many other national examination bodies. It can be noted that the process is heavily manual oriented and many persons interact with the manuscript, which can easily be a lieu way to cheating-irregularity cases, as some officers could disclose questions to potential candidates. This is a problem that can easily be sorted by the paper banking facility of the collaborative manuscript management system.

The same case applies in Kenya, where examination setters are invited to set the exam-on a hard copy, which is then moderated by a team of experts drawn for the teaching fraternity across the country. The
moderated manuscript is then typeset and checked for spelling and grammatical errors by proofreaders, which is then forwarded to the subject officer for approval to print.

The paper is finally securely stored, awaiting printing and administration of the examination.

2.3 Security

Security is defined as enforcing a policy that describes rules for accessing resources. It can be implicit or explicit but must not affect the functionality and reliability of the system. In securing a system, the users must ask themselves what they want to secure the system from and from whom (Karl Liebernerr, 1996, Adaptive Object-Oriented Software The Demeter Method).

The manuscript management system for high stake National examinations must be secured from a number of issues by use of multi-level security strategy: Unauthorised access to examination materials by candidates or any other malicious persons prior to sitting the examinations. These persons must be prevented from either accessing the yet to be sat (banked) examinations for the purpose of disclose the content to potential candidates or from damaging the examinations e.g. introducing a virus onto the system which might destroy the examination. To ensure only authorised persons access the system, all examination setters will be required to register and be approved by KNEC, before they are given a user name and password. They will therefore be allowed to use the allocated login credentials to access the system from anywhere.

As for the moderators, they will not only be given login credentials, but their workstations MAC address or IPs will also be registered by KNEC to restrict traffic. Only access by moderators form recognised machines will be allowed.

The KNEC officers, in particular subject teachers will only be allowed to access the system from their official work station (manuscripts room) and from specific PCs. No subject officer will access the system from home or anywhere else for that matter.

Denial of Service (DoS) where authorized persons are denied access to the system (Gaurav S. Kc, 2009, Privacy is essential for secure mobile devices.) The SCMMS must be secured from viruses, which can deny the various users of the system access. It must ensure that the system is available online to the examination setters, moderators and subject officers at any time.
During transit, the manuscript may be prone to eavesdropping and malformation. Malicious persons can tap the network to intercept the manuscript. Though such an intercept is worked around by the fact that the examination will be item banked and offered at unknown time, the best solution is the use of PKI for encryption and digital signatures for non-repudiation. The social aspects of security failure must also be considered in securing a system, this includes the 3Bs: Burglary, Bribery, and Brutality. The server hosting the system must be at a secure place, preferably at a data centre, with 2 dimension unlocking mechanisms. Use of Biometric is also encouraged.

In conclusion, Karl Lieberherr also stresses the importance of system monitoring, he suggest real-time auditing of high security systems to see who is logged in at a given time and what the person is accessing.

2.4 Collaborative systems

Collaborative software or groupware is an application software designed to help people involved in a common task achieve their goals.

The design intent of collaborative software is to transform the way documents and rich media are shared to enable more effective team collaboration. Collaboration requires individuals working together in a coordinated fashion, towards a common goal. Accomplishing the goal is the primary purpose for bringing the team together. Collaborative software helps facilitate action-oriented teams working together over geographic distances by providing tools that aid communication, collaboration and the process of problem solving.

In coming up with an examination question paper, the proposed SCMMS for national examinations must be able to utilize collaboration among examination setters, moderators and subject teachers.

Charles Sheppard, 1997, divides the collaborative framework into four levels of requirement, capability, service, and technology.

The requirement level of the collaborative framework describes the requirements of the group with respect to the tasks being performed by the group and the support necessitated by the characteristics of the group. The tasks described in the framework include work tasks as well as transition tasks. Requirements for supporting different types of groups include support for the social interactions of the
group as well as the requirements due to group size, location, computer platforms, etc. The requirement level is divided into four sections: work tasks, transition tasks, social protocol requirements, and group characteristics.

The capability level of the framework describes functionality that is needed to support the different requirements. The capabilities can be divided into subsections that correspond to the four subsections of the requirement level. The SCMMS will require users to have basic IT knowledge, specifically on browsing and use of MS. Office suite

The service level describes services such as e-mail, audio, video, application sharing, networking services, etc. that can be used to support the capabilities needed in CSCW systems.

In the proposed SCMMS, a use of a messaging tool will be incorporated in the system to allow communication among the various groups

The technology level describes specific implementations of services. This level could be considered as the set of all possible components needed to build a given CSCW system, including integration and user interface components.

In the SCMMS, use of Visual studio package in development has been encouraged.

2.5 Related work

This section discusses two similar systems, which have been done in the area of electronic management for manuscripts. It investigates the shortcoming of the system under discussion and how the proposed system will seek to solve them

2.5.1 Item Management System at BMC Medical Education, Germany

BMC Medical Education realised that the development, implementation and evaluation of assessments require considerable resources and often cannot be carried out by a single faculty/institution. Therefore some medical faculties did found a cooperation projects which mainly focus on the exchange of multiple choice questions.

In 2006 the Medical Assessment Alliance (MAA) was founded for mutual support and started to develop innovative assessment formats and facilitate content through a coordinated exchange of experiences. To support cooperation within this network, a web-based Item Management System (IMS)
was developed which supports all processes of the assessment workflow as an all-in-one working platform.

Each IMS user received their own protected user account and can access the IMS based on clearly defined roles and responsibilities with a personalized view. To support collaborative work, colleagues do set up working groups and design exams as a team or conduct quality control processes.

Six key components of this process are undertaken that involves: design of questions and answers; classification of questions according to subjects and sections; evaluation of questions prior to assessment (pre-review); Collating exam questions by drag and drop to form an examination paper; compiling an assessment-printing and lastly conducting the assessment.

In conclusion, the BMC Medical Education system is much similar to what is under my study only that it is only meant for multiple questions and it is questions based. The questions can be selected over and over, regardless of number of times.

The solution proposed in my project will, in addition to multiple choice questions will also take care of comprehensive form answers and will be paper-based. A system that will see a complete examination paper set and ensure that, once a paper is selected and examined, none of the questions contained can be repeated, within a specified number of years.

2.5.2 Electronic Manuscript Management in REVISTA ESPAÑOLA DE CARDIOLOGÍA-SPAIN.

Since its introduction in the 1990s, Revista Española de Cardiologia (REC) has tried to take maximum advantage of information technology (IT) tools in order to improve the quality and dissemination of their journal.

In the year 2007, REC did put into action its on-line electronic manuscript management system (EMM), where almost all manuscripts submitted for publication are sent using the EMM system available at www.revespcardiol.org. Introducing EMM meant one of the greatest transformations in the internal work processes of REC since its publication began more than 50 years ago.
REC noted that authors from other parts of the world also saw submitting their work to REC as having been simplified, given that sending work by post or courier from their respective countries was dissuasive.

REC noted that by introducing EMM a near to 20% increase in the number of manuscripts received in the first year was realized and the article quality did not diminish.

REC also noted that they were able to optimize productivity and internal efficiency in the peer-review process and thus shorten the time lapse between authors' finishing their manuscripts and receiving the final editorial decision. In a highly competitive field, this time lapse can prove definitive when it comes to choosing one publication or another.

Other fundamental achievements of their project included eliminating the risk of losing articles, cutting out postage costs and reducing the "mechanical" tasks that fall to the journal office.

Freeing up these resources through technological innovation benefited other highly expensive aspects of the editorial process at REC helping it to increase international distribution or offset costs.

For reviewers, REC also noted that the use of EMM also improved working practices by, among other features, providing immediate reception of documents, limiting full access to articles until agreement to submit a review has been received, incorporating search engines and disassociating manuscript review from physical presence at a specific geographical location.

In conclusion, the processes at REC are similar to what is proposed for national examinations only that it meant for submitting journals. REC experiences a few challenges which include situations where authors do not respect the structure of each manuscript type as provided and manuscripts exceeding the word limits. The proposed manuscript management system for national examinations provides a template that guides the examination setter and limit the length or number of words in a question.

The chances of realizing the same advantages realized at REC (as listed above) with its EMM, are higher with the proposed SCMMMS.
2.6 **Summary**

This chapter looked at the current manuscript management process at KNEC and other related bodies in Nigeria and Ghana and established how costly, time consuming and labour intensive they are. It studied the existing literature on similar manuscript management systems; the Item Management System at the BMC Medical Education in Germany and an Electronic Manuscript Management at REC in Spain, and establish the gains realised in coming up with their manuscripts.

2.7 **Conclusion**

The Item Management System at the BMC Medical Education in Germany focuses on objective questions and random selection of questions which can be repeated while the Electronic Manuscript Management at REC in Spain focussed on journals which are not structured by the system. The SCMMS has focused on examination paper, unique for every sitting, and whose development is guided automatically by the system.
CHAPTER THREE: METHODOLOGY

This chapter describes the steps that were undertaken in developing the SCMMS. It details how data was collected and from which participants, the system design and implementation process

3.1 Data collection methods and Sources

The following techniques were used to collect data on the current manuscript management process at KNEC, from the KCPE subject officers.

1. Interview

During data collection, analysis, design and implementation, one Subject Officer, volunteered to work with me hand in hand in carrying out this project. The subject officer in charge of mathematics paper in KCPE at the examination council, did provide very valuable information and guidance on manuscripts management and was very instrumental in pre-testing of the data collection tool, in particular questionnaires.

From the interview, the researcher was able to find out how the current process works, the steps involved in coming up with a paper, hence answering the first research question that asks for the main steps or activities in coming up with a paper. He was also able to obtain from the interviewees the features they would have wished to be included on the new system. Having two subject officers out of the eight to interview was good enough given that the system is the same for all subjects within the council, and again getting the staffs of the council is not easy, given their very busy schedule.

2. Written documents

Some written materials were used to gain more insight on the manuscript process, this included; past examination question papers, which gave insights on general structure of a paper, the format and layout of the front page; table of specifications for mathematics, English and Kiswahili that explained the taxonomy levels and how to categorise and allocate questions and marks; and lastly the Kenya National Examination Council Manuscript Management hand book, which elaborated on the procedure and timeliness to follow in coming up with a manuscript.

From the documents, the researcher was able find out the various factors considered in coming up with examination papers, i.e. the format of a paper, weighting and taxonomy levels to consider.
3. Questionnaires

The questionnaire was structured to fish data from the various Subject officers, on a wide area of issues, including; description of the current process, cost, time spent, the work force involved, security risks, level of ICT knowhow and the future envisaged by users.

The questionnaires were administered to all- eight KCPE subject officers, with six of them responding, representing 75% and had a one on one interview with two of the subject officers, and who were available at the time. Of the two interviewees, one was a mathematics subject officer while the other Kiswahili. This shows that the researcher was able to get information from the two general fields of Sciences and Arts subjects, as represented by the two subject officers. The six subject officers who responded to the questionnaire are for English, Kiswahili, Mathematics, Social Studies, Christian Religious Education and Islamic Religious Education while those who didn’t respond are for Science and Hindu religious Education. This shows that the response was a good representation of the subjects as the ones who didn’t response are still represented i.e. Hindu religious Education is correlated to other two religious educations subjects while Science is correlated to Mathematics hence well represented. The researcher worked very closely with one subject officer, who was able to guide and critique the system as design and development went on.

From the questionnaire, the researcher was able to find out the cost and time spent in carrying out the activities associated with the current manuscript process, the security risks involved and features to be included on the new system.

3.2 Rapid Development methodology

James Martin, in his book first coining the term, wrote, “Rapid Application Development (RAD) is a development Lifecycle designed to give much faster development and higher-quality results than those achieved with the traditional lifecycle. It is designed to take the maximum advantage of powerful development software that has evolved recently.

The Secure Collaborative Manuscript Management System was developed using Rapid Application Methodology (RAD). RAD is a form of System Development Life Cycle (SDLC) that compresses the conventional step by step method such as waterfall model into an iterative
process. The method thus includes developing and refining the process models, data models and prototype models in parallel using iterative method.

User requirements were collected through interviews and administered questionnaire to KCPE subject officers at KNEC. The solution was then designed based on the responses, which were then prototyped and subjected to users’ views. The prototype was then reviewed based on user’s reactions, and again presented back to users. The process repeated itself until a high-level prototype was obtained, which was transformed to a final system, tested and evaluated.

**Justification:** RAD allowed for active participation of the users throughout the process to ensure that their expectations and requirements were well understood. This avoided the danger of the system failing the User Acceptance Testing (UAT) and rejecting the system at the end and after a lot of work had been accomplished.

RAD used less time compared to the conventional software development methods of SDLC such as the waterfall approach. The various SCMMS users had an early visualisation of the end-product and hence performed rapid unit testing and gave rectifying suggestion in time. They were also able to give suggestions on the appearance of the system to ensure a more user-friendly interface.

The current ever changing technological world and competitive business scenario demands frequent software updates to ensure the customer remains on the business edge. RAD enabled a faster system review method, by eliminating the redundant steps or using prototyping methods.

RAD made development process be more credible, by facilitating customers to provide input in the development process. It utilised the use of evolutionary prototypes that were eventually transformed to a final product.

### 3.3 Design

In designing, the blueprint of the system was development based on the users’ responses and researcher’s knowledge. In this stage, a number of activities were performed to come up with a detailed design model of the system. This included the database (back-end), interface (front-end) and reports structure.
This stage also came up with the architecture of the system, and decision on platforms to be used in developing the system, based on the researcher knowledge and available software. For backend and reporting, Ms SQL Server 2008 was used and Visual Studio 2008 for front-end. These platforms are licensed to the Examination council, and given that the system will benefit it if implemented, they allowed me to use.

Finally a low level prototype was presented to a user—a subject officer for comments, due to his availability and experience at the time when the researcher needed someone to critique it.

3.4 System Architecture

The SCMMS has 4 layers:

- Interface layer, which is the graphical User Interfacing the user, and what he interacts with
- Input processing layer – Used stored procedures for fast processing
- Database layer which is where the data is stored
- File layer: a directory where the manuscripts are stored during development and as a final paper
Figure 3.1 Logical representation of SCMMS flow
The above logical representation of the SCMMS depicts

- The Systems Administrator adds users into the System. The users added could either be Trainers; Subject Officers or Printers and are assigned access rights to the system accordingly.
- The Trainer is given the rights to sign into the system and add details of Trained teachers
- The trained teachers can apply for vacancies, which could either be setter, proof reader or moderator
- The subject Officer logs onto the system and contract qualified teachers
- The setter logs onto the system to download taxonomy template and set the paper
- The moderator logs onto the system and accesses the paper set and moderates
- The proof reader checks the paper for spelling and grammatical errors and sends it to the printer for printing.

Tables’ fields and structure

Fig. 3.2 Static tables

The above figure shows four static tables; Subjects, Experience, Qualification and Districts that are used as Meta data tables to elaborate more on the fields used on the transaction table Contracted_professionals, while the below figure shows tables that are frequently affected while working with the system
3.5 Development

This stage largely involved the coding of the system; the database, user interface and expected reports. It saw the construction of the application, development of user aids and implementation work plan. The researcher came up with evolutionary prototypes, and took each to be evaluated by the users to determine usability before proceeding to the next stage. The feedback obtained from every evaluation done by users was analysed, incorporated in the design and coded in the system. This was a continuous cycle until the final product was obtained.

3.6 Testing

This is the process of verification and validation of the SCMMS. It is used for getting back the feedback from users, uncover errors and evaluate usability needs. The following aspects of testing were done.

This involved testing of the complete SCMMS based on the objective of developing the software, which is to replace the manual manuscript management process at KNEC with an electronic system.

The system was subjected into 3 types of testing:
3.6.1 Unit testing:
The SCMMS was split into 9 modules, based on its functionality, this units are; training, application, short listing, setting, moderation, combination, proof reading, banking and paper selection unit.

The units were subjected to separate testing by the researcher and successfully ensured that each unit functions as desired.

3.6.2 Volume testing
The whole system was subjected to testing, where the developer ensured that every unit feeds onto another, and the initial raw manuscript undergoes all the necessary steps to become an examinable paper.

3.6.3 Usability testing
These involved system users, where the various categories of contracted professionals were requested to fill in an online form to give feedback after using the system.

All the eight subject officers were invited to test the system and also requested to ask some teachers to log online, test and then fill the online questionnaire see appendix C for a period of one week. A total of ten users responded by testing and filling the online questionnaire. Of the ten respondents, five were examination setters, who form the bulk of the contracted professionals, two were subject officers, who are largely the process owners, two were moderators, with one being a KIE moderator (you’ll note that only two moderators are required per subject), and one proof reader (in a number of cases, a subject officer also doubles up as a proof reader).

The setters who responded came from across the country, one from Nairobi, two from Nakuru, one from Kisumu and another from Nyeri districts.

All the ten the respondents indicated that it took then less than a month to come up with the manuscript, with majority, nine out of ten saying they accessed the system form either work or own computer. All the ten concurred that they spent less than Ksh.100, to download the manuscript template, develop it and submit it back online. They also indicated that the system was user friendly see appendix D.
3.7 Summary

This chapter explained in detail and with justification how the project was carried out, the source of data and how it was collected. It also explained how the design and development was carried out, and finally the testing and evaluation.
CHAPTER FOUR: FINDINGS

4.1 Introduction

This chapter describes findings of the research in respect to the current manuscript management process at KNEC and the new system developed. It describes how the manual process is done, and its limitations.

4.2 The current Manuscript Management Process

The current manuscript management process is highly manual, costly, insecure and time consuming. The process starts with identification of contracted professionals: the setters, moderators and proof readers by the subject officers. These moderators are identified based on past work record in KNEC and if known to the subject officer. In some situation, a perennial contracted professional or a school head is asked to recommend a teacher, who or she feels is capable of doing the job. This means that the same persons who have been setting or contracted by KNEC are the same year in year out and whenever asked to recommend a person, in most cases, they bring their friends, relatives or colleagues in school at the expense of quality. This has contributed to poor quality exam papers and unfair competition where teachers with a common base have knowledge of the exam, which they easily pass on to their students. This exposes the paper to examination irregularities and hence insecure from exposure.

After the subject officer identifies the professionals, he\she recruits them by posting them letters, which is expensive compared to e-mailing, and has a higher danger of not reaching the intended person, due to loss, hence not secure or possible withheld by seniors of the person.

On receiving the invitation letter, the recipient is required to come up with some possible questions and travel to Nairobi on a set date, and remain for some days, to either refine or set the manuscript, moderate or proof read, which is time consuming. The council has to meet all the expenses for the contracted professionals (in many cases they are about five) including transport, accommodation and allowances / per diems. This is expensive to the council. On the part of the contracted professional, he\she has to prepare alternative person to stand in for him\her at work, or else do make up classes to catch up with the syllabus or compensate lost time.

Once a manuscript is set, another team of moderators is invited to join the setters and moderate the paper. Again the council has to take care of their expenses.
The contracted professionals are then released after moderation and the paper is taken for typesetting. Here, a number of typographic errors are introduced, and so the paper has to be proof read, once type setting is complete.

At the end of proof reading, and satisfied that the paper is ok, it is sent to the printer for production of examination papers.

4.3 Discussion on responses

A number of questions were asked by the researcher (appendix B) to understand the source of inefficiencies in the current system. All the eight KCPE subject officers were given questionnaires to respond to, but only six returned after filling.

The questions asked are discussed below:

The first was how the subject officers recruit the contracted professionals. All the 6 respondents said they recruit the professional through head hunting.

This meant the recruitment process is not competitive as it is limited to headhunting by the subject officer, who could compromise the recruitment process by giving chances to friends and relatives. The process therefore locks out other interested parties, who could have higher potentials in terms of teaching experience and academic qualifications.

The new system provides for electronic advertisement of openings and an electronic platform that is open to all interested and qualified persons to apply. This ensures a fair chance to all and a competitive process, which will see better deserving persons recruited, leading to high quality examination papers and reduced irregularity. Reduced irregularity is ensured by the fact that the setters will not come from people of the same background or region, hence no setter will be exposed to the whole paper.

Secondly the researcher asked how long it takes to come up with a manuscript. All the 6 respondents said it takes more than 5 months. Half of the respondents noted that in many cases, they are forced to play the roles of either setter or moderator to ensure a paper is ready in good time for printing, since some contracted professionals rarely turn up on time.
This increases pressure and workload on the subject officer, who in some cases can produce items that are below standard as noted on the questionnaire by the subject officers under the last question on challenges faced in coming up with a manuscript.

The new system enables an examination paper be completed within a month, given that setting and moderation can be done from anywhere and anytime where there is internet connection. The division of work in various taxonomy levels also eases workload on an individual, hence reduction of time spent in developing a manuscript from more than five months to less than a month as evident on the testing results.

With the introduction of a paper bank, it means papers will be set and banked, and only to be produced at instant when required.

The respondents were asked how they contact the contracted professionals and all the six respondents concurred that they contact them through post and do a follow up with telephone call.

This method of posting letters in many cases results to delays or loss of the invitation or recruitment letters. The process of drafting the letters and posting is not only time consuming but less cost effective and labour intensive.

The SCMMS takes advantage of the internet to send automatic e-mail to successful applicants upon short listing and recruitment.

When asked how the manuscripts are delivered to KNEC, the respondents said it is done through hand delivery. Contractors travel by road, some for many kilometres to deliver the manuscript, which is prone to loss.

The new system has created a portal where setters will upload the manuscript directly to KNEC online upon completion of setting. The contracted professional will be given passwords to use the system and only access what they need and at the time they need. This also ensures the manuscript is received on time and with less cost incurred as compared to transporting it by road.

Asked how much they spend on the contracted professionals, the respondents said the examination council spends about Ksh. 20,000 per setter; only a maximum of Ksh. 5000 is paid to the contacted professional, while the remaining Ksh. 15,000 is used for accommodation, transport and meals. The council hires about 5 setters per paper, which means it spends about
Ksh. 100,000 per paper, with only ksh.25,000, directly going to the setters, this is expensive to the council.

The SCMMS cuts on accommodation travel, costs of meals, and save the council about Ksh. 75,000 per manuscript. This is because the setters will not need to travel to Nairobi with the manuscript, which is also prone to loss, as it will be uploaded online. The cost of uploading online is very small hence negligible.

The same will apply to moderators, who will also not be required also to travel to Nairobi, for moderation exercises.

The examination council has employed typesetters to type the manuscript, once moderated. These type setters are paid on a monthly basis, hence more cost for the council. There is also a-to-and-from process of typesetting and proofreading, which is time consuming. At times, the typesetter is unable to read the setters\'proofreaders handwriting. They also pose an additional risk of disclosing manuscript content to potential candidates, hence security risk.

With the new system, the setter will typeset his/her own work on a provided template. The moderators will also edit the work on the same template hence no need of typesetting. This will save on cost, time and reduce threat to security of questions papers, as the number of persons handling the final paper will be reduced only the subject officer, proof reader and printer.

The researcher also asked the respondent to rate their ability to use the internet. All the 6 respondents indicated that their ability is average, while five of the six indicated that the contracted professionals’ ability to use internet is also on average. This gives the researcher some confidence that the system will easily be accepted and also as depicted by the test results.

The graph below shows the response of the SCMMS users on IT literacy.
From the graph, we deduce that since majority of respondents have average knowledge on IT, and based on the test results, see appendix D, then it would be easy for them to adopt the system.

The respondents were also required to outline the challenges they encounter with the current manual manuscript process as, which they gave as:

Limitation of time in coming up with an examination paper: The proposed system has a paper banking facility (where a number of ready to be administered examination papers are stored), which will ensure that examination papers are set and stored for future use. Whenever a paper is required for an examination, it will only be selected from the bank.

Poor quality examination papers: The SCMMS provides for a setter to only concentrate on one taxonomy area of a given paper, which ensures good quality as some form of speciality is built to a setter. One setter does not set a whole paper so he\ she gives the best within his\ her allocated taxonomy.
Late submission of manuscript: With the SCMMS, a setter is only given one taxonomy area of a given paper to concentrate on, this will reduce work load and therefore will be expected to submit in good time. The mode of submission is online, and which assures instant delivery as opposed to travelling all the way to Nairobi to hand deliver.

Lack of quorum during moderation: With online moderation provided by the new system, moderators, who are employees of other organizations other than KNEC, are not required to meet at KNEC offices in Nairobi. They are able to moderate the manuscript electronically at own time and place of convenience, hence the requirement to meet in a central place in most cases Nairobi and a given time does not apply.

Not detecting errors, this includes typographic and psychometric errors: The SCMMS ensures the manuscript passes through all the required persons-setter, moderators, proofreaders and subject officer, who checks all the possible errors and corrects them, before moving to the next person. The system also takes advantage of the word processors spell checker capability to detect and/or auto-correct errors.

Lack of adherence to instruction on format: The proposed system provides a template for setters to use in coming up with the manuscript, and which will automatically guide to ensure that the format required is adhered to. This is in contrast to the current method where instructions to setting are given and most setters don’t adhere to them, or even take time to read them.

Finally, the respondents also indicated some features, which they would have liked to see them included on the proposed solution:

Ability to recruit\assist in recruitment of contracted professionals: This module has been added onto the system, where only trained teachers will be allowed to apply for available spaces. The system then ranks them based on the level of working experience and
academic qualification. This makes it easier for the Subject officer, who shortlists, to quickly pick the best applicants.

Inclusion of paper banking facility: This is one of the core purposes of this system, to ensure that papers are generated and banked for future use, and that papers are not generated on a hurry.

Ability to keep Bio data of contracted professionals: The SCMMS has a table for keeping details of all applicants and their history

Ability to keep history of manuscript, i.e. when and who submitted, who received and whether it was sat for in and exam:

The new system has a table that is capable of tracking of all activities surrounding a particular manuscript.

4.4 SYSTEM ANALYSIS
This is the process of studying a procedure or business in order to identify its goals and purposes, and then create systems and that will achieve them in a more efficient manner.

4.4.1 Feasibility Analysis
Below is an evaluation and analysis of the implementation potential of the SCMMS project based on the economic, operational and technological factors.

1. Economic
The cost of collecting requirements, conducting feasibility study was cheaper given that the target respondents were KNEC staff, who are colleagues of the researcher and stationed within Nairobi, where the researcher too was stationed. The travelling cost was therefore reduced to near zero.

When it came to testing, the same KNEC staff, who had interest in the project were able to access the system from their offices and test it, hence no cost incurred
The contracted professionals too were able to do the system testing online and fill in the online questionnaire.

Acquisition of development tools, i.e. computer and software was also easy as the company; KNEC had readily provided them to the researcher, given that it had interest in the project too.

2. **Operational**

The current process is manual, no system in place, which results to higher cost and much time consumption. The KNEC management was eager to use the system to cut on cost and time. Users on the other hand are eager to have a system that will reduce their workload and time spent on this activity, as evident on the test result see appendix D.

The SCMMS was intended to adequately solve the problems associated with the manuscript from the point of recruitment of relevant manuscript personnel to banking and printing of examination papers. This is the complete process in developing a manuscript

3. **Technological**

The system could be designed using a number of development tools, but since KNEC uses Visual Studio 2008 and SQL 2008, which they are licensed, the researcher decided to utilise the same, having been allowed by the council.

Other equipments used in this project included:

- A computer
- Host server for hosting the application
- Network / internet
- Business intelligence for reporting

4.4.2 **System Limitations**

The SCMMS has some limitations, majority due to the platforms it uses:
• The System can only be used in managing KCPE examination

• The downloadable exam template can only be used in Microsoft word

• The maximum file size when uploading is 20 MB, a document with many or large graphics is timed out

• No support for password-protected files

• Response timeout: 90 seconds, users with slow internet connectivity, can be timed out

4.4.3 System Modelling

The researcher has used the sequence diagram models to conceptualize the SCMMS

A. Sequence diagram – (Recruitment)

1. Trainer adds successful trained professionals (teachers) on the system

2. Trained teachers, who must be on the system, apply for availed vacancies

3. Subject officer contracts shortlisted applicants for setters, moderators and proofreaders position for his/her subject

4. Subject officer retires professionals within his/her subject, who are deemed to be incapacitated or indisciplined
The above diagram explains how recruitment of contracted professionals is done. All applicants must have undergone training organised by KNEC for them to be included on the KNEC data store. The trainees can then apply for any available position.

The subject officers for the applied position does the short listing, based on experience, academic qualification, discipline etc, before the applicant is given a contract.
The subject officer may also retire a contactor based on age or indiscipline cases.

B. Sequence diagram – (Manuscript –outside Knec)

1. Subject officer, upon contracting, sends taxonomy level and manuscript template to setter

2. The setter sets and typesets the manuscript using the template

3. The setter uploads the manuscript onto KNEC portal

4. Subject officer verifies and validates the manuscript, that it meets the minimum requirements in terms of number and repetition of questions

5. The subject officer forwards the contracted manuscript to the moderator for that subject

6. The moderator checks the manuscript for grammar and difficulty level

7. The moderator passes the manuscript to the KIE(Kenya Institute of Education) moderator

8. The KIE moderator checks if content is within the syllabus

9. The manuscript, which is as per the taxonomy level, is passed to the subject officer for combination to form an examination paper
Figure 4:3 Process Flow- manuscript outside KNEC diagram

START

SEND TAXONOMY LEVEL AND TEMPLATE TO SETTER

SETTING OF MANUSCRIPT

UPLOAD MANUSCRIPT

VERIFICATION AND VALIDATION BY SUBJECT

DOES IT MEET MINIMUM REQUIREMENTS?

YES

MODERATION BY CONTRACTED MODERATOR

DOES IT MEET MINIMUM REQUIREMENTS?

NO

YES

MODERATION BY CONTRACTED KIE OFFICER

DOES IT MEET MINIMUM REQUIREMENTS?

NO

YES
From figure 4.3 above, once an applicant is contracted as a setter, a taxonomy level for him/her to work on is automatically e-mailed, with a template format. He or she then sets the manuscript and uploads it back to KNEC data store for verification and validation by subject officer. The subject officer then e-mails it to the moderators for moderation before it sent back to KNEC.

**Sequence diagram – (manuscript 2)**

**This process only happens within KNEC**

1. Subject officer receives manuscript of various taxonomy levels
2. Subject officer combines the manuscript into one paper
3. The proof reader reads through the paper, checking on spelling, grammar, ordering etc.
4. Subject officer approves and uploads the paper onto a paper bank for storage
5. The subject officer does a random selection form the paper bank of the paper to be sat
6. The Printer prints the paper and packages, in readiness to be sat at an examination.
From figure 4.4 above, the moderated manuscript is received by the subject officer for selection of questions to form an examination paper. The paper is then sent for proof reading, before it is stored on a paper bank. For administration of exam, the paper is selected at random and printed in readiness for an examination.
CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter gives the conclusion and recommendation to further enhance the management of manuscript at national examination. The conclusion of the project has been made in accordance to the objectives established at the beginning of the study. Further the chapter has offered possible recommendation and a suggestion for further development.

5.2 Conclusions

From the testing results of the developed SCMMS, the following was observed in comparison to the current manual manuscript process:

The Time taken to come up with a manuscript was seen reduced from over 5 months to less than a month. This means the system was able to achieve one of its objectives to cut on time spent

The logistics cost of developing a manuscript (what is spent on the contacted professionals transport, meals, accommodation etc) is reduced to about ksh.100, cost for internet services. This will save the council over ksh.100000 per manuscript that is spent on logistics

Contacting the contracted professionals is done thorough e-mail as opposed to telephone calls, smses and posts which are deemed more expensive. Use of e-mail will cut on costs.

The manuscripts are sent electronically, hence the danger of travelling with it and the security risks associated, i.e. losses of manuscript are eliminated.

One paper is set by a number of setters with distinct taxonomy levels to handle, hence exposure of a whole paper to a setter is not their hence the risk of disclosing examination questions to potential candidates by setters is avoided.

Once setting is done, the paper is stored on a paper bank and exposed to random selection for administration to an exam hence no one is certain when the paper will be offered. This has reduced the predictability of a paper developed being sat at a given year, even by the contracted professionals, hence enhanced examination security.

Recruitment is open to all trained professionals and based on their experience and level of education (system list applicants in ascending order based on experience and qualification) as opposed to the
current process of headhunting which is biased, because it depends on the subject officer knowledge of a potential person and preference.

The SCMMS has therefore proven to be more efficient and therefore best suited to handle examinations manuscripts.

5.3 Recommendation

Since the SCMMS only covers manuscript management from preparation and submission to printing, the researcher proposes that it be extended to cover management of examination scripts, i.e. the process that follows after printing of examination papers: tracking of the student answer scripts, while sitting the examination, routing, marking, processing and finally storage and disposal.

The researcher also proposes that since the system cuts on logistical costs, that the amount paid to the contracted professionals be increased to motivate them.
6.0 REFERENCES


2. Gaurav S. Kc : 2009, Programming Systems Lab; Compilers and Software Security

3. Gaurav S. Kc, 2009, Privacy is essential for secure mobile devices.


7. Kelvin Kagwi, 2012 Bsc computer science project

8. Casemaker Totten, 1997 what is Rapid Application Development


Appendix A: Interview Questions

1. How many examination manuscript have you oversaw for KNEC before?
   - [ ] none
   - [ ] 1-2
   - [ ] 3-5
   - [ ] Over 5

2. On average, how long does it take you to come up with a manuscript? (From the point of inviting setters to approving a manuscript as an examination paper)
   - [ ] Less than a month
   - [ ] 1-2 months
   - [ ] 3-5 months
   - [ ] More than 5 months

3. How do you recruit the contracted professional (setters, moderators, typesetters, proofreaders)?
   - [ ] Newspaper Advertisement
   - [ ] Head hunting
   - [ ] Electronic advertisement-website
   - [ ] Request through Institutions head
   - [ ] Other

4. How do you contact the contracted professional
5. How do you receive the manuscript from contracted professional

- Hand delivery
- Post office
- Scanned e-mail attachment
- Other

6. How do you send and receive the manuscript to and from the Printer?

- Hand delivery
- Post office
- Scanned e-mail attachment
- Other

7. How many examination setters do you engage per paper

- 1-2
- 3-5
- 5-10
- More than 10

8. How many typesetters do you engage per paper
9. How many moderators do you engage per paper

- 1-2
- 3-5
- 5-10
- More than 10

10. How many proofreaders do you engage per paper

- 1-2
- 3-5
- 5-10
- More than 10

11. On average, how many persons interact with the manuscript before it is sat as an examination paper?

- 1-4
- 5-10
- 11-20
- More than 20

12. On average how much does it cost you to pay the following contracted professionals
13. On average how much does it cost you to come up with a manuscript? (From the point of inviting setters to approving a manuscript as an examination paper)

- Less than a ksh.100,000
- Ksh. 100,000 – ksh.200,000
- Over Ksh. 200,000 – ksh.500,000
- More than Ksh. 500,000

14. How can you rate your ability to use internet?

- excellent
- average
- poor
- never used

15. On average, how can you rate your contracted professionals’ ability to use internet?

- excellent
- average
- poor
- never used
16. Which are the major activities in coming up with a manuscript?

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

17. What challenges do you encounter in coming up with the manuscript?

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

18. In coming up with an Electronic system for managing the manuscript, what features would you like to see included

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Appendix B: summary of findings on KNEC’s manuscript management process

<table>
<thead>
<tr>
<th>No</th>
<th>Question</th>
<th>Purpose</th>
<th>Choices</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>How many examination manuscript have you oversaw</td>
<td>To know experience of the</td>
<td>none</td>
<td>0</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>1-2</td>
<td>0</td>
</tr>
<tr>
<td>Question</td>
<td>Respondent</td>
<td>3-5</td>
<td>Over 5</td>
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<td>-------------------------------------------------------------------------</td>
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<tr>
<td>2. On average, how long does it take you to come up with a manuscript? (From the point of inviting setters to approving a manuscript as an examination paper)</td>
<td>To know the time spent, so as to compare with time spent on computerized process</td>
<td>Less than a month</td>
<td>0</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>1-2 months</td>
<td>0</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>3-5 months</td>
<td>0</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>More than 5 months</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>3. How do you recruit the contracted professional (setters, moderators, typesetters, proofreaders)?</td>
<td>To compare the current mode of recruitment and compare with the Electronic mode proposed in terms of cost and time</td>
<td>Newspaper</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Head hunting</td>
<td>6</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Electronic advertisement</td>
<td>0</td>
<td></td>
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<td></td>
<td></td>
<td>Request through Institutions head</td>
<td>1</td>
<td></td>
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<td></td>
<td></td>
<td>Other</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>4. How do you contact the contracted professional</td>
<td>To compare the current mode of contact and compare with the Electronic mode proposed – Email) in terms of cost and time</td>
<td>Telephone call, SMS</td>
<td>6</td>
<td></td>
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<td></td>
<td></td>
<td>E-mail</td>
<td>1</td>
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<td></td>
<td></td>
<td>Post</td>
<td>4</td>
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<td></td>
<td></td>
<td>Other</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>5. How do you receive the manuscript from contracted professional</td>
<td>To compare the current mode of posting/sending and compare with the Electronic mode</td>
<td>Hand delivery</td>
<td>6</td>
<td></td>
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<td></td>
<td></td>
<td>Post office</td>
<td>0</td>
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<td></td>
<td></td>
<td>Scanned e-mail attachment</td>
<td>0</td>
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<td>Other</td>
<td>0</td>
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<td>Question</td>
<td>Solution</td>
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<tr>
<td>6.</td>
<td>How do you send and receive the manuscript to and from the Printer?</td>
<td>proposed – Email) in terms of cost, time and security</td>
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<td></td>
<td></td>
<td>Hand delivery</td>
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<td>Post office</td>
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<td></td>
<td></td>
<td>Scanned e-mail attachment</td>
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<td></td>
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<td>Other 2 (DHL)</td>
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<td>7.</td>
<td>How many examination setters do you engage per paper</td>
<td>To compare the cost and security of the manuscript by getting to know the number of persons interacting with it</td>
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<td></td>
<td></td>
<td>1-2 3</td>
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<td>3-5 3</td>
<td></td>
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<td>5-10 1</td>
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<td></td>
<td></td>
<td>More than 10 0</td>
<td></td>
<td></td>
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<td>8.</td>
<td>How many typesetters do you engage per paper</td>
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<td></td>
<td></td>
<td>1-2 6</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>3-5 0</td>
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<td></td>
<td>5-10 0</td>
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<td></td>
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<td></td>
<td></td>
<td>More than 10 0</td>
<td></td>
<td></td>
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<tr>
<td>9.</td>
<td>How many moderators do you engage per paper</td>
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<td></td>
<td></td>
<td>1-2 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3-5 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5-10 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>More than 10 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>How many proofreaders do you engage per paper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-2 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3-5 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5-10 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>More than 10 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>On average, how many persons interact with the manuscript before it is sat as an examination paper?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-4 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5-10 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>11-20 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>More than 20 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>On average how much does it</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Less than 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of Manuscrupt</td>
<td>Range</td>
<td>Value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------</td>
<td>-------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ksh.100,000</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ksh. 100,000-200,000</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Over Ksh. 200,000 – ksh.500,000</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Over Ksh. 500,000</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

13. How can you rate your ability to use internet?

14. On average, how can you rate your contracted professionals’ ability to use internet?

To inform on the IT literacy level among the key users of the system, hence speculate on the acceptability of the system.

<table>
<thead>
<tr>
<th>Ability Level</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>0</td>
</tr>
<tr>
<td>Average</td>
<td>6</td>
</tr>
<tr>
<td>Poor</td>
<td>0</td>
</tr>
<tr>
<td>Never Used</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ability Level</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>0</td>
</tr>
<tr>
<td>Average</td>
<td>3</td>
</tr>
<tr>
<td>Poor</td>
<td>2</td>
</tr>
<tr>
<td>Never Used</td>
<td>1</td>
</tr>
</tbody>
</table>
Appendix C: Usability Testing Questions

Dear respondent,

This questionnaire is intended for users of this system i.e. the examination setters, moderators, subject officers and proof readers. Please select one option in every question and click POST button to submit.

1. What is your role in Manuscript development?  
   - Setter ☑  
   - Moderator ☐  
   - Proof Reader ☐  
   - Subject Officer ☐

2. How many examination manuscripts have you worked on?  
   - 3-5 ☐  
   - None ☑  
   - 1-2 ☐  
   - More than 5 ☐

3. How long did it take you to work on the manuscript (from time of receiving to sending)?  
   - Less than a month ☑  
   - 1-2 months ☐  
   - 3-5 months ☐  
   - Over 5 months ☐

4. From where did you access the system?  
   - Own Computer ☑  
   - Work Computer ☐  
   - Cyber Cafe ☐  
   - Other ☐

5. How much in total (Ksh) did it cost you, using the system?  
   - Less than 100 ☐  
   - 100 - 500 ☐  
   - 500 - 1000 ☐  
   - Over 1000 ☑

6. Was the System User friendly and easy to use?  
   - Yes ☑  
   - No ☐

7. Were the feedback messages easy to understand?  
   - Yes ☑  
   - No ☐

8. Was it easy to navigate through the system?  
   - Yes ☑  
   - No ☐

9. Any other comments about the system


## Appendix D: summary of user testing results on KNEC’s manuscript management process

<table>
<thead>
<tr>
<th>No</th>
<th>Question</th>
<th>Purpose</th>
<th>Choices</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>What is your role in manuscript management?</td>
<td>To know if all types of users where able to interact with the system online</td>
<td>Setter</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Moderator</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Proof reader</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Subject Officer</td>
<td>2</td>
</tr>
<tr>
<td>2.</td>
<td>How many manuscript have you worked on?</td>
<td>Business</td>
<td>none</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>To know the frequency of users</td>
<td>1-2</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3-5</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Over 5</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>On average, how long did it take you to work on the manuscript (from time of receiving manuscript\template to sending)</td>
<td>Business</td>
<td>Less than a month</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>To know the duration taken with the system in comparison with the manual process-if time was saved</td>
<td>1-2 months</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3-5 months</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>More than 5 months</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>From where do you access the system</td>
<td>To inform the level of accessibly to internet resources</td>
<td>Own computer</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Work computer</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cyber cafe’</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>How much in total (Ksh.) did it cost using the system e.g. the internet fees, movement costs etc</td>
<td>To compare the cost of the SCMMS with the manual process-if money was saved</td>
<td>Less than 100</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>100- 500</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Over 500-1000</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Over 1000</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Question</td>
<td>Requirement/Functionality</td>
<td>To know if the system will be easily acceptable to users</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------------------------------------</td>
<td>----------------------------</td>
<td>-----------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Was the system user friendly and easy to use?</td>
<td>User requirement/functional</td>
<td>Yes 9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No 1</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Were the feedback messages easy to understand?</td>
<td></td>
<td>Yes 9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No 1</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Was it easy to navigate through the system?</td>
<td></td>
<td>Yes 8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No 2</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Any other comment about the system</td>
<td>To receive any other information the user might want to convey, that is not covered by the questions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix E: Graphical User Guide

A. Creation of users

There are two groups of users, contracted professional (setters, moderators and proofreaders, who are added onto the system automatically, upon successful recruitment by the relevant subject officer) and administrators (subject officers, printer, KIE moderator and Trainer), who are added by the Super administrator.

1. To add administrators by the super admin

1.1 Login on the system as super admin

The below window appears
1.2 Fill in the users details as displayed

1.3 Click **post** button to submit

2. Add new trained teachers by the trainer

   2.1 Log onto the system as a trainer

   The below window appears
If batch upload;
2.1 download the excel template
2.2 fill in the teachers details
2.3 upload the details online by browsing to the file and click **Upload Excel Data** Button
   if single upload;
2.4 Fill in the teacher details as displayed
2.5 Click **post** button to submit

NB: An E-mail is sent to the teacher informing him\her that she has been added. Only after adding a teacher will he\she be able to apply for any position

3. Apply as a contacted professional by trained Teachers
3.1 Access the system, on [www.knec-registration.ac.ke\manuscript](http://www.knec-registration.ac.ke\manuscript). The following window is displayed:

![Login window](image1)

If a new user, please click **here** to apply. Your login credentials will be sent to your e-mail if successful and contracted.

3.2 Click the button **here** on the left panel to open the below widow:

![Application window](image2)

<table>
<thead>
<tr>
<th>National ID No.</th>
<th>3000000003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Names</td>
<td>MRS KAMAU EVA</td>
</tr>
<tr>
<td>Date of Birth</td>
<td>7/15/1976</td>
</tr>
<tr>
<td>Mobile No.</td>
<td>0721819002</td>
</tr>
<tr>
<td>E-Mail Address</td>
<td><a href="mailto:KAMAUeva@YAHOO.COM">KAMAUeva@YAHOO.COM</a></td>
</tr>
<tr>
<td>Teaching Subject</td>
<td>Science</td>
</tr>
<tr>
<td>Institution</td>
<td>STAREHE GIRLS CENTER</td>
</tr>
<tr>
<td>Institution Type</td>
<td>Secondary</td>
</tr>
<tr>
<td>District</td>
<td>BUNGOMA SOUTH</td>
</tr>
<tr>
<td>Profession</td>
<td>Select</td>
</tr>
<tr>
<td>Contract Subject</td>
<td>Select</td>
</tr>
<tr>
<td>Attach Curriculum Vite</td>
<td>Browse</td>
</tr>
</tbody>
</table>
3. Fill in the remaining details as above, you may also edit the pre-loaded data.

3.4 Click **Submit** button to post.

4. **Contract / Hire** Contracted professional by Subject Officer

4.1 Log in as subject officer.

The below window is displayed:

![Image of the window](image)

NB: the applicants are ordered based on merit.

4.2 Check/uncheck the checkbox on the last column-Contract to appoint/unappoint.

On contracting:

1. the appropriate taxonomy level and template is sent to the setter.
2. the login credentials are also e-mailed to the setter.

4.3 Click **Post** button to submit.

NB: hiring of Proof reader and Moderators follows the same procedure.
5. Upload manuscript after setting by the setter
   5.1 Log on to the system as a setter, using the credentials emailed by KNEC system
      The below window is displayed

      ![Image of the window displaying manuscript setting stage]

      NB: the window displays the stage of your manuscript and taxonomy level

      5.2 Click on **Browse** button to select your manuscript if done setting

      5.3 Click on **Upload** button to submit

6. Validation of manuscript by subject officer
   6.1 Select **Manuscript Validation** tab as below
      List of uploaded manuscript is displayed
6.2 click download to view the manuscript
6.3 click on Browse to attach the Manuscript after Validation
6.4 select Accept Action if OK
6.5 click Post button to submit

7. Moderation by 1\textsuperscript{st} Moderator

7.1 Log on as a moderator

The below window is displayed
7.2 click download to view the manuscript
7.3 click on Browse to attach the Manuscript after moderation
7.4 click Post button to submit
   NB: The same process applies to moderation2, done by KIE Moderator.

8. Combination of manuscripts by Subject Officer to for a Paper
8.1 Click on the tab **Manuscript Combination**

8.2 Click download to view the various manuscripts
   Combine all the manuscript into one Paper
8.3 click on Browse to attach the Manuscripts (Paper) after combination
8.4 click Upload button to submit

9. Proof Reading By the Proof reader
9.1 Log on as a proofreader

The below window is displayed

9.2 click download to view the paper
9.3 click on Browse to attach the paper after proofreading
9.4 click Post button to submit

10. Paper Banking by Subject Officer
10.1 Click on the tab **Paper Banking**
10.2 click download to view the paper
10.3 click on Browse to attach the paper to be banked
10.4 Click Upload button to submit

11. Paper selection (for printing to be sat for during an examination) by subject officer

11.1 Click on the tab **Paper Selection**

The below window is displayed
NB: it displays the No. Of papers in the Paper Bank

11.2 Select the date of exam

11.3 Select the Start and Stop Time

11.4 Click Select Button to randomly choose a paper
    NB: an e-mail is sent to notify the Printer

12. Printing the examination Paper by the printer

12.1 Log on as a printer
    The below window is displayed
12.2 Click download to view the paper to print

12.3 Print the Paper

12.4 Update Status under Action column to **Printed**

12.5 Click Post button to submit
Appendix F: Sample Reports

1. Status of manuscripts

![Image of manuscript status table]

2. List of Users

![Image of user list table]

3. No of Applicants per subject

![Image of applicant list table]
<table>
<thead>
<tr>
<th>Subject</th>
<th>Moderator</th>
<th>Proofreader</th>
<th>Setter</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECO</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>EOB</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>MAT</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>SCI</td>
<td></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>