

**PROCEEDINGS OF 2012 KABARAK UNIVERISTY 2<sup>ND</sup>  
ANNUAL INTERNATIONAL RESEARCH CONFERENCE**

**RESEARCH AND INNOVATION FOR SUSTAINABLE DEVELOPMENT IN AFRICA**

**16<sup>TH</sup> TO 18<sup>TH</sup> OCTOBER 2012**

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**Published by:**

Kabarak University  
Institute of Postgraduate and Research  
P O Private Bag – 20157  
**KABARAK**

**2012**

## **ACKNOWLEDGMENT**

This book of proceedings is the result of hard work on the part of many individuals who sat in the various committees that facilitated the success of the conference. We acknowledge with thanks the work of the various conference committees, listed below, and the entire faculty staff for their input that led to its production.

The monumental role played by the various paper presenters need no emphasis, for it is their work that really gave the conference a meaning. We really appreciate their immense contribution.

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## FOREWORD

On behalf of the Board of Trustees, the Governing Council, the Management Board, the Staff and Students of Kabarak University, I welcome all participants to the 2<sup>nd</sup> Annual International Conference being held at Kabarak University Main Campus.

The Conference, being multi-disciplinary offers a good platform for exchange of research ideas and networking. The presentations have been grouped into four symposia and enriched by keynote speeches by international scholars and policy makers. In order to link research to the industry, a number of industry players have been invited to showcase their products and services. This provides industry players with an opportunity to learn and possibly implement the invention/innovations and ideas generated by institutions of higher learning and other advanced research institutions. In any case, industrialization depends heavily on research and the ability to utilize the research findings and this cannot be achieved without the support of the key stakeholders in the industrial sector.

According to Food and Agriculture Organization, there are two major challenges that face the world today: reducing poverty and ensuring food security for all and at all times. Yet there is enormous untapped agricultural potential that exists in developing countries to meet the twin challenges of hunger and poverty. We must ensure the quality and safety of food, plant, and animal health, in light of the increased risks of trans-boundary transmission of diseases within an increasingly globalized and liberalized trading system. These shortfalls experienced in developing nations can only be bridged if research and innovation is emphasized and supported. Moreover, in the same developing nations, there are other enormous resources which have not been harnessed. This is evident from latest discoveries of natural resources such as oil and gas in some parts of Eastern Africa. This is an area which has great potential for research and needs to be developed. This will ensure value addition to the products and in turn may improve the living standards of the locals.

I thank the Conference Organizing Committee for the effort towards the success of this conference. Support from the well-wishers and sponsors are also highly appreciated.

It is my prayer that you will find the conference useful.

Prof. Jacob Kibor,  
Ag. Vice Chancellor

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## **KEYNOTE SPEECHES**

### **Benefits of Free Economy**

By Prof. Tom Palmer  
General Director, Atlas Economic Research Foundation

### **The Government's Initiative on Research and Development for Sustainable Development**

By Prof. Shaukat Abdulrazak  
Secretary/ CEO of the National Council for Science and Technology

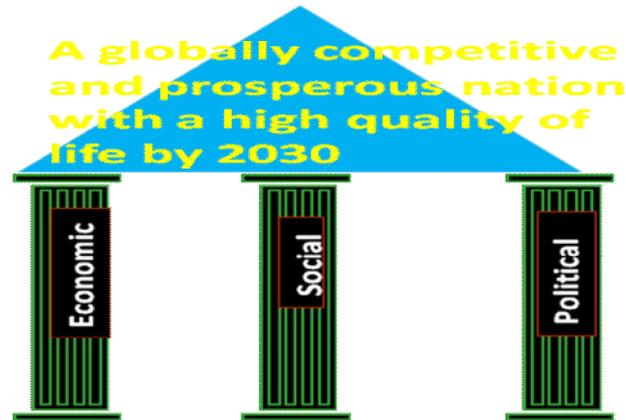
#### **Introduction**

Research and innovation has contributed heavily to socio-economic development in continents like Europe. Integration of Science and Technology (S&T) in national production processes is key to Government Policy priority and programme. S&T is also key to support a paradigm shift from product economy to knowledge based development. On recognizing the importance of ST&I in socio-economic development, the GoK established NCST in 1977 through S&T Act. In addition, various national research institutes (KARI, KEMRI, KEMFRI) were established. NCST has the following roles:

- Advisory
- Coordination
- Promotion

NCST became a Body Corporate as per the Kenya Gazette Supplement No. 34 (Bills No. 17) of 2nd May 2012.

## KENYA VISION 2030



*Science, Technology and Innovation, ICT, infrastructure, HR Development, public sector reforms and Security, peace building and conflict management*

Effective system for innovation, technology adoption, diffusion and transfer is required for use of ST&I as a tool for national development and international competitiveness. ST&I, supported to a large extent by ICT, has become a major driving force of economic change in many nations. Kenya has a no. of facilities for ST&I in research institutes and some universities that are important for national innovation activities and therefore should not be left behind. To realize the benefits of research and innovation:

- PPP should be strengthened.
- Research and innovation priority areas should be identified.
- Enough resources should be allocated to research and innovations.

### **Initiatives of the Government**

- ▶ Sessional Paper No. 2 of 1997 on 'Industrial Transformation to the year 2020'.
- ▶ Economic Recovery Strategy for Wealth and Employment Creation(2003-2007)
- ▶ Support of R&D activities in various ministries.
- ▶ Expansion of national institutions:
  - NBA –Biosafety Act 2009
  
- ▶ The other institutions to be created are:
  - National Commission for Science, Technology and Innovation.

- Kenya National Research Foundation
  - National Technology Acquisition Office
  - ▶ Higher Education funding initiatives through the Higher Education Loans Board.
  - ▶ Participated in Africa Science and Technology Indicators Initiative (ASTII)
  - ▶ Public awareness on ST&I
    - Annual National ST&I Week
    - ST&I desks
    - ISK
  - Annual Science Congress.
  - Draft ST&I Policy, 2012 - integrates ST&I in production and service sectors for social and economic transformation.
    - ▶ National Science, Technology and Innovation (ST&I) grant established in 2008 - administered by the National Council for Science and Technology.
- The grant supports ST&I priority areas in relation to the development agenda of the Government as provided in Kenya Vision 2030, Medium Term Plan and various sectoral plans.

Since its inception, 894 projects have been funded under the following categories:

- Research
- Innovations
- Research facility
- Post-Doctoral research
- Women Scientists
- Postgraduate Research (Ph.D and MSc./MA)
- Bilateral collaborative programmes
- Scientific conferences and symposia
- Cooperation and partnership in research.
- KEPSA
- Kenya/South Africa joint research projects
- NCST/ Japan Society for Promotional for Sciences
- Kenya/British Council
- Kenya/DAAD
- Kenya/IAEA partnership
- NCST/Nuclear electricity project
- ▶ Promotion of innovation by providing policy framework to link industries - Draft ST&I Bill, 2012.
- ▶ Developed Innovative ideas for social economic development

#### **Challenges faced**

- Low investment by private sector in ST&I in relation to percentage of GDP allocated to R&D.
- Weak inter-linkages currently existing among research, extension and production Systems.
- Lack of mechanisms to capture the contribution of ST&I in national production.

- Brain drain.
- Donor driven research.
- Lack of research Policy to inform research activities.
- Inappropriate and unresponsive IPR regime.
- Mismatch between skills acquired from Kenyan training institutions and the industry requirements.
- Enhancing the role of ST&I in national development.

### **Recommendations**

- ▶ Increase funding for R&D/GDP; 2% .
- ▶ Improve R&D infrastructure and capacity to develop innovations.
- ▶ Capacity building -Human resource
- ▶ Strengthen IPR regimes
- ▶ Nurture and sustain home-grown scientific talents.
- ▶ Brain gain through Brain circulation.
- ▶ Sustained Promotion of ST&I.
- ▶ Science Parks and innovations incubation Units.
- ▶ Research to be demand rather than supply driven.
- ▶ Innovations & Inventions into products and commercialisation – Innovations for industrialization.
- ▶ Develop problem-solving scientific research.
- ▶ Fuse economic planning with technology planning.
- ▶ Enhancing ST&I awareness.
- ▶ Encourage collaboration between the universities and the industries for the following reasons:
  - Speeding up the innovation process.
  - Ensuring relevance of doctoral education.
  - Increasing visibility.
  - Strengthening recruitment.
  - Developing the network.
- ▶ Effective National Innovation System
- ▶ Creating the Innovation Ecosystem

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**Integrating Faith and Learning**

By Rev. Prof. Jacob Kibor,  
Ag. Vice Chancellor, Kabarak University

**Open Data Concept**

By Dr. Bitange Ndemo,  
Permanent Secretary, Ministry of Information and Communication, Kenya

## **SYMPOSIUM 1**

### **B2012-01: Knowledge Management in Kenyan Higher Education: The Challenges of Dissemination**

Thiga M. Moses, Kabarak University, [mthiga@kabarak.ac.ke](mailto:mthiga@kabarak.ac.ke)

#### **KNOWLEDGE MANAGEMENT IN KENYAN HIGHER EDUCATION: THE CHALLENGES OF DISSEMINATION**

By

**Moses Mwangi Thiga**

#### **ABSTRACT**

Every day, in the 50 plus universities in Kenya, hundreds of thesis and research publications are written. While this is a good sign of an active academic and research community it has not escaped the attention of numerous forums that these documents and the knowledge that they contain seldom finds real life application in the Kenyan society, businesses and industry. These works are more often found on university library shelves rather than at the desks of business persons and industry captains who need to consume and apply their contents. In the academic circles the problem of intentional or unintentional duplication of research works continues.

Many attempts at addressing the problem of inaccessibility of research works from higher education institutions have been put forth over the years but there seems to be no significant progress that has been made in that direction. High level meetings and commitments by institutional heads to digitize and upload research findings have been made, ICT platforms have been bought or developed and deployed with minimal success.

This study therefore sought to investigate the effectiveness of these ICT platforms, the existence and enforcement of supporting policies as well as the existing processes of implementing knowledge dissemination in Kenyan higher education. A total of 124 respondents, mostly academic staff, from 13 private and public universities in Kenya were reached using online and paper questionnaires. Interviews were also conducted with a few respondents in order to collaborate the findings from the questionnaires.

It emerged that the concepts of knowledge dissemination were not well understood among the Kenyan Higher education fraternity. This lack of understanding was evident among top management as well as with the researchers themselves. A number of challenges facing the effective dissemination of knowledge such as research processes that do not take knowledge

dissemination into account, the non existence of supportive policies and environments, and the lack of clearly assigned knowledge management responsibilities were revealed.

Based on the findings of the study a knowledge dissemination framework was proposed. The proposed framework incorporates a number of key issues such as leadership, responsibility for the process and an enhanced research process. It is hoped that the adoption of the proposed framework can lead to an improvement on the effectiveness of knowledge creation and dissemination processes in Kenyan Higher education.

**Keywords:** Knowledge, Dissemination, Kenya, Higher Education

### **Introduction**

Knowledge, knowledge management and other related concepts have in the recent past gained ground in terms of their utilization in discussions on economies, business, research and education the world over. But beyond being just concepts they represent a shift from what has previously been referred to as the information age to the new knowledge age and society. Knowledge itself has been defined in a number of ways that attempt to emphasize its key aspects such as contextualization and personal experience in its creation, storage, dissemination and application. However a clear and concise understanding of knowledge and its management has remained elusive due to its intangible nature and differing definitions. (Senapathi, 2011)

Institutions of higher learning and research bodies have been the focal point of this knowledge revolution given the fact that they exist primarily to query existing beliefs and facts as well as to devise new ways of tackling the problems of humanity. In practice this is effected in the form of research activity whose traditional primary output is a research report. The situation with regards to research activity and production of outputs in the form of reports in Kenya is no different from the rest of the world. However there is a concern about the level of impact that these research or knowledge outputs have on the Kenyan Industry and society. (CHE, 2008)

### **Problem Statement**

Every day, in the 50 plus universities in Kenya, hundreds of thesis and research publications are written. While this is a good sign of an active academic and research community, it has not escaped the attention of numerous forums, that these documents and the knowledge that they contain seldom finds real life application in the Kenyan society, businesses and industry. These works are more often found on university library shelves rather than at the desks of business persons and industry captains who need to consume and apply their contents. In the academic circles the problem of intentional or unintentional duplication of research works continues.

Many proposals and solutions aimed at addressing the problem of inaccessibility of research works from higher education institutions have been put forth over the years. However, no significant progress has been made in that direction. High level meetings and commitments by institutional heads to digitize and upload research findings have been made, ICT platforms have been bought, developed and deployed with minimal success. Meanwhile, the Kenyan Higher education fraternity continues to produce research outputs while the Kenyan industry and society daily awaits solutions to their day to day challenges. These solutions may be available but are not

accessible by the intended audiences due to the lack of suitable platforms, tools and policies for their dissemination.

## **Background and review of literature**

### **Background and Review of Literature**

Knowledge management has outlived the perceptions that it was just another management and academic fad in spite of there being little evidence of the consequences of its adoption in many organizational setups. However there is a general agreement that we are now firmly in the age of the knowledge society and knowledge based economy. Knowledge is now regarded as the main competitive tool for businesses rather than capital, land and labour. (Rowley, 2000)

### **Knowledge**

Knowledge is a combination of contextual information, expert insight, framed experience and values that provides a framework for evaluating and incorporating new experience and information. It originates and is applied in the minds of the 'knowers'. In organizations it is embedded in documents, repositories, routines, processes, practices and norms. (Davenport, De long and Beers, 1998) Knowledge can be classified as procedural (know how) or declarative (know facts), general or specific as well as tacit (in people's minds) vs explicit (expressed in words and numbers). Of particular interest in the context of higher education is the tacit vs explicit classification of knowledge. Tacit knowledge is very personal in nature, difficult to express and share. Explicit knowledge on the other hand can be shared formally in the form of data, specifications, manuals and using audio visual methods among other methods. (Becerra-Fernandez & Sabherwal, 2010) Knowledge management is a discipline that is concerned with the analysis and technical support of practices that are used to identify, create, represent, distribute and enable the adoption of knowledge in an organization. (Omona, Weide and Lubega, 2010)

### **Knowledge Dissemination**

Knowledge dissemination is an active, directed, managed and interactive process of communicating knowledge to the target audiences for adoption and application. Dissemination does not happen by chance as is the case with diffusion but rather by design and careful execution. Dissemination is not just about moving information from one point to another as is the case with transfer. Successful knowledge dissemination requires; a strategic approach, a good knowledge of the target audiences, the identification of an optimal combination of methods and tools, specific timeframes, adequate funding and evaluation measures to quantify the impact of the dissemination efforts. (Ordonez and Serrat, 2009) Knowledge dissemination has been regarded as the logical conclusion to the research process which according to Whitemore and Melkus, (2012) comprises of the conceptual phase, the design and planning phase, the empirical phase, the analytic phase, and the dissemination phase.

The need for efficient, timely and accurate knowledge dissemination cannot be underscored and many investments have been made over time to improve the processes. Indeed it can be said that the process of knowledge dissemination is just as important as the knowledge creation process. Technologies such as knowledge repositories, wikis, blogs, electronic media, data warehouses and groupware as aptly discussed by Omona, Weide and Lubega, (2010) exist and greatly facilitate dissemination. Numerous frameworks such as those proposed by Lee and Roth (2009) for higher education knowledge management, by Green et al, (2009) for knowledge dissemination in public health and Omona, Weide and Lubega, (2010) for the use of ICT in higher education knowledge management exist.

However, despite the existence of these tools, methods and frameworks, challenges in disseminating knowledge still abound. This is especially so in developing countries who in most instances lack resources for not only the dissemination but also the creation of knowledge. In addition it has been noted that psychological and social barriers have also been found to hinder dissemination. Where knowledge dissemination efforts and measures are in place, poor planning and the lack of well thought out dissemination strategy also serve to hinder the process of dissemination. The greatest challenge in the whole process remains to be the lack of measurement, monitoring and evaluation of the impacts of knowledge dissemination. (Ordonez and Serrat, 2009)

#### **Knowledge Dissemination in Higher Education**

The production of new knowledge through research and scholarship lie at the heart of universities missions. However without effective and ongoing dissemination of knowledge these efforts of researchers are wasted on an ongoing basis. Dissemination of knowledge is thus a core responsibility of universities. (AAU *et al*, 2009)

In proposing a conceptual framework for examining knowledge management in USA higher education contexts, Lee and Roth (2009), rightly state that higher education institutions are not immune to the challenges of knowledge management. They are faced with challenges in budgetary allocations, building knowledge based organizational cultures, promoting leadership for effective knowledge management, application of technology and measuring the results of their knowledge management efforts.

#### **Kenyan Higher Education**

As of March 2012 there were 63 universities and constituent colleges in Kenya comprising of; 7 public universities, 24 public university constituent colleges, 14 chartered private universities, 5 private university constituent colleges, 11 private universities with letters of interim authority and 2 registered private universities. The growth in the number of universities has also led to a corresponding increase in enrollment and in the number of programs on offer. (CHE, 2012)

Despite the large number of universities, growing student numbers and programs, Kenyan universities have continued to be ranked very low in international rankings. The commission of higher education, in a 2008 workshop report on enhancing quality in Kenyan Higher Education, attributes this to very low utilization of research outputs from universities. They further note that despite the fact that universities are best placed to generate research outputs there are very low levels of research outputs and industry collaborations that are critical for utilization of research outputs. (CHE, 2008)

#### **Theoretical Framework**

##### **Knowledge Dissemination Theories**

A number of theories have been proposed and developed in the past with regards to knowledge dissemination. Three of these theories were identified for use as a theoretical basis for this study;

1. **Theoretical framework 1:** Knowledge Dissemination is a process that requires a match between the following key aspects in the greater knowledge management process;
  - a. The process of creating knowledge: This refers to the actual steps and activities that go into conducting research or other activities that lead to the creation of knowledge.
  - b. The context within which knowledge is created: This refers to the social, economic or cultural conditions surrounding the knowledge creation process.

- c. The characteristics of the target audience: This refers to the needs, socio-economic contexts, prior experience, as well as value and belief systems of the intended recipients and users of the knowledge.
- d. The manner in which the knowledge is delivered: This includes the content, delivery media, format of the communication, and language that are used to deliver knowledge to the target audiences.

(Senapathi, 2011)

- 2. **Theoretical framework 2:** A strategic approach, a good knowledge of the target audiences, the identification of an optimal combination of methods and tools, specific timeframes, adequate funding and evaluation measures to quantify the impact of the dissemination efforts. (Ordonez and Serrat, 2009)
- 3. **Theoretical framework 3:** Sufficient budgetary allocations, building of knowledge based organizational cultures, promoting leadership for effective knowledge management, application of technology and measuring the results of their knowledge management efforts can help organizations to enhance knowledge management and dissemination efforts. (Lee and Roth, 2009)

#### Knowledge Dissemination Methods

Knowledge can be disseminated in a number of ways depending on whether it is tacit or explicit in nature. (Senapathi, 2011)

- 1. Tacit knowledge is disseminated through methods that usually require interaction between persons. These include communities of practice, focus groups, video conferencing as well as classroom setups.
- 2. Explicit knowledge on the other hand is disseminated through methods that do not necessarily require a direct face to face interaction between persons. These methods are mainly in the form of print and electronic media such as print and online journals, websites, blogs and knowledge repositories.

#### Knowledge Dissemination Technologies

Knowledge dissemination technologies can be broadly classified into three categories;

- 1. Networking technologies such as intranets, extranets, knowledge repositories, knowledge portals. These technologies are usually used to connect people, processes and content in organizations or communities with shared interests.
- 2. Groupware and collaboration tools such as email, messaging, voice over IP, group calendars and schedules, shared authoring tools, file sharing, video conferencing, online forums and online newsletters. These tools help people to synchronize activities and to work together on the creation as well as management of shared knowledge.
- 3. Wikis are web driven software that help people to create content for the web and share it. They are useful for collaborative knowledge management. (Hallouche & Sultan, 2008)

These technologies are suited mainly for the conversion of tacit knowledge into its explicit form and its subsequent dissemination

#### Integrated Theoretical Framework

An integrated theoretical framework was developed for this study based on the identified theoretical frameworks, methods and technologies for knowledge dissemination.

Successful knowledge dissemination is thus determined by a combination of the following factors;

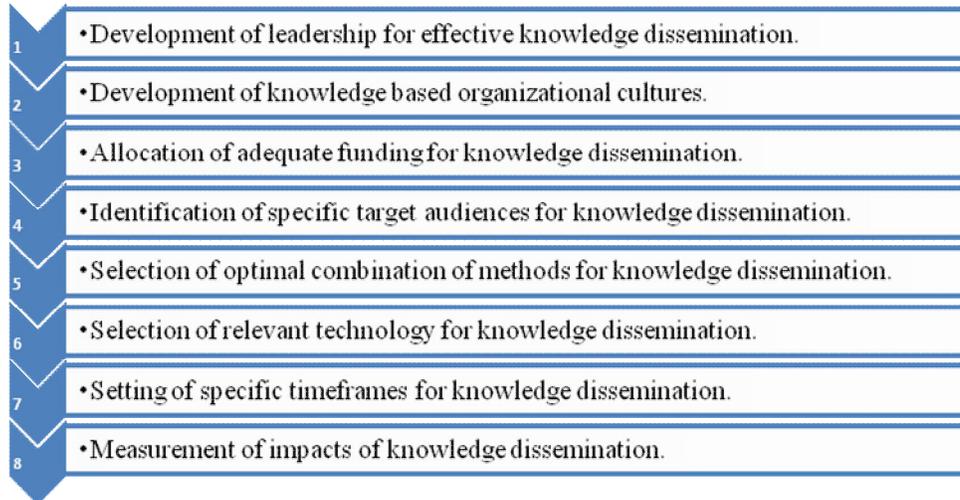


Figure 1: Integrated Theoretical Framework

The integrated theoretical framework depicts in a sequential manner the order in which the various activities in a knowledge dissemination process could be carried out in order to achieve a successful dissemination effort.

Factors 1 – 3 are leadership oriented and placing them at the beginning of the process reflects the critical role that leadership must play in making any dissemination effort a success.

Factors 4 - 6 are preparation oriented and their order implies that the identification of the target audience is a critical first step that subsequently guides the selection of relevant methods and applicable technologies.

Factors 6 – 7 are evaluation oriented and reflect the need to set a specific timeframe for any dissemination activity and most importantly the need for evaluation of all dissemination activities as a reasonable conclusion to the process.

#### Conceptual Framework

Based on the identified theoretical frameworks the following conceptual framework was developed to guide the study.

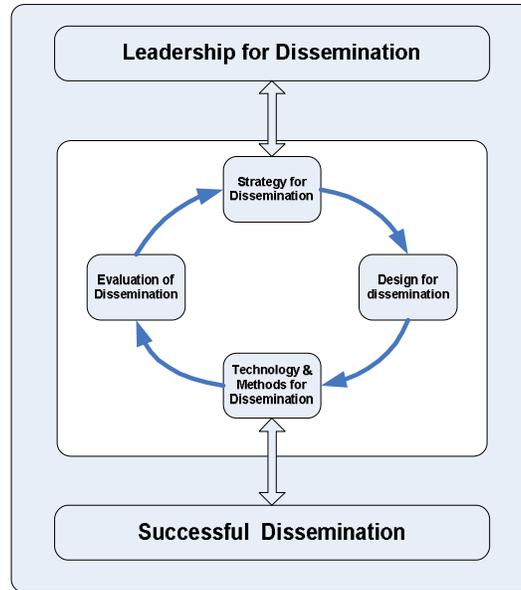


Figure 2 : Conceptual Framework

Knowledge dissemination relies on the existence of appropriate strategies for dissemination, research designs that incorporate dissemination, the selection of appropriate technologies for dissemination and the evaluation of the impacts of dissemination efforts. These are in turn facilitated by the presence of leadership that is aware and supportive of the knowledge dissemination process.

### **Research Design**

Research design refers to the conceptual structure that holds the different elements in a research project together. (Trochim, 2006) The design provides for the collection of relevant information with minimal effort, time and money. The selection of a design requires the consideration of the objectives of the study, the type of data to be collected, the source of information, the tools to be used for data collection, the data analysis methods to be used and the methods to be used in disseminating the results to the appropriate audience. (Whittemore and Mekus, 2012) An appropriate research design is important in ensuring that valid responses to the research questions and hypothesis are obtained. The research approach that was used in this study was a non-experimental, cross-sectional and descriptive survey.

### **Non-Experimental**

Non-experimental research is research where there is no manipulation of the independent variable by the researcher. The researcher only observes what has already occurred naturally. (Trochim, 2006) Non-experimental designs in turn take a number of different forms such as descriptive, comparative, correlational, survey, ex post facto and secondary data analysis (McMillian, 2010) The study did not require the manipulation of any of the situations or circumstances that the respondents were currently in at the universities with regards to knowledge management and dissemination. The information sought from the respondents was simply about the current state of knowledge management in Kenyan Higher Education.

### Survey research

Surveys are designed to allow information about a large group (population) to be inferred from responses obtained from a small number or subset of the bigger group (sample). (McMillian, 2010)

1. It is a very effective way of assessing opinions and trends in populations as well as in organizations.
2. It allows for the collection of unique and primary data that may not be available from other sources.
3. It allows for the use of probability sampling which ensures an unbiased representation of the population under study.
4. It allows for the standardization of measurement in that the same information is collected from every respondent.
5. It provides data that can be used to complement existing data from other secondary sources.

(Owens, 2002)

This study targeted a total of 20 out of over 50 universities and 180 respondents to represent the over 3,000 academic staff in these universities.

### Cross-Sectional Study

A cross-sectional study is a study in which data is collected at one point in time from a sample that represents the larger population. (Owens, 2002) The data in this study was collected between 16<sup>th</sup> May and 23<sup>rd</sup> of August 2012 with no repeat collections on the same sample of respondents at different points in time.

### Descriptive

A descriptive study seeks to systematically describe a situation, problem or phenomena in order to provide information about the area or subject of study. (McMillian, 2010) The ultimate goal of the study was to describe the situation in Kenyan Higher education with regards to knowledge management and dissemination.

### Research Questions

The study was guided by the following research questions;

1. What is the role of Kenyan Higher Education Leadership in knowledge dissemination?
2. What are the strategies and policies for knowledge dissemination in Kenyan Higher education?
3. What are the research design considerations for knowledge dissemination in Kenyan Higher education?
4. What are the technologies and methods for knowledge dissemination in Kenyan Higher education?
5. What evaluation methods are in place for knowledge dissemination in Kenyan Higher education?
6. What are the attributes of a framework that would be suitable for Knowledge Dissemination in Kenyan Higher education?

### Software Used

A number of software packages were used in the course of the study. These include the Statistical Package for the Social Sciences (SPSS) version 11.5 that was used to generate the descriptive statistics from the quantitative data obtained from the questionnaires. Microsoft Excel

2007 was used to generate the graphs during the preparation of the final report as well as to prepare the data collected using the online form for import into SPSS version 11.5. Microsoft Visio 2007 was used to generate the integrated theoretical framework, conceptual framework and the final proposed framework for knowledge dissemination. Google docs was used to generate an form that was used for the online data collection and data entry.

### Data Analysis

The data collected in the study was both quantitative as well as qualitative in nature. The quantitative data obtained from the paper and online questionnaires was analyzed using frequencies generated from SPSS version 11.5. The qualitative data obtained from the comments on the questionnaires and interviews was analyzed by identifying patterns, similarities and differences in the views expressed by the respondents in order to relate the emergent themes to the findings from the questionnaires.

### Sampling Design

The sampling design used was a combination of the stratified and purposive sampling methods.

#### Stratified Sampling

A total of 20 universities were selected for the final data collection as outlined below. They were categorized based on their student populations and based on their types i.e public vs private

Table 1: Stratification

	Public University	Private University
<b>Student Population</b>		
< 2,500	2	2
2,501 – 5,000	2	2
5,001 – 10,000	2	2
10,001 – 20,000	2	2
> 20,000	2	2
<b>Total</b>	<b>10</b>	<b>10</b>
<b>Grand Total</b>	<b>20</b>	

#### Purposive Sampling

Respondents in the study were selected based on the roles that they play in their respective universities. In particular the following were selected;

1. Top management – Academic registrar or Deputy vice chancellor Academics
2. Academic department – Dean of school / Faculty or Head of department
3. Research department – Head of research
4. ICT - Head of ICT or webmaster.
5. Researchers – Lecturers actively involved in research projects.

#### Sample Size Calculation

The total number of universities in Kenya is currently 62 and a total of 9 individuals were targeted to be sampled from each of the universities as follows;

1. Top management - 1

- |                        |   |   |
|------------------------|---|---|
| 2. Academic department | - | 3 |
| 3. Research department | - | 1 |
| 4. ICT                 | - | 1 |
| 5. Researchers         | - | 3 |

The population in this study comprised of  $62 \times 9 = 558$  members of staff in 62 universities. Using Cochran's (1997 in Bartlett et al 2001) sample size calculation formula for continuous data a sample size of 180 respondents from 20 universities was determined. Of the targeted sample of 180 respondents a total of 124 respondents were reached representing 68.8% of the target.

#### Data collection methods

The following data collection methods were used in the study.

1. Paper questionnaires were distributed to respondents at their respective universities. The questionnaire used can be found in Appendix B.
2. Online questionnaires were distributed online through existing email contacts. The online questionnaire can be accessed at <https://docs.google.com/a/kabarak.ac.ke/spreadsheet/viewform?formkey=dFNORnFabVlEcU4xSDlqd1JreUw5VVE6MQ#gid=0>.
3. Interviews: These were carried out in person and via email In an attempt to validate information received in the questionnaires. The interview schedule used can be found in Appendix C.

#### Data Collection

##### Pilot Study

A pilot study was conducted at Kabarak university to test the data collection methods and instruments. A total of 9 questionnaires were distributed on 3<sup>rd</sup> May 2012 and a total of 5 were received back by 9<sup>th</sup> May 2012 representing a 55.56% return rate.

##### Data Collection

The final data collection was conducted between 16<sup>th</sup> May and 23<sup>rd</sup> of August 2012.

##### Distribution of Questionnaires

A link to the online questionnaire was sent to existing and relevant email contacts while the paper questionnaire was distributed to the targeted respondents in person at their respective universities. Some respondents filled the questionnaires immediately while others chose to do it at their own pace. The return rate for those who remained with the questionnaires was lower. The distribution of the paper questionnaires was done with the help of 5 volunteer research assistants who were existing contacts in their respective universities.

##### Return Rate

The online questionnaire had a 37% response rate with 27 responses out of a total of 73 that were sent out. The response rate for the paper questionnaire was 54% with 108 responses out of a total of 200 questionnaires that were sent out. In total 124 respondents out of a targeted 180 was reached representing 69% of the targeted number of respondents.

##### Data entry and extraction

The data collected from the paper questionnaires was keyed in using the same online form that was in use for the online data collection for ease of data entry. The data was subsequently

exported in CSV format for import into SPSS version 11.5. The qualitative data collected was keyed in into the same online form exactly as the respondents stated it on the questionnaires. The bulk of the data entry was done by a volunteer data entry clerk.

### Interviews

The interviews conducted in the study were guided by an interview schedule that was administered in two ways;

1. Personally during a discussion with the respondents. Two interviews were conducted using this approach.
2. As a set of open ended questions sent on email to all 60 respondents who had indicated an interest in the findings of the study by providing an email address. Only 4 of them responded.

The responses received were summarized and incorporated as additional views in the final report

### Results

This chapter discusses the findings from the survey on knowledge dissemination in Kenyan Higher Education. The discussion focuses on two the state of knowledge dissemination in Kenyan Higher Education. The characteristics of the respondents and their universities are also briefly discussed.

#### University and Respondent Characteristics

The objective of the study was to study the state of knowledge dissemination from academic staff in Kenyan Higher education institutions. In the following figure (Figure 3) the proportions of the universities involved is indicated.

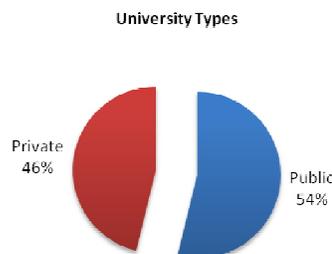


Figure 3: University Types

A total of 13 public and private universities were involved in the study. Of these 7 were public universities and 6 were private universities. It is significant to note that collecting data from some universities was difficult due to the requirements for authorization that they requested. Some approvals were not obtained in time and thus data was not collected from them. Private universities tended to be more strict on the permit requirement as opposed to public universities.

A total of 124 respondents were involved in the study with a majority of them drawn from public universities. Figure 4 reflects the proportions of respondents according to the type of university that they were drawn from.

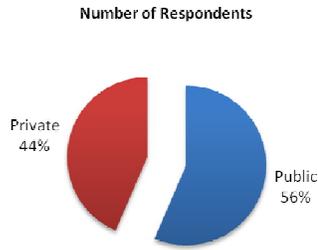


Figure 4: Number of Respondents

A total of 70 respondents were drawn from public universities with 54 of them being drawn from private universities. Figure 5 reflects the diversity of respondents involved in the study.

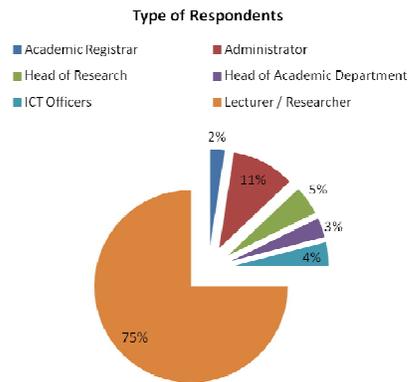


Figure 5: Type of Respondents

The majority, 75%, were lecturers or researchers, 10.5 % administrators, 4.0% ICT staff, 3.2% heads of academic departments, 4.8% heads of research and a further 2.4% being academic registrars.

### Dissemination methods

The study sought to determine what knowledge dissemination methods the respondents were familiar with as utilized within their institutions. The methods used for knowledge dissemination were broadly categorized as publications, person to person and online methods as indicated in Table 2.

The respondents appeared to be more familiar with the methods grouped under publications and person to person with an average of 64.6% and 51.1% of the respondents indicating that they were familiar with the use of the methods within their institutions. The online methods such as email, blogs and wikis on average scored very low with only an average of 38% of the respondents indicating that these methods were in use in their universities.

Table 2: Dissemination Methods in Use

	Yes (%)	No (%)	Not Sure (%)
<b>Publications</b>			
Working documents	69	12	19

Research reports	86	10	4
Academic journals – Print	78	15	7
Academic journals – Online	64	20	16
Professional journals	64	18	18
Text books	71	15	14
Training manuals	69	15	16
Policy briefs	47	27	26
Mass media	58	19	23
DVD	40	31	29
Video	42	28	30
<b>Average</b>	<b>64.6</b>	<b>18.2</b>	<b>17.2</b>
<b>Person to Person Methods</b>			
Conferences, workshops and seminars	85	7	8
Networking	62	13	25
Consultancy	53	18	29
Focus groups	30	36	34
Trade fairs	52	22	26
Promotions	47	24	29
Field demonstrations	54	26	20
Intermediary organizations	26	26	48
<b>Average</b>	<b>51.1</b>	<b>21.5</b>	<b>27.4</b>
<b>Online Methods</b>			
Electronic newsletters	38	32	30
Email	67	15	18
Blogs	31	32	37
Wikis	11	37	52
Institutional repositories	41	18	41
Social Media	40	27	33
<b>Average</b>	<b>38.0</b>	<b>26.8</b>	<b>35.2</b>

Conferences, workshops and seminars emerged as the most commonly used method of disseminating knowledge in the universities sampled with 85% of the respondents indicating that indeed this method was used. The use of intermediary organizations came across as a method that was not widely utilized according to 26% and 48% of the respondents who indicated no and not sure respectively to the use of the method.

The respondents gave a mixed reaction on the dissemination of knowledge using policy briefs. There were 47% of the respondents who indicated that they were aware of knowledge dissemination through policy briefs. The rest, 27% and 26% were either sure that this was not done or not sure about the use of policy briefs for knowledge dissemination. This in a way indicates that the use of research outputs to influence policy is not something that the respondents were quite certain about. The use of other electronic media such as the mass media, DVD's and video was also not quite clear to the respondents as evidenced by the somewhat mixed reactions to the use of these methods.

The use of consultancies, promotions and field demonstrations in the person to person category also registered mixed reactions indicating a possible lack or partial utilization of these methods. The use of focus groups for dissemination of research outputs was clearly something that respondents were not aware of as a dissemination method with 36% indicating that the method was not used at all and 34% indicating that they were not sure about focus groups.

The use of online methods clearly emerged as an option that most respondents were not aware of. It is only the use of email for disseminating their results that the respondents were familiar with. Other methods such as the use of blogs, institutional repositories, wikis, electronic newsletters and social media for knowledge dissemination was clearly something that the respondents were aware of. In particular, wikis had the lowest score with only 11% of respondents indicating that the method was utilized in their universities to disseminate knowledge. Social media, according to the respondents was not widely used according to 27% and 33% of the respondents who indicated no and not sure respectively to the use of the method.

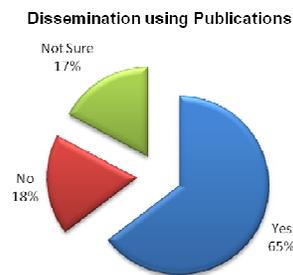


Figure 6: Dissemination using Publications

Dissemination using Person to Person Methods

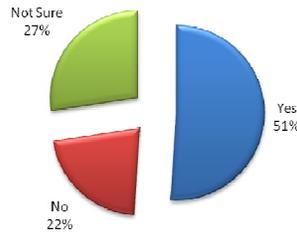


Figure 7: Dissemination using Person to Person Methods

Dissemination using Online Methods

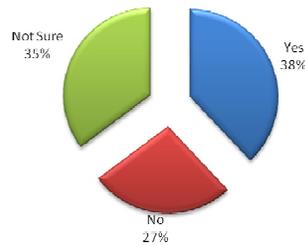


Figure 8: Dissemination using Online Methods

### Evaluation of dissemination

The study sought to establish what measures, efforts and activities were in place for the evaluation of knowledge dissemination in the sampled Higher Education Institutions in Kenya.

Table 3: Evaluation of Knowledge Dissemination Activities

	Yes (%)	No (%)
We actively evaluate the impact of our knowledge dissemination efforts for our research outputs	27	73
We have records of the number of people accessing our research outputs through the various mediums such as journals, blogs and websites.	50	50
We avail contact information for receiving feedback from our target audiences regarding our research outputs.	32	68
We have feedback from our target audiences regarding the research outputs we disseminate.	28	72
We have feedback from our target audiences regarding the adoption and utilization of our research outputs.	21	79
We have follow-up surveys to evaluate the impact of our dissemination activities.	17	83
We have follow-up interviews to evaluate the impact of our dissemination activities.	31	69
<b>Average</b>	<b>29.4</b>	<b>70.6</b>

With regards to the evaluation of dissemination activities 73% of the respondents indicated that they were not aware of any evaluation efforts of knowledge dissemination activities within their institutions.

Monitoring of access levels to the various dissemination media that the institutions use to disseminate knowledge such as journals, blogs and websites is also not monitored according to 50% of the respondents.

The sharing of contact information with the target audiences for knowledge dissemination was not done according to 68% of the respondents. However, despite the perception that contact information was somewhat shared according to 32% of respondents who said that this was done, 71% of the respondents indicated that they were not aware of any feedback that had been received from the recipients of their research outputs on the level of adoption and utilization.

The use of follow-up surveys and interviews to determine the impact of the dissemination activities is also something that the respondents were not aware of according to 83% and 69% of the respondents respectively.

Overall, 70.6% of the respondents indicated that evaluation of knowledge dissemination activities was not done in their respective institutions.

Evaluation of Knowledge Dissemination Activities

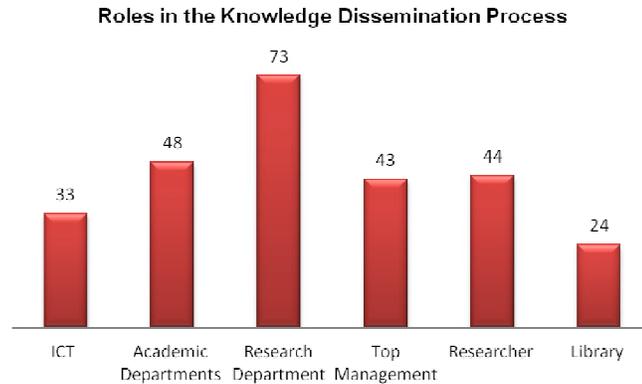


Figure 9: Evaluation of Knowledge Dissemination Activities

### Roles in the dissemination process

The study sought to establish who among the various players within the university the respondents felt was responsible for various aspects of the knowledge dissemination process. The respondents, by selecting all the departments / players they thought were relevant in effect ranked them in the manner presented in

Figure 10 below.



**Figure 10: Roles in the Knowledge Dissemination Process**

The research department emerged as the one that most respondents felt was most responsible overall for the knowledge dissemination process. They were followed by the academic departments then the researcher, followed by the top management, ICT and finally the library.

#### **Perceived Importance of Selected Knowledge Dissemination Strategies**

Respondents were also asked to state how important they felt that a selected number of strategies were in making the knowledge dissemination process a success. The selected strategies were as follows;

1. Providing accessible summaries of research
2. Keeping the research reports brief and concise
3. Publishing in journals or publications which are user friendly
4. Using language and styles of presentation which engage interest
5. Targeting the material to the needs of the audience
6. Extracting the policy and practice implications of the research
7. Tailoring dissemination events to the target audience.
8. Evaluating the impact of dissemination activities
9. Using electronic and print media
10. Using a combination of dissemination methods
11. Being proactive
12. Understanding external factors

Respondents were generally in agreement that the application of these strategies could help make the knowledge dissemination process more effective.

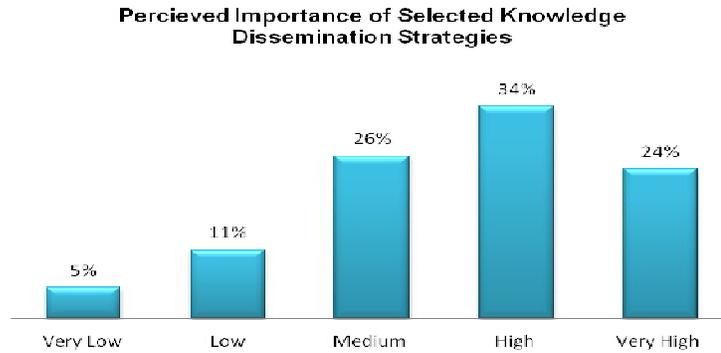


Figure 11: Perceived Importance of Selected Knowledge Dissemination Strategies

### Challenges facing Knowledge Dissemination in Kenyan Higher Education

The study sought to establish the possible causes of ineffective knowledge dissemination in Kenyan higher education. The findings indicate that there were five major categories of issues that impacted on the effectiveness of knowledge dissemination activities in Kenyan Higher Education.

**1. Enabling environment:**

- a. The lack of policies and strategies for knowledge dissemination.
- b. The lack of supportive cultures for knowledge dissemination.
- c. The lack of awareness of knowledge dissemination.
- d. The lack of sufficient motivation for knowledge dissemination

**2. Leadership:**

- a. Low level of awareness among top university leadership on knowledge dissemination.
- b. Low levels of funding for knowledge dissemination.

**3. Dissemination methods:**

- a. The choice of inappropriate methods for knowledge dissemination.
- b. Low levels of industry collaborations for knowledge dissemination.

**4. Barriers**

- a. Language barriers between those disseminating knowledge and the target audience.
- b. Limitations in Information and Communication Technologies (ICT).
- c. Geographical barriers between the sources and users of research outputs.

**5. Research Designs:**

- a. Research designs that do not take knowledge dissemination into account.
- b. Research designs that do not take the evaluation of knowledge dissemination into account.
- c. Lack of relevance of research outputs.

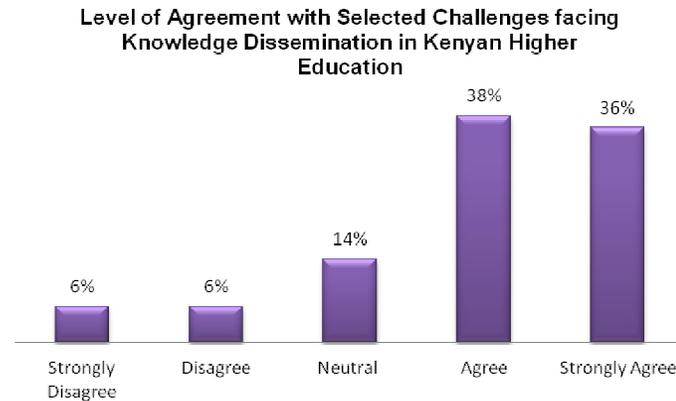


Figure 12: Level of Agreement with Selected Challenges facing Knowledge Dissemination in Kenyan Higher Education

There was a general agreement among the respondents on the impact that the factors listed above have on the knowledge dissemination process. The only exception was the issue of geographical barriers which according to the respondents does not present a challenge to the effective dissemination of knowledge.

#### Additional findings

A total of six individuals were interviewed in order to collaborate the findings from the questionnaires. A number of issues were discussed during these interviews;

#### **The role of university management in knowledge dissemination.**

The interviewees felt that university management ought to assume the overall responsibility for advancing the mission of the university which is the creation and dissemination of knowledge by doing the following;

- (a) Encouraging the generation of new knowledge.
- (b) Creating suitable channels for knowledge dissemination.
- (c) Facilitating the availability of staff to handle knowledge dissemination.
- (d) Putting in place procedures and mechanisms to guide the creation, storage and dissemination of knowledge.
- (e) Putting in place procedures and mechanisms to ensure that the impact of knowledge dissemination activities is evaluated.
- (f) Ensuring that there are sufficient funds available for the dissemination of knowledge.

However, despite the statement that more funding was required for knowledge dissemination activities, interviewees from two universities in particular indicated that there were indeed funds set aside for research but the uptake was very low.

#### **The existence of policies and strategies for knowledge dissemination.**

The interviewees were not very certain about the existence of policies and strategies specifically addressing knowledge dissemination in their institutions. Their responses to this particular question touched on research, publication and institutional communication guidelines.

#### **The technologies and methods in use for knowledge dissemination**

With regards to technologies and methods for knowledge dissemination the interviewees indicated that there were quite a number of these in use within their institutions. These included;

- (a) Mass media such as newspaper adverts and press statements.

- (b) Electronic media such as websites and email.
- (c) Internal communication methods such as intranets and memos.
- (d) Journals both print and electronic.

**The existence of evaluation efforts for knowledge dissemination.**

The measures in place in the various institutions for the evaluation of knowledge dissemination efforts were not very clear to the interviewees.

The only other responses to this particular question touched on the use of paper presentation in conferences and publication of research findings in journals for the purpose of performance reviews.

**How to structure institutions to facilitate knowledge dissemination**

On the issue of institutional structures for the facilitation of knowledge dissemination the interviewees indicated the following;

- (a) Universities should acknowledge that there is a need to clearly define the knowledge creation and dissemination process within the institutions.
- (b) Universities should specify a department with the responsibility of managing the entire knowledge management process as well as the evaluation.
- (c) Universities should develop policies for knowledge management and dissemination as well as for the evaluation of these activities
- (d) Universities need to set aside funds and time for research activities.
- (e) Universities need to recognize research accomplishments.

**How to structure leadership to facilitate knowledge dissemination**

With regards to the provision of leadership for the knowledge management and dissemination process a majority of the interviewees did not have an idea on what could be done. However there was one suggestion that institutions ought to appoint a knowledge manager to oversee the knowledge management and dissemination process.

**How to structure the research process to facilitate knowledge dissemination**

The research process came across as an area that influenced in a big way the way knowledge is created and disseminated. A number of useful remarks were given by the interviewees in this regard.

- (a) There is no problem with the way research is done only that the dissemination of the results is not well thought out.
- (b) That the problem with disseminating research findings or knowledge arises from their perceived lack of relevance to the target group.

**General Observations**

A number of observations were made during the course of the study with regards to knowledge management in Kenyan Higher education.

- (a) It was evident from the comments and responses given by most respondents that they were not aware of the concept of knowledge management and dissemination.
- (b) Those respondents who came close to understanding knowledge management did so in the context of a research process that they were already familiar with.

**Conclusions**

Knowledge is indeed disseminated in Kenyan Higher education but not as knowledge. It is disseminated as research outputs.

### **The role of Kenyan Higher Education Leadership in knowledge dissemination**

Creating an enabling environment and providing funds are the two most important roles of leadership in the knowledge dissemination process. In this regard the development of visions, policies and strategies plays a big role in making any knowledge dissemination process a success. However their lack of awareness comes across as a major hindrance to their effective performance of this role.

### **The strategies and policies for knowledge dissemination in Kenyan Higher education**

There are no specific strategies and policies for knowledge management and dissemination in place in Kenyan Higher education. The policies that exist have to do with the research process and the dissemination of research outputs.

### **Dissemination methods**

Knowledge is disseminated in Kenyan Higher education but not as knowledge but as research outputs. The methods in use are the traditional ones mainly publications. The use of person to person methods such as networking and focus groups is also done. However the use of online methods is not as common

### **Research design considerations for knowledge dissemination in Kenyan Higher education**

The nature of the research process has been found to have implications of knowledge management and dissemination in Kenyan Higher education.

- (a) The processes are not inclusive of the potential consumers of their outputs which subsequently renders their outputs irrelevant to their needs.
- (b) There are no indications of requirements for knowledge dissemination in the processes that generate the knowledge in the universities sampled.
- (c) Additionally it is clear that the evaluation of dissemination efforts is also not a part of the research processes in the universities sampled.

### **Technologies and methods for knowledge dissemination in Kenyan Higher education**

The methods in use for knowledge dissemination are mainly inclined towards the publication of research findings in various forms such as journals and reports. The use of what we can refer to as person to person dissemination methods such as consultancies and through collaborations is not commonly used. The use of emergent methods of communication such as online repositories, social media and wikis is very low. This in way implies that some potential target audience who rely on these media are not reached effectively.

### **Evaluation methods in place for knowledge dissemination in Kenyan Higher education**

The evaluation of the impact of dissemination activities is generally not done in Kenyan Higher education. No follow-ups in terms of contact information, interviews or questionnaires are availed in order to determine if the recipients of knowledge outputs actually put them into use.

### **Proposed framework for Knowledge Dissemination in Kenyan Higher Education**

A suitable framework for knowledge dissemination in Kenyan Higher education must thus address the challenges identified as well as incorporate suggestions and best practice in other higher education settings;

- (1) Leadership to facilitate;
  - (a) Development of required visions, strategies and policies for knowledge dissemination in Kenyan Higher education.
  - (b) Creation of an enabling environment through allocation of time, provision of rewards and motivation for knowledge dissemination in Kenyan Higher education.

- (c) Provision of adequate funding for knowledge dissemination in Kenyan Higher education.
- (2) A research process that takes care of;
  - (a) Involvement of the target audience in the entire process; It is recommended that the targeted consumers of the research works ought to be involved at the inception of a research activity and all the way to its completion.
  - (b) Selection of appropriate dissemination methods; Deliberate action needs to be taken requiring that relevant methods of dissemination be identified as part of the research process.
  - (c) Evaluation of dissemination activities; Measures ought to be put in place to facilitate the evaluation of all knowledge dissemination activities in order to bring to light whether or not they are effective with respect to reaching the intended audience and finding practical applications.
- (3) Active management of the knowledge management process that involves
  - (a) Research departments
  - (b) Researchers
- (4) Selection of relevant dissemination methods and tools in terms of
  - (a) Relevant and accessible technology
  - (b) Type and level of language that can be understood by the target audience.
  - (c) Level of interaction with target audience required
- (5) Evaluation of dissemination to determine if the knowledge has reached the intended target

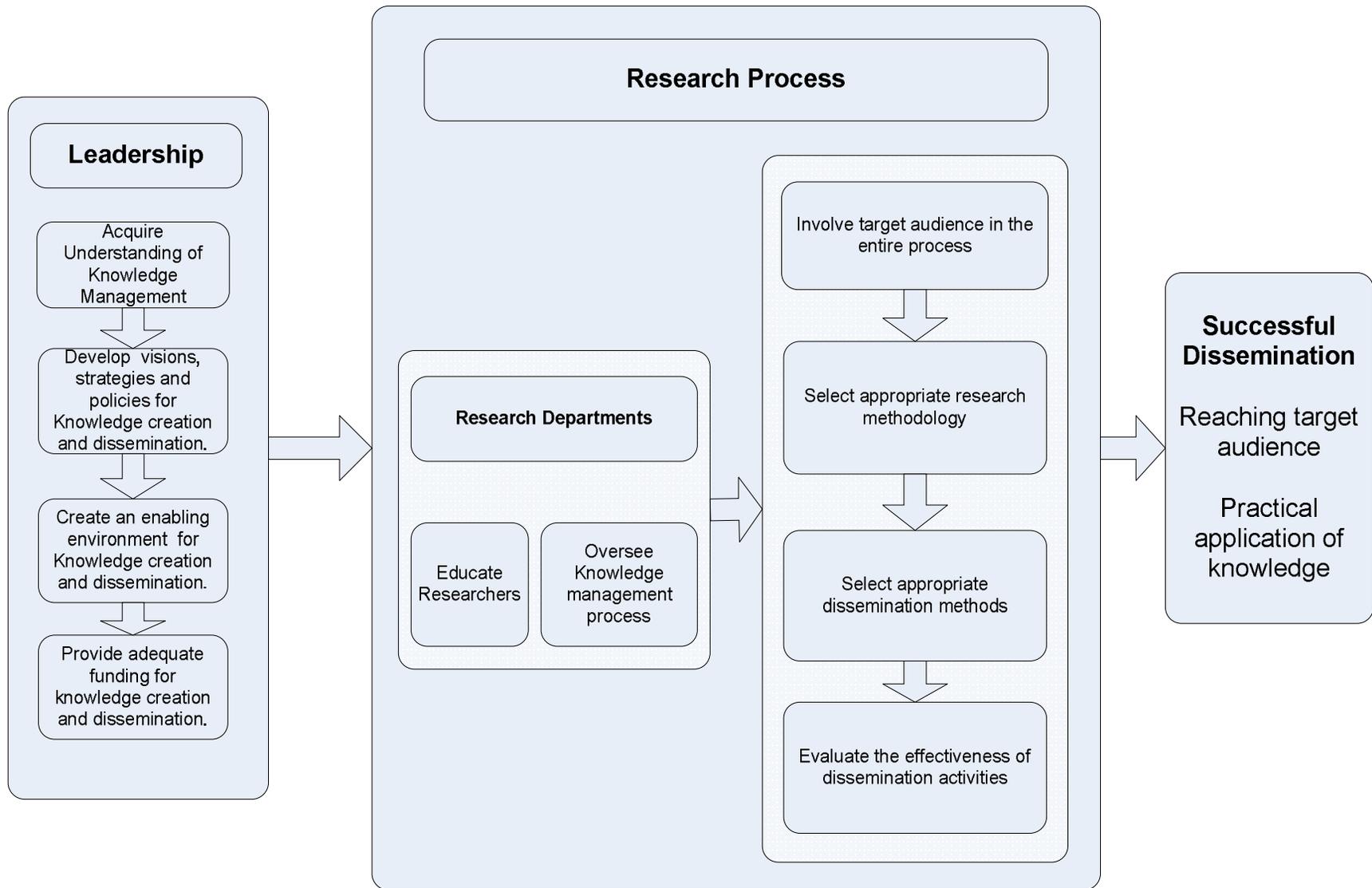


Figure 13: Proposed Framework for Effective Knowledge Dissemination in Kenyan Higher Education

### **Recommendations**

Based on the findings of the study and the proposed framework for effective knowledge dissemination in Kenyan Higher education a number of action points are proposed;

- i) There is need to revise the research processes in use to incorporate the involvement of target users in the process, the selection of appropriate knowledge dissemination methods and the evaluation of all dissemination efforts.

### **Prospects for Further Work**

There are a number of unaddressed and emergent issues that were not investigated in this study that are recommended for further study.

1. The study did not look into the influence of organizational and other cultures on the practice of knowledge dissemination. It would be interesting to compare different cultures in order to determine which ones are supportive of knowledge dissemination practices.
2. The study did establish that the research processes in use do not currently factor in knowledge dissemination as well as evaluation. There is thus a need to investigate what enhancements are required in order to achieve effective knowledge dissemination in Kenyan Higher education.
3. The study did establish that online methods of knowledge dissemination such as social media are not widely used. It will be useful to investigate why their use is not as widespread for knowledge dissemination as compared to other similar academic setups.

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## **B2012-02: The Role of Value-Based Management Tools on the Performance of Firms Listed in the Nairobi Securities Exchange**

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### **Abstract**

The purpose of this paper was to determine the role of value-based management tools namely the Balanced scorecard and selected organizational factors on the performance of firms listed in the Nairobi Securities Exchange. The paper also highlighted the characteristics of the managers who had implemented value-based management tools in their organizations. The research was based upon a Descriptive Survey of the Heads of Departments or top managers of firms registered at the Nairobi Securities Exchange and who are based at Mombasa. Data from the questionnaires was analyzed using SPSS version 16. The model used in the study was Multiple Regression Analysis;  $y = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e$ . The study found out that there was a positive relationship between the use of the Balanced scorecard and firms performance. It however found out that the Balanced Scorecard was used by companies listed in the Nairobi Securities Exchange to a fairly low extent. Majority of the companies that had implemented VBM tools were larger companies which had employed young managers below the age of 35 years. The study found out that the lower application of the Balanced Scorecard by companies listed in the Nairobi Securities Exchange could be a major contributing factor to the poor performance of these companies.

**Key Words:** *Value-based Management (VBM), The Balanced Scorecard (BSC), The Nairobi Securities Exchange (NSE) Capital Markets Authority (CMA)*

### **1.0 Introduction**

Value-based management is a management approach where the companies' overall aspirations, strategies, analytical techniques and management processes are aligned in order to achieve the ultimate

objective of maximizing value by focusing on key value drivers in a firm (Copeland, Koller and Murrin 2000). According to Haspeslagh et al (2001) there is a huge global pressure on companies to deliver constantly superior value to their shareholders regardless of their corporate heritage. It is because of this challenge that companies are obliged to measure their performance and this is evidenced by the maxim “what gets measured gets done” (Williamson, 2006; Kouzmin et al, 1999)

According to Kibuthu (2005) the stock exchange started in Kenya in 1920's but there was no formal trading arrangements because business was carried out according to gentleman's agreements. The first professional stockbroker was established in 1951 and the NSE began in 1954 with the permission of the London Stock Exchange (Munga, 1974). NSE is the fourth largest stock exchange in terms of trading volume and works in collaboration with the Uganda and Dar es salaam Stock Exchange. The key function of the NSE is to provide an exchange system in which buyers and sellers interact for the purpose of trading in shares and other securities issued by publicly traded companies. Through stringent listing requirements, the market promotes higher standards of accounting, resource management and transparency in the management of business. The NSE is regulated by Capital Markets Authority which provides surveillance for regulatory compliance(CMA, 2011).

## **1.2 Statement of the problem**

Studies in Kenya have shown that the performance of companies listed in the NSE has been declining over the past ten years. For example; Gekonge (2003) states that according to the Nairobi Securities Exchange (NSE) year book 2001; the Kenyan capital market is very fragile and in many cases investors have suffered heavy losses in their investments due to decreased earnings. This has discouraged further investments and hence the need for companies to uplift their performance by embracing VBM tools to improve their products and services. The performance of the NSE in Kenya has been continuously showing a consistent downward trend which is indicative of the poor performance of the companies listed at the NSE. Despite the long history and efforts made to revitalize the Nairobi Securities Exchange, the growth of the primary market is still very slow because the number of firms listed in 2005 is less than that at independence (1963). Firms listing at the market is driven by the need to grow their productivity and performance and therefore this study has shed some light on the use of VBM tools which could trigger productivity and improvement of performance which will result to more value to shareholders.

## **1.3 The Specific Objectives of the study were:-**

- (i) To establish the influence of the Balanced Scorecard on the performance of firms listed in the NSE.
- (ii) To determine the role of Managerial characteristics on the performance of firms listed in the NSE.
- (iii) To examine the influence of organizational factors on performance of companies listed in NSE.

## **2.0 Theoretical Review**

Many theories have come up explaining the governance of companies but this research has adapted the Agency theory, Stewardship Theory and Stakeholder Theory as the key theories appropriate to this research.

### **2.1.1 Agency Theory**

This theory has its roots in Economic Theory by Alchian and Demsetz (1972) but it was further developed by Jensen and Meckling (1976) as a contract in which the principal engages an agent to perform some services. There are times when conflict of interest between managers and shareholders occur because of various reasons such as agency costs. Agency costs must be reduced to increase firm value and link company governance to performance. The theory stipulates that Managers are agents of shareholders but they do not work to enrich shareholders. They can, however, be made to make profits for shareholders when the chair of the board is not the CEO or where the CEO has similar interests with shareholders through compensation (Williamson 1985)

### **2.1.2 Stewardship Theory**

This theory originated from psychology and sociology theories and it contents that managers are stewards of the organization and they make profits on behalf of shareholders (Donaldson & Davies,1991). It also states that managers are happy with their work and they are motivated when the company performs well. The theory emphasizes the autonomy of managers which reduces control costs and interests in good structures to empower managers to perform well. Motivated executives will continue to enhance their careers in order to influence the perception of their individual performances in the organization. According to Shleifer & Vishny (1997) Managers make money for shareholders and they re-invest it for them to build future good relations. This theory contradicts the Agency theory by asserting that managers are responsible people and therefore they are not opportunists. They aspire to do

good and to be good stewards to corporate assets because they aim at profit maximization to improve a firm's performance. The stewardship model is commonly used in Japan (Donaldson and Davis 1991).

### **2.1.3 Stakeholder Theory**

According to Freeman (1984) stakeholders are groups of people who are affected by an organizations objectives. Friedman (2006) stresses that organizations should consider the interests of shareholder groups in addition to the investors. Stakeholder Theory is practical because it directs how managers operate businesses. According to Freeman (2004), it answers two questions, that is, what is the purpose of the firm? and secondly "what responsibility does management have to stakeholders? According to Clarkson (1995), stakeholder theory is used as a basis for effectively analyzing relationships in concepts such as the performance of organizations. This paper adopts Mitchell, Angle, and Wood (1997) narrow definition of stakeholders as the people who bear some risk as a result of their investment in a firm. They are those whom without their participation, the firm cannot survive and they include suppliers, shareholders, employees, customers, community and the natural environment (Clarkson 1995). A firm is therefore viewed as a set of interrelationship among a system of stakeholders (Donaldson and Preston 1995). If organizations manage stakeholders effectively, the company will be able to outdo its competitors in terms of value creation and performance.

## **2.2 Empirical Review**

### **2.2.1 The selection of VBM tools and Performance Measurement**

VBM is a control system that measures, encourages and supports the creation of networth (Ameels and Sheipers, 2002). When VBM is implemented in a company it changes the focus of the organization to increasing shareholder value by producing returns in excess of the cost of capital (Simmons 2000). VBM uses analytical tools and processes to focus an organization on the single objective of creating shareholder value (Condon and Goldstein 1998). It is therefore implemented as a management tool, a control system, and an apparatus that is used to integrate resources and tasks towards the achievement of stated organizational goals. Trahan and Ryan (1999) assert that increased competition, managerial labour and capital markets have led to heightened pressure on corporations to focus on maximizing shareholder value. VBM tools however fail to deliver the targeted results if measures are not used in the right way (Neely et al 2001). Amaratunga and Baldry (2002) recommend that organizations have to manage through VBM tools in order to reap the benefits of performance measurement and enhance organizational performance.

### **2.2.1.1 Traditional performance measurement tools**

Traditional financial performance measurement tools are the most common performance tools which are used to assess the wellbeing of a company (Neely 1998). These tools are called traditional because they have been used commonly in the past and are still in use today (Rappaport 1981). They include Earnings Per share (EPS), Return on investment (ROI) and Return on Equity (ROE). Organizations prepare financial statements to show their financial net worth using traditional performance measurement tools which are not all that is needed to measure performance. Ittner and Larcker (1998) assert that there is too much emphasis on financial measures such as Earnings and Accounting returns and little emphasis on drivers of value such as customer and employee satisfaction, innovation and quality.

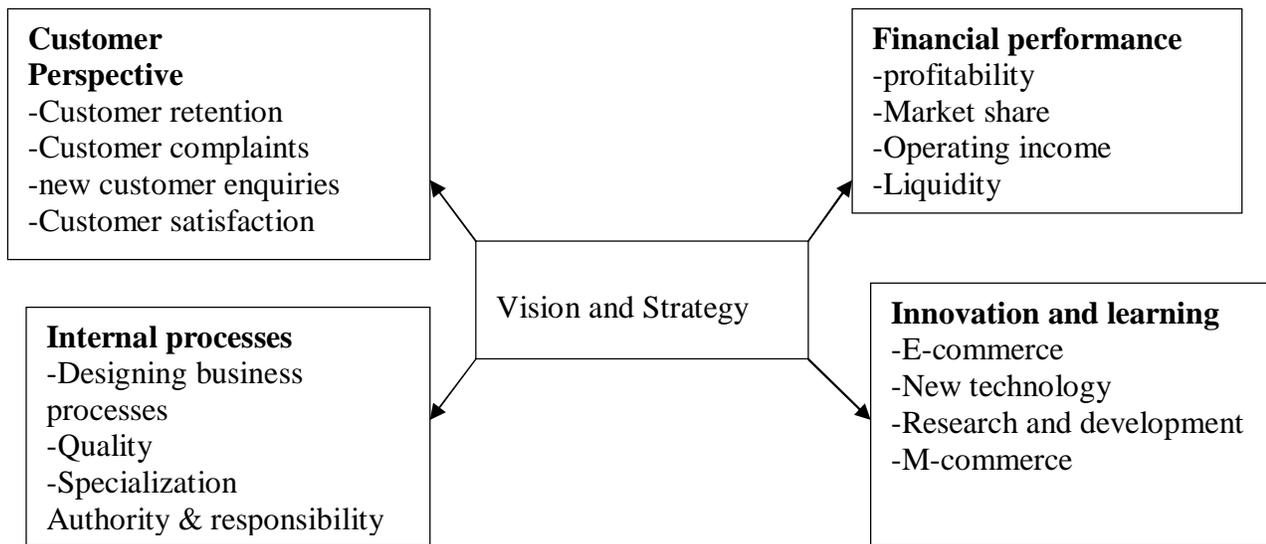
### **2.2.1.2 Modern performance measurement tools**

Value-based Management tools were developed in order to complement the traditional financial measurement tools. The research findings of Kaplan and Norton (1998) recognize non financial measures such as VBM as key in determining the profitability of a firm. However, in the 1950's traditional financial measurement tools became more value-based than cost-based and this encourages studies to look for performance measurement tools that would link strategies to finance. According to Biddle et al (1997), there are many value-based management tools such as Economic Value added (EVA), Balanced Scorecard (BSC) and Cash Flow Return on Investment (CFROI) which provide better incentives in motivating managers to take the right actions. The right value-based management tools are the identity of an organization and hence the importance of aligning them to strategy and performance.

## **2.3 Research Variables**

### **2.3.1 The Balanced Score-Card**

Kaplan and Norton (1998) developed the balanced scorecard by stating that traditional accounting systems did not have the customer component. The BSC emphasizes the importance of both financial and non-financial information through four perspectives which are financial, customer, internal processes and innovation and learning.



**Fig. 1 The Balanced Scorecard**

**Source: Developed for this research**

### 2.3.2 Managerial Characteristics

Literature on organizational performance views managers as key in defining the strategies of an organization to improve organizational performance(Ocasio,1993). This therefore necessitates the study of managerial characteristics and their influence on the performance of organizations. The managerial characteristics that will be studied in his research are:-Age, Education Level and Professional Background.

### 2.3.3 Organizational factors

#### a) Leadership

Leadership is the skill of giving direction to other people towards the achievement of organizational objectives. Leadership will play a role in the selection of the VBM tools to be used in an organization. Good leadership will lead to good selection of tools hence improving on performance. The type of a leader will, however, determine the use of the tools after they have been selected. Good leadership will mean that staff will be motivated to follow the leader's choices. According to Fielder (1996), the effectiveness of a leader is an important tool for the success or failure of an organization. Darcey and Kleiner (1991) states that because of the importance of leadership to organizations, companies need to train and equip leaders with the relevant skills. There are reasons which justify the leadership-performance relationship such as the dynamism of the environment, innovation, competition,

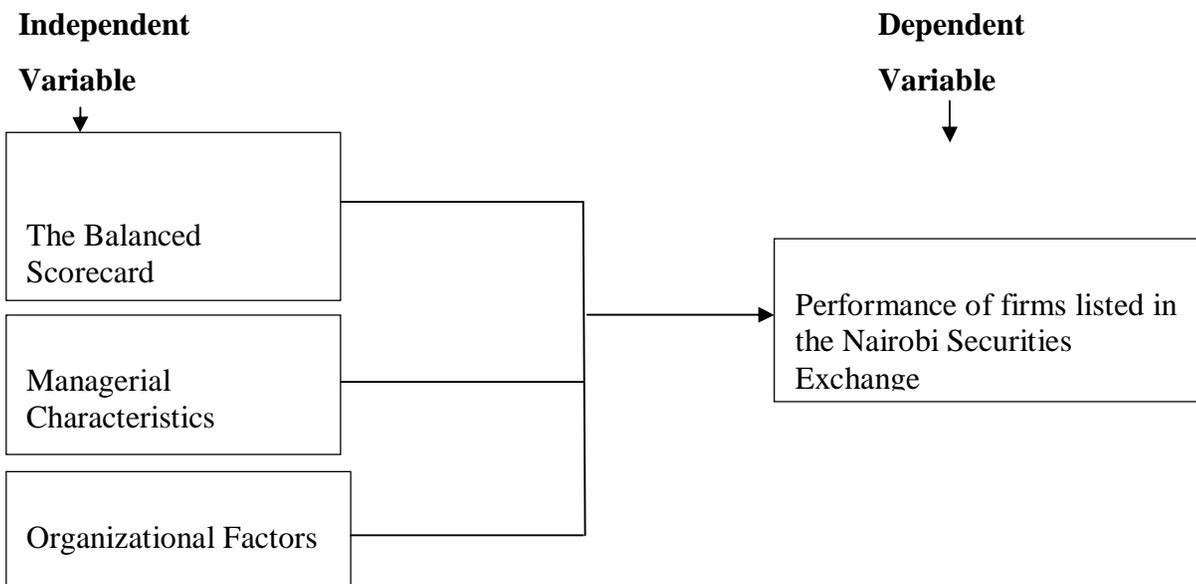
and price rivalry among others (Sentora et al. 1999). There are very many other studies which have suggested improved performance with good leadership (Teece, Piasano and Shuen 1997).

**b) Organizational culture**

Organizational culture is defined as a combination of artifacts, values, beliefs and underlying assumptions that organizational members share about appropriate behaviour (Detert et al, 2000, p. 851). Culture consists of a company's way of life and acts of employees which have a direct influence on the day-to-day activities of an organization. Schein (1992) states that organizational culture refers to the basic assumptions developed by certain groups to cope with its problems. Culture is a communities' reaction to changes and unforeseen circumstances in an organization. It includes what the organization values, what it assumes to be true and its perception and methods which are the identity of the organization. Peters and Waterman (1982) highlighted a positive relationship between organizational culture and performance. He further stated that culture was a determinant of performance because it determines the strategies that the organization will undertake in its mission, vision, goals and objectives. Culture plays a very important role in organizational performance by laying the foundation for the formulation and implementation of organizational strategies. Culture binds an organization together towards organizational performance through the cultural web whereby the institutionalization and operationalization of strategies is embedded in all organizational practices.

**c) Human Resource Management**

According to Pfeffer (1994), human resource management is important for sustained organizational performance. Katou and Bedhwar (2006) established the existence of a positive relationship between a firm's performance and human resource functions. Rizov and Croucher (2008) also found a positive relationship between collaborative human resource management practices and organizational performance. Some of these practices include considering employees as both assets and partners, proper communication and motivation.



Source (Developed for this research)

**Fig. 2 Conceptual Framework**

### 2.4 Critique of literature and Research Gap.

According to Ernest & Young (2003), only 30% of companies use value-based management programs. Value-based management is not also easy to apply in organizations because organizations have competing interests and also because VBM consumes time and resources. (Knight, 1998). There has been a lot of research on VBM tools as evidenced by Rappaport (1981); stern et al (2001) and Stewart (1995) However, there is no much evidence of such research in Kenya and this research will fill this gap

### 3.0 Research Methodology

The method that was used to collect data was survey design. (Van der Stede et al. 2007). Data from the survey was collected using a questionnaire and analyzed with SPSS version 16 Statistical Package. The target population of study comprised of 55 companies based at Mombasa and listed in the Nairobi Securities Exchange. The sampling technique used was Stratified Random Sampling (Sekaran, 2003).

**Fig. 3.1 Classification/Sample of companies**

Sector	Commercial and Services	Finance and Investment	Industrial and Allied	Alternative market segment	TOTAL
Number/Size	12	15	17	8	55

Source: Developed for this research.

The study used primary data that was collected using a 5-point likert scale questionnaire that was served on the respondents and findings presented using tables. Pearson’s correlation coefficient and multiple regression analysis model were used to define further relationships between variables.  $y = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e$ . Where  $y$ =dependant variable (org performance)

$X_1$  independent variable #1(BSC)

$X_2$  independent variable #2(Managerial characteristics)

$X_3$  independent variable #3(Organizational factors)

$\beta_1 \beta_2 \beta_3$ =Regression coefficient for each Independent variable

$E$ =Random error

#### 4.0 Research findings and discussions

#### 4.1 The role of the balanced scorecard.

##### 4.1.1 Customer focus

**Table 4.1.1 Descriptive Statistics for Customer focus**

	N	Mean	Std. Deviation
In Our Organization, retaining customers is considered to be a priority	35	4.2571	1.17180
In our organization, customer complaints are considered to be a valuable asset	35	3.7143	1.31890
Our employees are given freedom to take action on new customer enquires	35	2.6000	1.28795
Valid N (listwise)	35	3.5238	

Table 4.1.1 indicates that new customer enquires was ranked lowest with a mean of 2.6 while customer complaints were ranked the highest with individual means of 4.15 and 3.7 respectively.

**Table 4.1.2. Pearsons Correlations on internal processes**

		In Our Organization, retaining customers is considered to be a priority	In our organization, customer complaints are considered to be a valuable asset	Our employees are given freedom to take action on new customer enquires
In Our Organization, retaining customers is considered to be a priority	Pearson Correlation Sig. (2-tailed) N	1  35	-.351*  .039 35	-.125  .475 35
In our organization, customer complaints are considered to be a valuable asset	Pearson Correlation Sig. (2-tailed) N	-.351*  .039 35	1  .039 35	.589**  .000 35
Our employees are given freedom to take action on new customer enquires	Pearson Correlation Sig. (2-tailed) N	-.125  .475 35	.589**  .000 35	1  35

\*. Correlation is significant at the 0.05 level (2-tailed).

\*\*. Correlation is significant at the 0.01 level (2-tailed).

Table 4.1.2. indicates that organization and business processes being designed to enhance quality was rated the highest and employees being given authority and responsibility was rated the lowest with means of 4.05 and 2.7 respectively.

**Table 4.1.3**

**Innovation and Learning**

**Table 4.1.3**

shows a positive correlation of 0.05 between the use of innovation and e-learning on organizations.

**Table 4.1.4**

**Financial**

		We focus on employee e-communication	In our organization, we use technology in our systems	There is research and development in our systems	Our organization uses e-commerce e.g. e-mail, website, interactive digital tv	Our employees use M-commerce e.g. Mobile phones, or Short Message Service (SMS)
We focus on employee e-communication	Pearson Correlation Sig. (2-tailed) N	1  35	.431**  .010 35	.516**  .001 35	.030  .865 35	-.190  .274 35
In our organization, we use technology in our systems	Pearson Correlation Sig. (2-tailed) N	.431**  .010 35	1  .010 35	.224  .197 35	.311  .069 35	-.143  .412 35
There is research and development in our systems	Pearson Correlation Sig. (2-tailed) N	.516**  .001 35	.224  .197 35	1  .001 35	-.113  .517 35	.392*  .020 35
Our organization uses e-commerce e.g. e-mail, website, interactive digital tv	Pearson Correlation Sig. (2-tailed) N	.030  .865 35	.311  .069 35	-.113  .517 35	1  35	.163  .348 35
Our employees use M-commerce e.g. Mobile phones, or Short Message Service (SMS)	Pearson Correlation Sig. (2-tailed) N	-.190  .274 35	-.143  .412 35	.392*  .020 35	.163  .348 35	1  35

\*\*. Correlation is significant at the 0.01 level (2-tailed).

\*. Correlation is significant at the 0.05 level (2-tailed).

## perspectives descriptive statistics

	N	Mean	Std. Deviation
Increase in net profits	35	4.0571	1.58936
Increase in market share	35	3.9429	.63906
Increase in operating income	35	2.6857	1.18251
Liquidity position	35	2.8571	1.37505
Valid N (listwise)	35	3.3857	

From table 4.1.4 the results obtained from the survey shows that the average mean response was 4.0571 which implies a moderate level of agreement given the scale range from 5 to 1, 5 being strongly Agree while 1 being strongly Disagree. Means for each questions ranged from 4.05 to 2.68 . Increase in net profits parameter was rated the highest.

## 4.2 Organizational factors

**Table 4.2.1 Pearson's Correlations on Organizational Culture**

	To what extent does the mission and vision statements of your organization influence performance?	To what extent does cultural processes and systems affect performance?	To what extent does culture influence your customer base?	To what extent does culture influence decision making in your organization	To what extent does your organization offer financial motivation?	Does your organization offer non-financial motivation to staff?	What is the extent of turn-over in your organization?	To what extent does your organization train and develop staff
To what extent does the mission and vision statements of your organization influence performance? Pearson Correlation Sig. (2-tailed) N	1 .057 35	.057 .743 35	-.180 .301 35	-.379* .025 35	.519** .001 35	.250 .147 35	-.480** .004 35	.123 .481 35
To what extent does cultural processes and systems affect performance? Pearson Correlation Sig. (2-tailed) N	.057 .743 35	1 .142 35	.253 .142 35	.081 .645 35	-.253 .143 35	.152 .383 35	.313 .068 35	.237 .171 35
To what extent does culture influence your customer base? Pearson Correlation Sig. (2-tailed) N	-.180 .301 35	.253 .142 35	1 .142 35	.511** .002 35	-.311 .069 35	-.179 .304 35	.317 .063 35	.428* .010 35
To what extent does culture influence decision making in your organization Pearson Correlation Sig. (2-tailed) N	-.379* .025 35	.081 .645 35	.511** .002 35	1 .002 35	-.021 .906 35	.308 .072 35	.322 .059 35	-.123 .483 35
To what extent does your organization offer financial motivation? Pearson Correlation Sig. (2-tailed) N	.519** .001 35	-.253 .143 35	-.311 .069 35	-.021 .906 35	1 .002 35	.515** .002 35	-.646** .000 35	-.052 .768 35
Does your organization offer non-financial motivation to staff? Pearson Correlation Sig. (2-tailed) N	.250 .147 35	.152 .383 35	-.179 .304 35	.308 .072 35	.515** .002 35	1 .113 35	-.272 .113 35	-.195 .262 35
What is the extent of turn-over in your organization? Pearson Correlation Sig. (2-tailed) N	-.480** .004 35	.313 .068 35	.317 .063 35	.322 .059 35	-.646** .000 35	-.272 .113 35	1 .076 35	.304 .076 35
To what extent does your organization train and develop staff Pearson Correlation Sig. (2-tailed) N	.123 .481 35	.237 .171 35	.428* .010 35	-.123 .483 35	-.052 .768 35	-.195 .262 35	.304 .076 35	1 35

\*. Correlation is significant at the 0.05 level (2-tailed).

\*\* . Correlation is significant at the 0.01 level (2-tailed).

From the table above, the means for each questions ranged from 3.8 to 2.7. Table 4.2.1 indicates that cultural processes and systems affect performance the most while organization training and developing staff was rated the last.

**Table 4.2.2 Pearsons Correlations on Leadership style**

According to the correlation analysis shown in table 4.2.2 below; there was a moderate positive relationship between the type of leadership influence and performance. There was also a positive relationship between training and development and fridge benefits.

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		To what extent does the type of leader influence training and development in your organization	To what extent does the type of leader influence fringe benefits i your organization?	To what extent does the type of leader influence employee relations in your firm	To what extent does the type of leader influence motivation of employees	To what extent does th type of leader influence the working conditions in your firm
To what extent does the type of leader influence training and development in your organization	Pearson Correlation Sig. (2-tailed) N	1  35	.566** .000 35	.094 .591 35	-.312 .068 35	.405* .016 35
To what extent does the type of leader influence fringe benefits i your organization?	Pearson Correlation Sig. (2-tailed) N	.566** .000 35	1  35	.499** .002 35	.050 .774 35	.269 .117 35
To what extent does the type of leader influence employee relations in your firm	Pearson Correlation Sig. (2-tailed) N	.094 .591 35	.499** .002 35	1  35	.138 .431 35	.297 .083 35
To what extent does the type of leader influence motivation of employees	Pearson Correlation Sig. (2-tailed) N	-.312 .068 35	.050 .774 35	.138 .431 35	1  35	.067 .704 35
To what extent does th type of leader influence the working conditions in your firm	Pearson Correlation Sig. (2-tailed) N	.405* .016 35	.269 .117 35	.297 .083 35	.067 .704 35	1  35

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

**istics on Age.**

	N	Mean	Std. Deviation
Below 35 years	35	4.3714	1.03144
35-45 years	35	3.8857	.99325
45-50 years	35	3.3429	.80231
50 years and above	35	2.1714	1.04278

Valid (listwise)	N	35	3.4429	
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From table 4.3.1 shows that the average mean response was 3.44 which implies a level of moderate level of agreement that age influence performance given the scale range from 5 to 1, 5 being to a very great extent while 1 being not at all level of agreement. The analysis on individual means shows that age below 35 years was perceived to affect management the most.

**Table 4.3.2 Descriptive statistics on qualifications**

	N	Mean	Std. Deviation
Diploma	35	4.4000	1.19312
Higher Diploma	35	3.1143	1.15737
Degree	35	3.6571	1.05560
Masters	35	2.6286	.97274
PhD	35	1.9143	1.29186
Valid (listwise)	N 35	3.1429	

The analysis in table 4.3.2 shows that diploma qualifications affects the performance of organizations the most while Phd. qualifications affected performance the least.

	N	Mean	Std. Deviation
Accounting	35	3.8000	1.54919
Management	35	3.6286	1.13981
Engineering	35	2.6286	.97274
Others	35	3.0286	1.09774
PHd	35	2.2571	1.61506
Valid (listwise)	N 35		

**Table 4.3.3 Past Experiences.**

The analysis in table 4.3.3. shows that past experience in accounting was perceived to have the greatest influence in organization

performance.

## 5.0 Conclusions and Recommendations

### 5.1 Summary of Findings

The first analysis was to establish the role of the balanced scorecard on the performance of companies listed in the Nairobi Securities Exchange. A large number of respondents agreed that customer retention and handling customer complaints was considered to be a valuable asset. Organization and business processes being designed to enhance the quality of organization focusing on E- learning and increase in

net profit had the highest rating towards affecting organizations listed in the NSE. The second part of the analysis was to evaluate the influence of organizational factors on the performance of organizations. A large number of respondents had the perception that cultural processes and systems affect performance and leader training and development influenced organizational performance to a great extent. The last part of the analysis was to evaluate the effect of managerial characteristics on the performance of organizations in the Nairobi Securities Exchange. Majority of the respondents agreed that managers below the age of 35 years and diploma holders had the greatest influence on organizational performance.

### **5.3 Conclusions**

The Balanced Scorecard was found to influence the performance of organizations as stated below:-

- (i) It was found out that customer focus influenced the performance of organizations in the NSE. Customer retention was a key priority to organizations. Handling of customer complaints also influenced the performance of organizations. However, organizations were found not to give freedom to employees to respond to customer enquiries.
  - (ii) Business processes were found to influence the performance of organizations positively but employers were found not to give responsibility and authority to employees in designing the business processes which were geared towards the enhancement of quality.
  - (iii) The use of technology and e-commerce was found to influence organizations positively. However, firms were found not to invest in research and development.
  - (iv) Increase in profits was found to be the highest measure of performance followed by increase in market share, operating income and liquidity position.
2. Organizational factors were found to influence the performance of organizations in the following ways:-
- (i) Cultural processes and systems influenced performance to a very great extent.
  - (ii) Leadership styles influence performance to a low extent.
  - (iii) Human resource management influenced performance to a great extent but employers were not willing to invest in human resource.
3. Managerial characteristics were found to influence performance in the following ways:-
- (i) The managers below 35 years of age were found to introduce value-based management in their organizations and to be high performers.

- (ii) Managers with Accounting background were found to introduce value-based management in their organizations.
- (iii) Managers with less than Phd. qualifications were found to influence the performance of organizations to a great extent.

#### **5.4 Recommendations**

Organizations listed in the Nairobi Securities Exchange should implement the use of the Balanced Scorecard both as a value-based management tool and as a performance measure to improve the performance of their organizations.

#### **5.5 Suggestions for further Research.**

This study has implications for future research.

- (i) Further research could be done to establish why Diploma Holders were found to influence the performance of organizations more than Phd. holders.
- (i) Further research could also be done to establish why organizations were not willing to invest in research and development as well as on staff training and development.
- (ii) This research could be replicated in different organizations, and with different stakeholders. Preferably, new studies should be conducted in other sectors to see if the results can be extended.

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## **B2012-05: Marketing Strategies that Attract and Increase Student Enrollment in Institutions of Higher Learning: Case of Private Universities in Kenya**

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### **Abstract**

University Education in Kenya has experienced tremendous growth in the last decade due to rising number of students seeking post secondary school education. A mismatch between capacity in public university and the number of students, who directly qualify, result in a number of students to seek admission in private universities while some still find admission in public universities as privately sponsored students. It is important for private universities to have up-to-date knowledge and information regarding marketing strategies to adopt in order to attract and enroll a good number of students. This study is aimed at identifying marketing strategies that could be applied by private universities so as to attract and enroll students. Descriptive research design was adopted in the study. Probability-simple random sampling technique was used to obtain a sample of 98 continuing undergraduate students and 28 employees from two private universities in Kenya and a questionnaire was used as the research instrument. Descriptive data was analyzed using statistical program for social science (SPSS). The findings indicate that advertising using an institution web site, advertising using the various media stations, use of social networks such as face-book, encouraging word-of-mouth, career fair involvement, open day on campus and alumni support are marketing strategies that can offer opportunity to attract and increase enrolment of students.

**Keywords:** *Marketing Strategies, Students Enrolment, Private Universities*

### **Introduction**

University education in Kenya has expanded dramatically in recent years. Since the year 2000 there has been a significant expansion of both public and private universities in Kenya in response to higher demand for university education. This is evident by the number of constituent colleges and campuses that have so far been established in the past three years. A number of Technical Training Institutions including National Polytechnics have been upgraded to university college status. Currently there are 25 Private Universities and 7 Public Universities in Kenya, with 24 public university constituents' colleges (Commission for Higher Education, 2012).

The emergence of several private universities and public university constituent colleges means that private universities must become more aggressive in marketing their institutions in order to increase their market share in terms of student number and the quality of those enrolling. This has resulted to fierce competition among the private and public universities trying to offer the best so as to enhance its enrolment of students. Nevertheless, public universities have an upper hand arising from support in terms of long standing government financial support. As such, even without aggressive marketing strategies, public universities still enroll students to their programmes through Joint Admissions Board (JAB) while

some enroll through self sponsorship programme (SSP). However, the number of students absorbed by public universities represents a small fraction of those who qualify. For instance, in 2007, about 82,000 had qualified but public universities through JAB enrolled about 16,000 students only (Daily Nation, March 6, 2009). Normally, the remaining students with financial ability and desire to pursue university education seek admission either in Private universities or Public universities' self sponsored programmes. As a result, Institutions of Higher Learning (IHL) make every effort to maximize their full potential through effective use of marketing strategies in order to create awareness of their services in order to attract and enroll students.

According to Richardson (2000) an institution can fail to achieve its objectives thereby losing its competitive edge hence lose its market share to its competitors. Further, it will depend on how effectively the institution uses the scarce institutional resources to enhance quality on the same. With a view to gaining a competitive edge and gaining a larger share of the national market, universities have finally realized the role of marketing as a powerful source of competitive advantage in increasing enrolment of its students (MacGregor, 2000; Merten, 2000). Competitive pressure has forced the higher educational institutions to look for more competitive marketing strategies in order to compete for students in their respective markets (Joseph & Joseph, 2000). In response to these changes, the value, effectiveness and potential benefits of using marketing theories and concepts, which have been effective in the business world, are gradually now being applied by many universities so as to attract and enroll a good number of students. It is against this background that the study sought to establish competitive marketing strategies towards enhancing students' enrolment (a case of two Private Universities in Kenya).

### **Objectives**

Though the results may have implications for all private universities in Kenya, the study focused on two selected private universities. The first objective was to determine the rate of student enrolment between the period (2006 - 2010) in the selected private universities. The second was to establish marketing strategies that offer opportunity to attract and increase enrolment of students and what could be improved on in order to attract and increase students' enrolment. . We sought to answer the questions on what was the rate of student enrolment between the period (2006 - 2010) in the selected private universities in Kenya and what are the marketing strategies that could be employed in order to attract and increase enrolment of students in private universities. Finally, to answer the question on what marketing strategies that private universities could improve on in order to attract and increase students' enrolment.

## Methodology

This study employed the descriptive research design aimed at collecting information by interviewing a sample of individuals to determine their attitudes, opinions and habits (Kothari, 2004). This design was suitable for the study for it sought to describe staff and students' attitude and perception towards their institutions in regards to marketing strategies that could be employed by institutions of higher to attract and increase enrollment of students. This design was preferred because it enables direct generation of information and creates the opportunity for in-depth responses, and consequently provides a good understanding of the phenomenon under study (Mugenda & Mugenda, 2003).

Population refers to the entire group of individuals, objects, items, cases, articles or things with common attributes or common observable characteristics that fit specifically for being sources of the data required to address the research problem (Mugenda, 2008). The population comprised all continuing undergraduate students and staff working in the marketing/corporate affairs, admissions and academic departments (HODs) in the selected private universities. Target population comprise of all individuals, objects or things that the researcher can reasonably generalize his or her findings (Mugenda, 2008). The target population was derived from all 4<sup>th</sup> years continuing undergraduate students and all staff working in the admissions, marketing/corporate affairs and academic departments (HODs). A total of 976 students fall under the targeted 4<sup>th</sup> year continuing undergraduate students (Kabarak 276, Daystar 700) and 28 members of staff (Kabarak 11, Daystar 17).

A sample size refers to the number of objects to be selected from the population to constitute a sample (Gravetter & Forzano, 2009). The sample size was 98 fourth year continuing students which was 10% of the target population of 976 which is in line with Mugenda and Mugenda (2003) who gives 10% of the target population as the minimum sample size for descriptive studies. Since the number of staff working in the selected departments was relatively small, all the 28 employees in these departments were included in the study (100%). The sample size therefore, was 98 for continuing undergraduate students and 28 staff as shown in Table 1 on page 5.

Table 1: Target population and Sample size

University	Target population		Sample size	
	Staff	Students	Staff	Students
Kabarak university	11	276	11	28

Daystar university	17	700	17	70
Total	28	976	28	98

Source: Kabarak and Daystar University Admissions offices (2011)

Sampling is defined as the process of selecting a number of individuals for study in such a way that the individuals selected represent the large group from which they are selected (Cooper & Schindler, 2003). Simple random sampling method was used whereby three classes of 4th year students for Daystar University were identified where a sample of 70 undergraduate 4th year students were asked to voluntarily fill the questionnaires. For Kabarak University, a sample of 28 students was randomly sampled from a class of 36 continuing 4th year students where the first 28 students to enter class had a chance of being included in the sample. All the staff (28) working in the admission, corporate affairs and academic staff (who were represented by Head of Departments) were part of this study. The sample was therefore 98 for continuing undergraduate 4<sup>th</sup> year students and 28 for staff as shown in Table 1 on page 5.

Both primary and secondary data was used for this study. Primary data was collected from the respondents through the questionnaires while secondary data was collected from the institutions' records and reports. Based on our own insights developed during learning marketing, a questionnaire was developed and tested on a judgmental sample of students and staff in a private university, resulting in some changes being made to clarify certain issues. Permission were sought from the government (National Council for Science and Technology) to conduct research. A number of questionnaires were administered at the beginning or end of lecture, with the permission and assistance of the lecturers while the researcher self-administered other questionnaires to staff members.

A total of 126 questionnaires were administered to 4<sup>th</sup> year continuing students and staff in the corporate affairs/marketing, admissions and academics department (represented by HODs) where a total of 113 were filled and returned which constituted an 89.6% response rate. Out of the 113 respondents (those who answered and returned the questionnaires), 79.6% were students while 20.4% were the staff as shown in Table 2 on page 7. The 89.6% is adequate response rate as argued by Mugenda and Mugenda (2003) that the return of 50% or more is acceptable. Non response rate in this study was 10.3%. The

findings and the results were analyzed using SPSS. Presentation is done in frequencies and percentages followed by the interpretation of the occurrences of the findings from the data analyzed. Other findings of the open ended questionnaires were examined qualitatively.

Table 2: Response rate

Respondents	Questionnaires Issued	Questionnaires Received	Percent
Students	98	90	79.6
Staff	28	23	20.4
Total	126	113	100.0

### Results and discussion

The study used enrolment data obtained from the admission offices in the selected universities, as reflected in Tables 3 and 4 on and Figure 1 and 2 on page 19 & 20 respectively which indicated that there was a steady growth in student enrolment of undergraduate students of Kabarak university between the periods 2006 and 2007 but it declined between 2007 and 2009 whereby the student enrolment started increasing in the year 2010. Daystar university students' enrolment also increased steadily between the years 2006 and 2009 whereby it declined in the year 2010. The figures for May semesters and January 2010 were not included because it was not forthcoming; hence the results regarding the student enrolment indicated in Table 4.3 excludes data for May semesters.

Table 3: Kabarak University undergraduate student total enrolment (2006-2010)

	2006	2007	2008	2009	2010
January	437	749	943	974	1191
May	526	859	952	941	1191
September	640	984	968	1059	1400

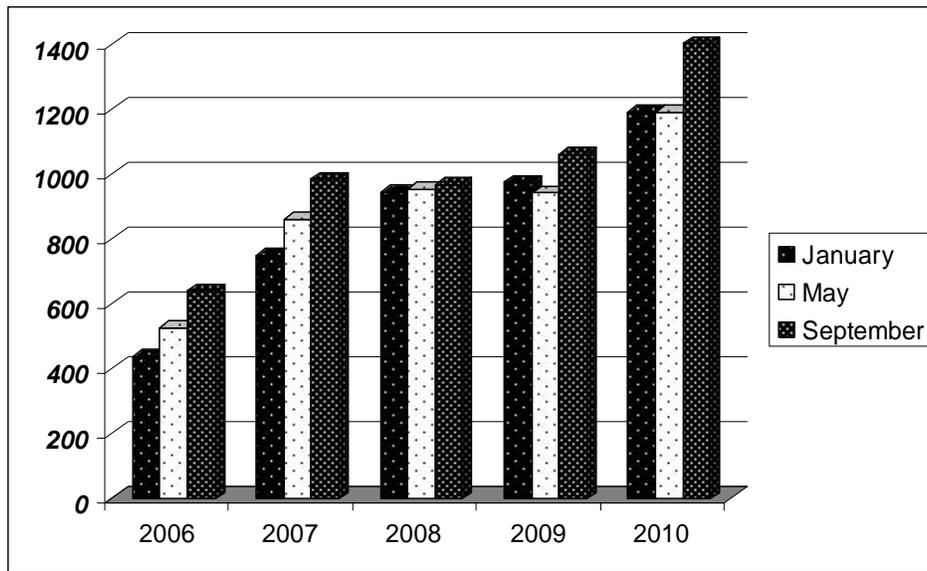


Figure 1: Kabarak University undergraduate student total enrolment

Source: Kabarak University Admission office

Table 3: Daystar undergraduate student total enrolment (2006-2010)

	2006	2007	2008	2009	2010
January	2109	2210	2491	2655	0
September	2180	2339	2612	2914	2828

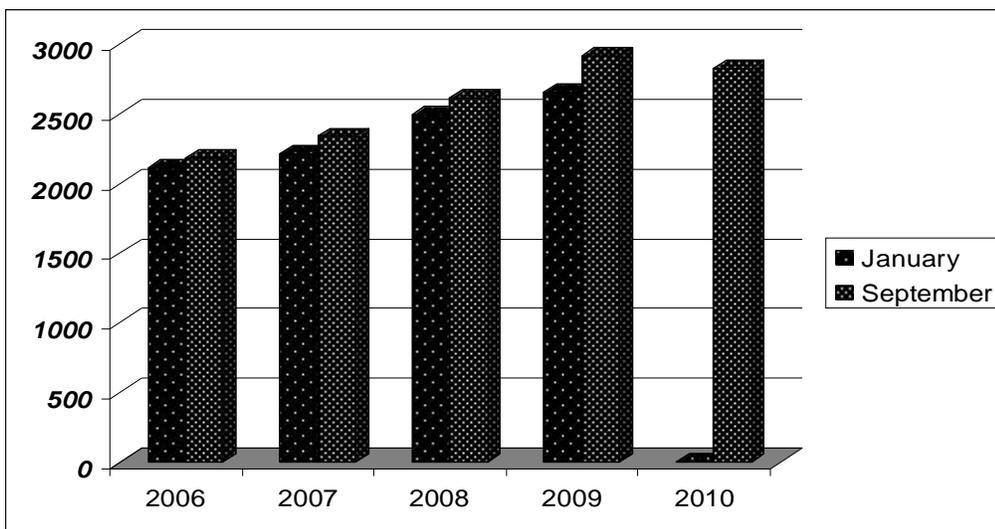


Figure 2: Daystar University undergraduate student enrolment

Source: Daystar University Admission office

Rate of student enrolment

The study sought to establish the rate of student enrolment for the last five years from 2006 to 2010 in the selected private universities. Regarding Kabarak University rate of student enrolment, the results in Table 4 and Figure 3 on page 59 indicates that rate of students' enrolment between the period 2006 to 2007 was 71.3% in January, 63.3% in May and 53.8% in September while, between the year 2007 and 2008 the rate of students' enrolment decline at a rate of 25.9% in January, 10.8% in May and -1.6% in September. Consequently, between the year 2008 and 2009, the rate of increase of students enrolment also increased but on a declining rate of 3.2% in January, -1.1% in May and 9.4% in September and finally between the year 2009 and 2010 the rate of increase of student enrolment increased on an increasing rate of 22.3% in January, 15.9% in May and 32.2% in September. This implies that although there was an increase in enrolment of students, the rate of increase was on the decline in some years however, an increase of student enrolment was realized in the year 2010 as seen in Table 4.2 and Figures 4.2 respectively.

Table 4: Kabarak university undergraduate student rate of enrolment

	2006/7	2007/8	2008/9	2009/10
January	71.3	25.9	3.2	22.3
May	63.3	10.8	-1.1	15.9
September	53.7	-1.6	9.4	32.2
Total rate of increase	61.7	10.5	3.9	27.2

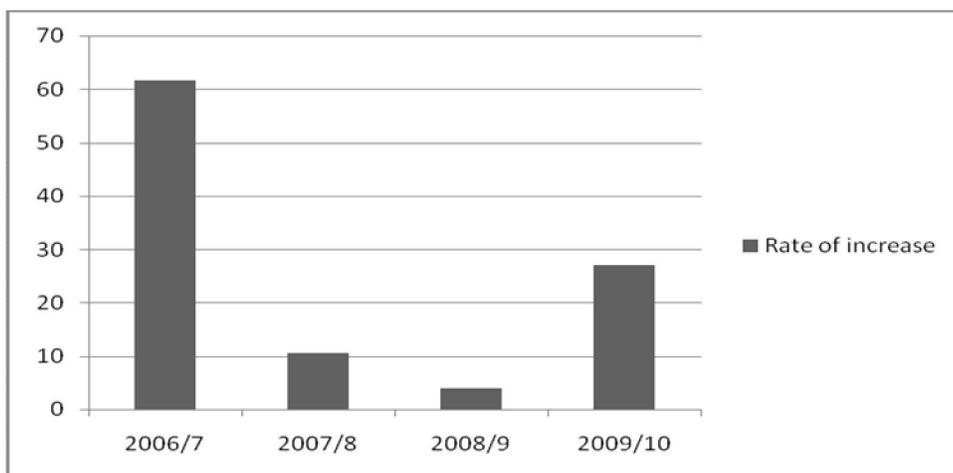


Figure 3: Kabarak university undergraduate student rate of enrolment

Source: Daystar University Admission office

Table 4.3 and Figure 4.3 shows the findings of Daystar University rate of undergraduate student enrolment between the period 2006 to 2010.

Table 4.3: Daystar university undergraduate Student rate of enrolment

	2006/7	2007/8	2008/9	2009/10
January	4.8	12.7	6.6	0
September	7.3	11.6	11.6	-2.9
Total rate of increase	6.1	12.1	9.1	1.5

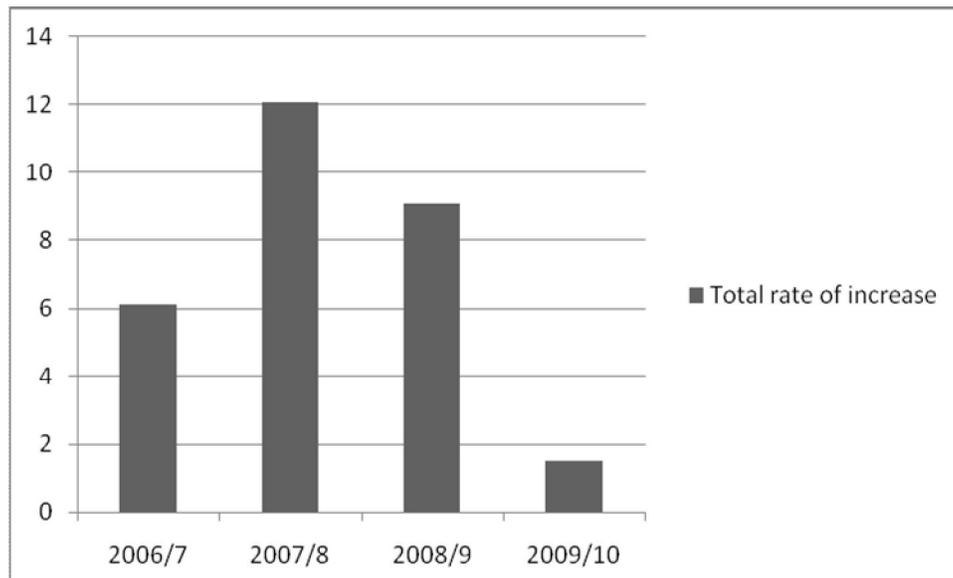


Figure 4.3: Daystar University undergraduate student rate of enrolment

Source: Daystar University Admission office

The results therefore, revealed that in the period 2006/7 there was an increase of students' enrolment with a rate of 4.8% in January and 7.3% in September. For the period 2007/8 there was also an increase of student enrolment with rate of 12.7% in January and 11.6% in September. But in 2008/9 the rate of increase of students' enrolment increase with a declining rate of 6.5% in January and an increasing rate of 11.5% in September. Consequently, in 2009 to 2010, the rate of increase of student enrolment decreased on a declining rate of -2.9% as indicated in Table 4.3 and Figure 4.3 on page 60 respectively.

The findings regarding the rate of undergraduate student's enrolment in the selected Universities revealed that the rate of student enrolment was increasing on an increasing rate but the increase is on the decline as reflected in Figures 4.2 and 4.3 on page 59 and 60 respectively. The changes in enrolment rate could be as a result of the emergence of several private universities and public university's constituent

campuses that has made the field of Higher Education to become increasingly competitive as stated by (CHE Handbook, 2010).

### Marketing strategies that can offer opportunity to attract and increase enrolment of students

The study sought to find out the extent of some marketing activities that private universities may employ in order to attract and increase enrolment of students by extent of agreement. The findings revealed that 83.3% of the respondents agreed with higher employability after graduation while 10% disagreed. This was followed closely with promotional aspects like promotion via the web (i.e. world wide web), with 80.5% agreeing while 10.6% disagreeing, advertising with 79.6% agreeing while 10.6% disagreeing, whose findings are in line with the literature according to Hayes (2009) who claimed that advertising is but one of the tools the universities employ to inform, remind and persuade prospective students to select their institution. At the same time, the respondents also agreed with Career fair involvement, Open day on campus and alumni support each with 79.6%, 72.5% and 71.9% respectively. Respondents also regarded faculty specific prospectuses as important with 72.5% agreeing while 10.7% disagreeing which support the findings of Nicholls (1985) who argued that despite there being a considerable growth in the role of the internet in accessing information about universities and the programmes that they offer, printed materials mailed to or collected by students remains an important tool in the marketing armoury and considerably more so than the traditional forms of promotion. In regard to contact with university career counsellors and recruiters visit high schools 69.0% and 65.4% of the respondents agreed while 16.8% and 22.1% disagreed respectively.

The findings showed that the main marketing strategies that can offer opportunity to attract and increase enrolment of students are promotional strategies which include promotion via the web (i.e. world wide web) advertising through the media, Career fair involvement, open day on campus and recruiters visit high schools. Faculty specific prospectuses, higher employability after graduation, alumni support and contact with university career counsellors are some of marketing strategies that can attract and enhance enrolment of students.

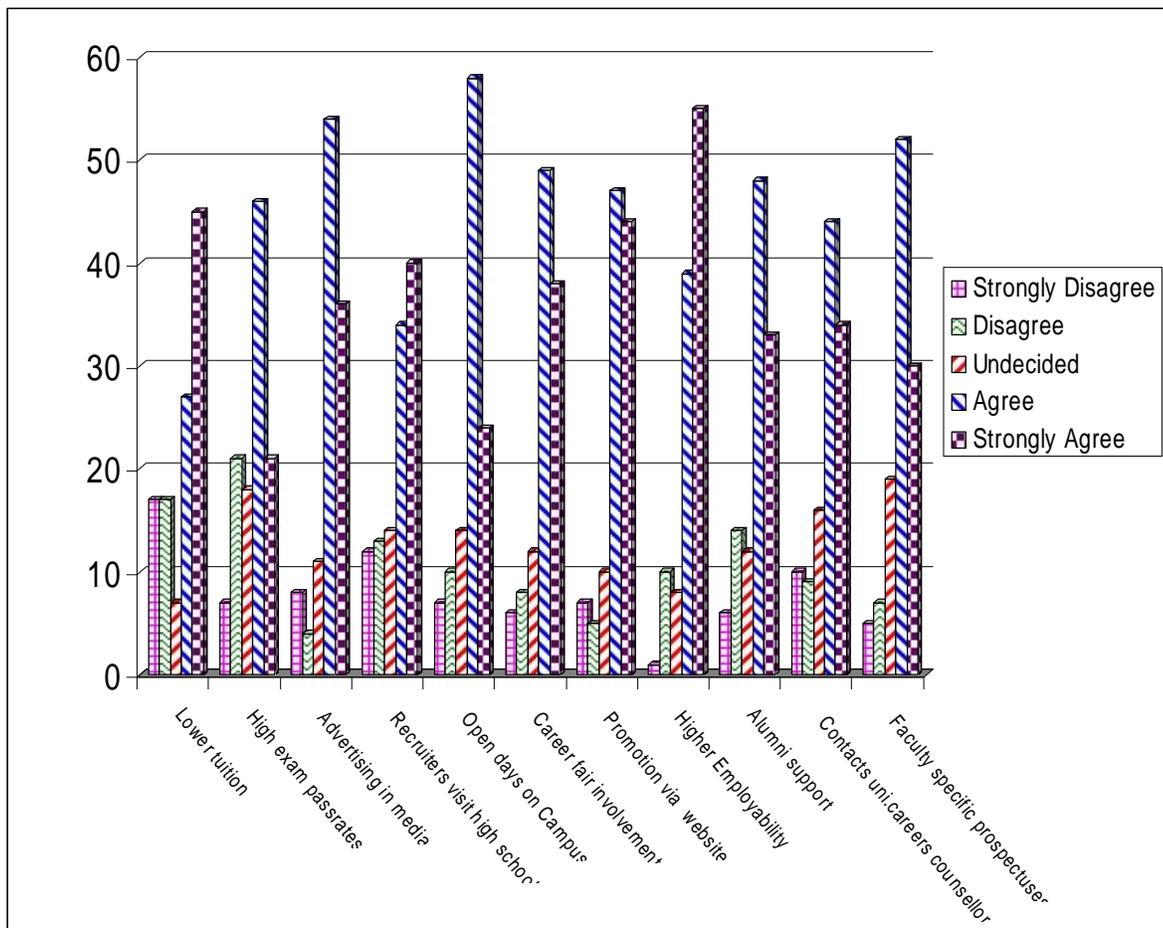


Figure 4.5: Extent to which marketing activities may be employed by private universities

Other suggested marketing strategies that private universities could employ in order to attract and increase students' enrolment included advertising through various media stations such as print media like newspaper, radio stations, and social networks such as Facebook as well as word of mouth. Others are promotional strategies such as career days, exhibition, open days and campus visit. Image and reputation through publicity in form of corporate social responsibility, support for the community, educational scholarship through sports and assisting students get employment. Others included support from the management, fee waiver for parents with more than one student, outdoor advertising such as billboards and road shows.

#### *Marketing strategies universities need to improve on*

The study found that there are several areas that a university needs to improve in order to attract enrolment of students. These areas include improving registration process by going online, constant update of the institution website, creation of close links with industries, involving students in marketing

and encouraging word of mouth. There is need to introduce sports into academic curriculum through which sports scholarship can come in. The study also found out that programs should always be reviewed and more to be developed that are marketable and are in line with the industry needs in order to attract student's enrolment. This supports the literature by Kotler and Keller (2009) who stated that highly innovative firms are able to identify and quickly seize new market opportunities. This can be done through development of new programs, new learning concepts and new research findings.

## **B2012-07: Relationship between Human Capital and Business Performance of Pharmaceutical Firms in Kenya**

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### **Abstract**

Human capital is a range of valuable skills and knowledge a person has accumulated over time and it is the resourcefulness that gives an organization a competitive advantage since it cannot be imitated by the competitors and therefore it is a strategic resource and an asset to the organization. There is no doubt human capital plays a crucial role in the current ever-challenging and aggressive business environment, particularly in knowledge-intensive organizations such as pharmaceutical industry. The organizations that aspire to be successful and competitive need to demand and find better ways to improve their business performance by utilizing their human capital. This study sought to establish the relationship between human capital and business performance of pharmaceutical firms in Kenya. Three research questions were used to test the relationship of the components of Human capital with the Business performance of the pharmaceutical companies in Kenya. Data was collected from 19 pharmaceutical firms. Pearson correlation and regression were used to test the relationship and significance. The findings indicated that the three dimensions of Human capital that is learning and education, experience and expertise, innovation and creation have positive and significance relationship with business performance of pharmaceutical firms'. However learning and education was the most significant variable. Therefore, accounting for human capital is essential for the improved business performance of pharmaceutical firms.

**Key words:** *Human Capital, Learning and Education, Experience and expertise, innovation and creativity, Business performance, pharmaceutical industry.*

### **Introduction**

The growing importance of human capital and intellectual property as determinants of economic success at both the macroeconomic and enterprise levels, it should also be clear that the nature of investments made by firms needs to shift to reflect the new economic realities. Specifically, if human capital is a key determinant of organizational success, then investments in training and development of people also become critical (Flamholz, 2002).

As an intangible asset, human capital gains no specific recognition on the standard financial statements of corporations. However, in the new economies of the 21<sup>st</sup> century it is becoming increasingly clear that intangible factors such as the firm's investments in human resource are playing an increasingly dominant role in the creation of wealth. The capability for a value proposition to the marketplace through economic activity increasingly consists of exchanges of information, ideas, communication, and expertise in distinctive competencies and services. Corporate profitability is often driven more by organizational capabilities than by control over physical resources, and even the value of physical goods are often due to such intangibles as technical innovations embodied in the products, brand appeal, creative presentation ( Lev, 2001).

### **Pharmaceutical industry in Kenya**

Kenya uses about 8% of the GDP on health. According to African countries supplying pharmaceutical products to the Common Market and COMESA, Kenya exported US\$ 43,677 in 2008 and this is likely to go up UNIDO, (2011). The pharmaceutical industry in Kenya consists of three segments namely the manufacturers, Distributors and retailers and all these play a major role in supporting the country's health Sector which is estimated to have about 4557 health facilities country wide (PSK , 2010). Kenya is currently the largest producer of pharmaceutical products in the common market for eastern and southern Africa region supplying about 50% of the regions market. Out of the regions estimated 50 recognized pharmaceutical manufacturers, approximately thirty are based in Kenya. It is also approximated that about 9,000 pharmaceutical products have been registered for sale in Kenya.

Currently, medical care is a prerequisite among employers; the law requires that every employer ensure the provision of proper medicines and attendance to employees unless otherwise provided for by the government (labor laws, 2007). The pharmaceutical industry is important and crucial sector in the Kenyan economy. The pharmaceutical sector consists of about 31 licensed concerns which include local manufacturing companies and large multinational corporations. These firms collectively employ over 2000 people, about 65% of who work in direct production. The companies that were considered in this study were sought from the pharmaceutical society of Kenya which its roles and objectives are licensing the pharmacists, as well as ensuring the drug store managers are members of the pharmaceutical society and have sworn allegiance to the pharmacy practitioners professional oath (PSK,2010).

### **Statement of the problem**

Conventional financial statements treat human resources investments as expenditures; hence training human resources is treated as an expense rather than investments in the business organizations. Human

capital is not recognized in the statements of financial position of business organizations as assets yet from human resource perspective it is referred to as strategic asset (Canibano *et al*, 2000, Ashton, 2005).

Firms that extensively account for the input of human capital in their organizations are more competitive than those that do not and therefore they are more successful (salleh, 2007). In Kenya seldom none of the pharmaceutical firms account for their human capital in their financial statements and therefore, have difficulties attracting investors (Kristandl & Bontis, 2007). Hence the need to study the relationship between human capital and business performance of pharmaceutical firms in Kenya

### **Specific objectives of the study**

Specifically the study sought to determine whether learning and education, experience and expertise, innovation and creativity influences business performance among pharmaceutical firms in Kenya.

### **Literature Review**

#### **Human capital theory**

This theory emphasize the value added that people contribute to an organization. It regards people as assets and stresses that investments by organizations in people will generate worthwhile returns. The theory is associated with the Resource based view of the firm as Barney, (1991). The theory proposes that sustainable competitive advantage is attained when the firm has a Human Capital that cannot be imitated or substituted by its rivals, for the employer investments in training and developing people is a means of attracting and retaining human capital as well as getting better returns from those investments.

Human Capital is a component of intellectual capital which has been referred to as a strategic asset (Bontis, 1998) and this is what makes an organization to perform better due to its unique characteristics that cannot be imitated. These returns are expected to be improvements in Business performance, human productivity, flexibility and the capacity to innovate that should result from enlarging the skills base and increasing levels of knowledge and competence. According to Schuller (2000), he suggests that the general message is persuasive skills, knowledge and competences are key factors in determining whether organizations and firms will prosper or fail. The dimensions of human capital investigated in the study include the following;

#### **Learning and Education**

This contains the competencies, skills and intellectual agility of the individual employees. Tan *et al* (2007), adds that as part of intellectual capital variable it also includes collective knowledge of individuals which steers the organization to achieve objectives and goals hence improved business performance.

#### **Experience and Expertise**

These are the competencies and the skills which are presented by the individuals in the organizations. This is what gives the organizations competitive advantage over other organizations when a company has employees with the conceptual skills and they have worked in related departments for some times and therefore they are in a position to transform the organization to better performance. This is indicated by employees being experts in their respective areas and they are professionals in their careers (Curado & Bontis, 2006).

### **Innovation and Creativity**

Creativity is the ability to think a new idea. Innovation is the process by which the new idea is put into practice. This definition of creativity allows for the artistic creative genius and the brilliant inventor, but also enables everyone to be creative, since anyone can have a new idea. The definition of innovation links the world of ideas to the world of human affairs. Innovation and creativity are addressed everywhere in the organization where by employees come up with new ideas that give the organizations competitive advantage over the others hence improved business performance (Edward, & Roberts, 2007).

### **Business Performance**

Many authors strongly believe that human capital could have positive effect on the company's financial performance (Riahi- Belkaoui, 2003; Youndt *et al*, 2004; Chen *et al*, 2005; Tan *et al*, 2007). Business performance is defined as measurable result of the level of attainment of organizational goals or measurable result of the organizations management of its aspects mechanism for improving the likelihood of the organization successfully implementing a strategy. Business performance evaluation is the process to help management's decisions regarding an organizations performance by selecting indicators, collecting and analyzing data, assessing information against performance criteria, reporting and communicating and periodically reviewing and improving this process.

The business performance was measured by use of (Sales Growth, Profits Growth), Human Productivity (Employee Productivity, Process Productivity, Industry leadership) and Market valuation (Stock Value). According to (Youndt *et al* 2004) intellectual capital intensive companies are more competitive than other companies and are therefore more successful. It has been argued that the success of an organization depends on how best the scarce physical resources are utilized by human resources. The physical resources are being activated by the human resources as they cannot act on their own.

According to the resource based view, firms may gain competitive and can achieve superior performance through the acquisition, holding and subsequent use of strategic assets (Barney, 1991). Both tangible and intangible assets are perceived as potential strategic assets. Among the invisible assets,

human capital is generally considered to be a vital strategic asset (Riahi-Belkaoui, 2003, Seethamraju, 2000). Many scholars argue that in comparison with the tangible resources, intangible resources are more likely to be the key resources for many enterprises which help them in acquiring the required competitive advantage or to ensure market dominance Marr, (2004).

### **Methodology**

The study adopted descriptive research design to identify, analyzes, and describes the relationship between human capital and business performance of pharmaceutical firms in Kenya (Thorn hill *et al*, 2009, 2009, Nicholas, 2011, William, *et al*, 2010). This design provides an accurate account of characteristics of a particular individual event or group in real life situation, (Kothari, 2004, Mugenda, 2008). Descriptive design may be used for the purpose of developing theory, identifying problems with current practice, justifying current practice, making judgments' or determining what others in similar situations are doing (Herbert, 2011, Sekaran, (2008).

The target population was pharmaceutical manufacturing firms listed by the pharmaceutical society of Kenya. The target population was 89 pharmaceutical firms as per the directory of manufacturers (Kimotho, 2010). The sample frame was 31 local manufacturing pharmaceutical companies' licensed by the pharmacy and poisons board 2010.

### **Sample and sampling technique**

Sampling is done to some elements of a population so that conclusions about the entire population can be drawn. The ultimate test of a sample design is how well it represents the characteristics of the population it purposes to (Kothari, 2004, Thorn hill, 2009, Nachmias & Nachmias, 2008). The entire target population constituted 89 local pharmaceutical manufacturers, but only 31 local manufacturers were chosen since they had been licensed by Pharmacy and Poisons Board. This constituted 35% of the population.

According to (Mugenda 2008, William *et al*, 2010, Orodho and Kombo, 2002) they recommend that for small populations a sample of 30 is statistically significant. The respondents were human resource managers but their deputies were considered where the Human resource managers were not present to respond to the questionnaires. These managers of each pharmaceutical firm were chosen using simple random sampling to give them equal chances of being selected.

### **Measurement of Dependent Variable**

Three dependent variable were taken into account namely; profitability, human productivity and market valuation. Correlation analysis was done to establish whether there was correlation between Profitability and human capital, Human Productivity and human capital and Market valuation and human capital of the Pharmaceutical firms. These are denoted respectively as:

### **Profitability**

Profitability was measured using sales growth which is the increase in sales over a specific period of time, often but not necessarily annually and profit growth which is a combination of profitability and growth, more precisely the combination of economic profitability (Brealey *et al*, 2005).

### **Human Resource Productivity**

In human resources, productivity is more difficult to measure, understand and define. According to (Rob, 2010, Saari, 2006, Lazear, 2000, Bandiera, *et al*, 2010), what influences the productivity levels of staff is wide variety of skills, characteristics and attitudes. Productivity describes how efficiently inputs are converted into outputs. According to Watson (2002), the productivity of a firm lies more on its intellectual capital and system capabilities than on its hard assets.

Bontis *et al* (2000) argues that leveraging knowledge assets is the key to a firm's prosperity. A firm with higher capital performance is expected to have higher rate of profitability and also it may experience higher productivity (Rob, 2010, Saari, 2006, Lazear, 2000). This was measured by employee Productivity and Process transaction Productivity, success rate in new products launches.

### **Market Valuation**

Intangible Assets are difficult to measure; it is common to find use of proxy metrics Kannan & Albur (2004). There is no adequate empirical evidence that supports the superiority of any proxy measure over the others. The sub construct in the dependent variable was measured by the company's stock value, response to competition, overall business performance and success as well as future outlook

### **Measurement of Independent Variables**

The independent variables were first run through the statistical package for social sciences to test their reliability by establishing their cronbach alpha. Then they were subjected to factor analysis so that the sub contrast that had an item to total correlation of less than 0.2 were eliminated and they were not to be used for further analysis. The cronbach alpha of the three variables that is; learning and education, experience and expertise, innovation and creation was 0.70, which is considered good for exploratory research (Nunnally, 1978).

### **Instruments**

The main primary tool of data collection was the structured questionnaire which was used to collect factual information with likert scale from 1 to 5. The structured questionnaires are recommended because they help the respondents to respond more easily and help the researcher to accumulate and summarize responses more efficiently (William, 2006, Thorn hill, 2009). In this study likert scale was used since the data obtained was ordinal.

### **Multiple Linear Logarithmic regression**

For the analysis of the respective relationship between the business performance and dimensions of human capital were defined from the conceptual framework, multiple linear regression analysis was performed based on the model.

$$\ln BP = \beta_0 + \beta_1 LE + \beta_2 EE + \beta_3 IC + \varepsilon$$

Where  $\ln BP$  = logarithm of Business Performance

$\beta_0$  = Intercept

$\beta_1 - \beta_3$  = Slopes coefficients representing the influence of the associated

Dimensions of human capital over the business performance

$LE$  = Learning and education

$EE$  = Experience and expertise

$IC$  = Innovation and creation

$\varepsilon$  = Error term

### Data Collection Procedure

The questionnaire targeted the Human resource managers and their deputy's managers drawn from the pharmaceutical manufacturer's population. Human resource managers and their deputy's of the pharmaceutical firms were the most knowledgeable with respect to the overall situation of their firms. Cooper & Schindler (2006) recommends the use of questionnaire in descriptive studies because typically cost less than personal interviews, sample accessibility.

### Data Processing and Analysis

Data analysis was guided by the research objectives. Data from the questionnaire were edited, coded and analyzed. In order to test for the normal distribution of response data, a Kolmogorov – Smirnov test for dependent and independent variables was conducted. Pearson Bivariate correlation coefficient was used to test the relationship between independent and dependent variables.

The correlation coefficient was calculated to determine the strength of the relationship between independent and dependent variable. Analysis of variance test was then used to analyze whether the relationships were statistically significant (Mugenda, 2008, Herbert, 2011, Sekaran, 2008 & William, *et al*, 2010). Multiple regression analysis was conducted to test whether the individual research question was statistically supported (Cooper & Schindler, 2006, Sekaran, 2008).

## Results and Discussions

**Table 4.1 Descriptive of learning and education**

	N	Mini mum	Maxi mum	Mean	Std. Deviation
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	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Q1LE competence of company employee	18	2	5	3.67	.243	1.029
Q2LE company gets most out of employees cooperation	19	2	5	4.11	.228	.994
Q3LE undergo continuous training program to employees annually	19	1	5	3.79	.271	1.182
Q4LE company employees continuously learn from each other	19	1	5	3.53	.221	.964
Q5LE Ratio of educated personnel on average compared with industry	19	1	5	3.37	.267	1.165
Q6LE Company devotes a lot of time effort update and develop employees knowledge and skills	19	1	5	2.84	.220	.958
Q7LE Company's market share continually improve over past few years	19	1	5	3.42	.233	1.017
Q8LE Employees learning and education affect company's productivity	19	1	5	4.00	.216	.943
Q9LE Employees learning and education affect company's profitability	19	2	5	4.11	.169	.737
Q10LE Employees learning and education affect company's market value	19	2	5	4.00	.171	.745
Valid N (listwise)	18					

Table 4.2 indicates the descriptive statistics of learning and education. The results indicate that the pharmaceutical firms get much of results out of employee's cooperation(Q2LE), employees learning and education affects pharmaceutical firm's productivity and profitability as well as market value(Q8LE,Q9LE,Q10LE). This conforms to previous studies by (Cabrita & Bontis, 2008, Saari, 2011, Khalique *et al*, 2011). However, the pharmaceutical firms they need to devote a lot of time and effort to update and develop employee's knowledge and skills (Q6LE).

**Table 4.2 Descriptive of experience and expertise**

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Q1EE Company employees are experts in respective areas	19	1	5	3.74	1.098	1.205
Q2EE Company employees consistently perform their best	19	2	5	3.47	.964	.930
Q3EE Company employees generally give their all to make company different	19	1	5	3.32	1.003	1.006

Q4EE Company employees work for many years in the firm	19	1	5	3.21	1.273	1.620
Q5EE Company prides itself on being efficient	19	2	5	3.68	.946	.895
Q6EE staff are highly professional	19	1	5	3.37	.955	.912
Q7EE company has lowest cost per transaction of any in the industry	19	1	5	2.68	.946	.895
Q8EE Employees experience and expertise affect company profitability	19	3	5	4.16	.501	.251
Q9EE Employees experience and expertise affect productivity	19	2	5	3.89	.809	.655
Q10EE Employees experience and expertise affect market value	19	1	5	4.00	1.054	1.111
Valid N (listwise)	19					

Table 4.2 indicates the employees experience and expertise affects company productivity, profitability and market value (Q8EE, Q9EE, and Q10EE). It is indicative that employees are experts in respective areas (Q1EE). These results confirm other previous studies done by (Bin Ismail, 2005, Salleh & Salamat, 2007, Moslehi *et al*, 2006). However, the transaction cost of the industry needs to be improved (Q7EE).

**Table 4.3 Descriptive of Innovation and Creation**

	N	Mini mum	Maxi mum	Mean	Std. Deviation	Varian ce
Q1IC Company employees are considered creative and bright compared to other companies in the industry	19	1	5	3.26	1.098	1.205
Q2IC Company employees are keen to voice opinions in group discussions	19	1	5	3.47	1.172	1.374
Q3IC Company employees usually come up with new ideas	19	1	5	3.26	1.046	1.094
Q4IC Large numbers of new products are launched with competitors	19	1	5	2.89	.937	.877
Q5IC company employees encouraged new ideas and knowledge	19	1	5	3.26	1.147	1.316
Q6IC company employees satisfied with company innovation policies and programs	19	1	5	3.21	1.084	1.175
Q7IC company employees highly motivated and committed to share new great ideas	19	1	5	3.21	.976	.953
Q8IC employees innovation and creation affect company productivity	19	2	5	3.84	.765	.585
Q9IC employees innovation and creation affect company profitability	19	3	5	4.00	.667	.444

Q10IC employees innovation creation affect company market value	19	3	5	4.11	.658	.433
Valid N (listwise)	19					

Table 4.3 indicates that employee innovation and creativity affects company's productivity, profitability and market value (Q8IC, Q9IC, and Q10IC) (Cabrita & Bontis, 2008, Saari, 2011, Khalique *et al*, 2011). However the pharmaceutical firms they need to launch large number of new products with competitors.

### Reliability and validity analysis

**Table 4.4: Reliability and validity measures**

Variable	Number of items	Cronbachs alpha
Learning and education	6	0.736
Experience and expertise	5	0.542
Innovation and creativity	8	0.850
Business Performance	10	0.860

Table 4.4 indicates the reliability measures for the four variables that is Business Performance which had a cronbach alpha of 0.860, which shows that it is acceptable measure for business performance as per the Cronbachs rule of internal consistency reliability. Learning and education had a cronbach alpha of 0.736 which indicates that it is acceptable for further analysis. Experience and expertise had Cronbachs alpha of 0.542. However out of the independent variables innovation and creation had the highest Cronbachs alpha of 0.850 which indicates that it was highly reliable for further analysis.

### Influence of Human capital on business performance

The dimensions of human capital were used to test the influence. Pearson correlation coefficient indicated that LE, EE and IC influence Business performance with 0.723, 0.846 and 0.868 coefficients respectively. The overall logarithmic linear model was significant at  $F=140.034$  and  $P$  value 000. The overall model indicated that 95.9% of the variance in business performance was jointly explained by log of LE, EE and IC.

Three interaction models were used to come up with the best model of the study. Model 1 constituted  $LogEE$  and  $LogLE$  the model had adjusted  $R^2$  of 73.8% and was significant at  $F=24.890$ , and  $p$ -value 000 hence,  $\ln BP = -5.976 + 2.377LE$  and  $p$ -value 0.001 (without IC) Model 2 constituted  $LogIC$  and  $LogLE$  the model had adjusted  $R^2$  of 75.7% and was significant at  $F = 27.466$ ,  $p$ -value 000, hence  $\ln BP = -5.778 + 1.766LE$  at  $p$  value 0.043 (without EE). Model 3

constituted *LogEE* and *LogIC* the model had adjusted  $R^2$  of 70.3% and was significant at  $F = 21.130$ ,  $p$  value 000, hence  $\ln BP = -5.901 + 1.922IC$  at  $p$  value 0.003 (without LE). The best overall model of the study was Model 1 where learning and education was highly significant at value 0.001 as shown on table 4.5

**Table 4.5 Regression coefficients**

Model		Unstandardized		Standardized	t	Sig.
		Coefficients		Coefficients		
		B	Std. Error	Beta		
1	(Constant)	-5.976	1.303		-4.586	.000
	ln_LE	2.377	.596	.736	3.991	.001
	ln_EE	.645	.663	.180	.974	.345

## Conclusions

The findings showed that human capital influences Business Performance of Pharmaceutical firms in Kenya. The results indicated that learning and education, experience and expertise, innovation and creativity positively and significantly influence business performance. However business performance is a result of combined product of experience and expertise, learning and education. The objectives of the study were tested and the results indicated that all the three independent variables that is; learning and education, experience and expertise, innovation and creation had a positive significant influence on the Business Performance of the pharmaceutical firms in Kenya.

The purpose of the study was also arrived at since it was established that the pharmaceutical firms in Kenya do not account for their human capital and therefore they turn away the investors to other sectors of the economy. It was also discovered that the domestic pharmaceutical firms in Kenya are not listed in the securities exchange market and therefore their information is not public and this is a negative publicity to their operations in the market. As compared to international pharmaceutical firms the Kenyan pharmaceutical firms are performing poorly and it was discovered that the international pharmaceutical firms that operate in Kenya practice intellectual capital accounting hence their performance is above that of the domestic firms. An example of international firms that practice intellectual capital accounting is glaxosmithkline ltd.

The findings demonstrated that accounting for Human capital can be used to mobilize, assemble and manage all intangible resources in order to enhance business performance of pharmaceutical firms in

Kenya. The findings emphasize that Learning and education is the most important dimension of human capital that positively and significantly influences Business Performance.

### **Recommendations**

The following recommendations were derived from the results and findings;

#### **Recommendations on Research Findings**

The domestic pharmaceutical firms need to practice Human capital accounting because that is the only way they can lure the investors by providing sufficient information to them and therefore make informed decisions whether to invest or not, otherwise asymmetric information would affect the business performance of the pharmaceutical firms.

##### **1. Recommendation from the perspective of market leadership**

Managers can improve the company's market leadership through improving employee learning and education, experience and expertise, innovation and creation since they affect the company's market value.

##### **2. Recommendation from the perspective of Financial Performance**

Managers can improve the company's financial Performance through devoting a lot of time, efforts to update and develop employee's knowledge and skills. In order to achieve the objectives of the firm, managers should provide more incentives for employees to give their all. The firms should also launch large number of new products in the market and this would enhance competitive advantage hence improved financial performance.

##### **3. General recommendations for Market leadership and Financial Performance**

Managers can improve the pharmaceutical firms Business Performance through creating an environment where employees can brainstorm for creativity freely in order to improve firm's business performance.

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**B2012-09: Asymmetry of Information on Credit Reference Bureaus for Bank Customers in Kenya:  
A Case Study of Nakuru Town**

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**Abstract**

Credit Reference Bureaus (CRBs) are institutions that collect information from banks, creditors and available public sources on a borrower's credit history. The role of CRBs in Credit Information Sharing (CIS) is to compile database of customers' credit information and generate Credit Reports which banks and other authorized lenders use to appraise the credit worthiness of the customers. The purpose of the study was to establish the nature and extent of the information which the customers lacked about CIS and the causes of the asymmetry of information with a view to improving awareness and participation. The researchers conducted unstructured interviews involving customers from banks in Nakuru town, and wrote their responses verbatim. The data was analyzed qualitatively by identifying major themes, coding them, and carrying out content analysis. The researchers found that 62% of the customers were unaware of CIS. Furthermore, the informed customers had more exposure to their obligations in the CIS and the consequences of violating them. In contrast, they had no or little information about their rights and how they could benefit, hence low participation. Therefore, the policymakers and promoters of the CIS in Kenya should develop message content that highlights the benefits and rights of customers in the CIS.

*Key Words: Asymmetry of information, Credit Reference Bureaus, Customer, Credit Information Sharing, Credit Rating, Obligations, Rights.*

**INTRODUCTION**

Pursuant to the Banking Act (Credit Reference Bureau) Regulations 2008 (henceforth "the Act"), Credit Information Sharing (CIS) was rolled out in Kenya by the Central Bank of Kenya (CBK) in July 2010 and the banks started submitting the customers' credit information<sup>1</sup> in August 2010 to the two CRBs: The CRB Africa Ltd and the Metropol Ltd. According to CBK (2011) as of 11<sup>th</sup> April 2011 banks had submitted over 760,000 records and accessed 442,128 credit reports<sup>2</sup> from CRB Africa Ltd which was the only CRB. Against this commendable progress by banks, customers accessed only 865 credit reports which were below the CBK's expectations due to unawareness of CIS. However, to the researchers' knowledge there is no published works that empirically assesses the information gap about CIS in Kenya due to the infancy stage Kenya is at implementing CIS.

Therefore, this study seeks to establish the nature and extent of the information which the customers lacked about CIS, the causes of the asymmetry of information, and recommend ways to improve customer awareness and participation in CIS. The pertinent question which was of primary concern to the study was, 'are customers' aware of how CIS affects them?' The study found that 62% of the customers were not aware of CIS, and those who were informed had skewed knowledge in favour of

customers' obligations against customers' rights. The next section presents the theoretical and empirical review about asymmetry of information on CRBs followed by the methodology, discussion of the findings of the study, and lastly the summary, conclusions and recommendations.

## LITERATURE REVIEW

### Formal Credit Information Gathering and Monitoring

Valdez (2000) posits that credit ratings business started in 1909 when John Moody issued his first ever-ratings of company debt-200 American railway companies.

<sup>1</sup>Credit Information means any positive or negative information bearing on an individual's credit worthiness, credit standing, credit capacity, character, general reputation, personal characteristics or mode of living, including but not limited to history and/or profile of an individual or entity with regard to credit, assets, and any financial obligations.

<sup>2</sup>Credit Report means a customer information file containing a subject's credit history compiled by a CRB and may include publicly available information.

These basis statistics profiled the risk of securities to guide investors. In 1913, John Fitch also published financial statistics for use in the investment industry, and in 1914 Moody improved the statistics to cover all government bonds. In 1941 Standards and Poor's issued P&S 500 , a stock market index for investor analysis and an economic indicator for the United States. In 1970s Moody included commercial paper and bank deposits in the ratings. The rating of bank deposits indicated the exposure of Banks to credit risk. Between 1965 and 1981, 8 Banks in the United became bankrupt. There was a 'Savings and Loans Crisis' in the 1980's; Banks across the world were lending extensively at unsustainable levels leading to Bank failures. Pandey (2005) posits that in 1974 the Tandon Committee found that loans given by Banks in India to companies were misused or mismanaged because of the existing system of Bank lending; the cash credit system. Under the cash and credit system Bank lending was related directly to the security in the form of 75% of inventory and receivables leaving a margin of 25% irrespective of the borrower's operations. Within this limits, the Banks considered loans to be safe and did not bother about the way in which the advances were being used. In Response to the 'Savings and Loans Crisis' the Basel 1 Capital Accord was created in 1988 and focused on the capital adequacy of financial institutions to deal with capital adequacy risk. It recommended that Banks operating internationally must have a risk weight of 8% or less, based on the five risk categories of assets of the financial institution (0%, 10%, 20%, 50%, and 100%). Subsequently Basel Accord II focusing on minimum capital requirements, supervisory

review and market discipline was created to be fully implemented by 2015. As part of supervisory reviews, the 'know your customer policy' was developed for Banks in the 1990s requiring them to monitor closely the activities of their customers as a way of minimizing Bank exposure to risk and preventing economic crimes including money laundering, tax evasion and corruption.

Hubbard (2008) posits that Banks can reduce their exposure to credit risk on loans by investing in information gathering and monitoring. Valdez (2000) posits that some markets, for example the US, want the credit rating of the borrower officially assessed so as to guide them as to the risk and the appropriate rate of interest. Millaer & Guandamillar (2006) posits that the regulatory framework for CIS that meets international good practice must provide for: the maintenance of data for a reasonable time period-at least 5 years; enabling customers to make a fresh-start and erase the negative data once the time period for maintaining it has been reached; alerting customers of the problems associated with their report (an adverse action notice); restricts access of the information to authorized users; protects the rights of the customers to access the information and resolve disputes by correcting any erroneous or outdated information; and the system of supervision that allows regulators to go to court for public good, access the databases of the CRBs, perform external audits and specify penalties and sanctions against errant parties in the CIS.

However, there have been limitations in CIS. Cloos (1963) found that the reference dates used by the National Bureau of United States of America (US) for information analysis had not been tested adequately. In some instances the bureau's reference dates were wide off the mark by as much as 3 months, and important economic decisions were based on outdated or incorrect information. He recommended that bureaus should spell out more clearly the rationale behind the selection of their reference dates. Semenova (2008) found that given the opportunity to get extra profits and offer less expensive credit to new clients, banks may prefer a strategy of dishonest behavior (misreporting information). Therefore, adequate regulations and supervision of banks and CRBs was critical for protecting customers' interest. Banasik & Crook (2005) found that most credit scoring models were used to assess the creditworthiness of all applicants, yet the only observed performance of creditworthiness available to the model analyst was from the applicants previously judged good enough to be granted credit. In reality, an individual's changing financial circumstances and situational factors could reverse past credit history favorably or adversely.

Madeddu (2010) found that in Morocco CIS formally started in 2007 and only one licensed CRB was in operation. The Bank of Morocco (BAM) licensed and supervised CRBs, and also took a proactive and intermediary function between the CRBs and lenders. Lenders periodically provided the BAM with all credit information which was then transmitted by BAM to all CRBs operating in the market. In contrast, information sharing scheme in Egypt did not require the involvement of the Central Bank; information was shared deliberately and directly exchanged between lenders, the CRBs and users. The World Bank Group (2008) found that Malawi had one informal CRB; there were no specific laws or support from the Reserve Bank of Malawi. There were concerns over the violation of customer privacy, and lenders were unwilling to share credit information with, and access reference services from, the CRB. Thus the CRB was ineffective.

The Banking Act (Credit Reference Bureau) Regulations 2008 (Act), gave the customers rights: to have credit information record that reflects the existing situation of the customer at any given time (S.17); to dispute inaccurate, erroneous or outdated information maintained in CRBs' databases (S.20); to receive a detailed notice of the customer's information submitted by banks to the CRBs (S.28.a); to access the credit reports relating to the customer from the database administered by the CRB; to receive an adverse action notice from the Banks (S.28.b) which communicates to a customer the consequences he or she must suffer as a result of having negative credit information; and the discretion to share or not share positive credit information because suppression of positive information did not expose lenders to credit risk beyond their compensation. In contrast, banks were obligated to share with the CRBs their customer's negative credit information without consulting the customer. According to Bagyenda (2008) the Ugandan banks shared with CRBs a customer's positive credit information upon the customer's express written authorization similar to the Kenyan model (S.14).

The Act obligated CRBs to maintain: incorporation status under the Companies Act; operational manuals that ensure the accuracy of the information contained in its database; timely updating of the information; the software required for the operation; the security and control measures to prevent misuse or improper management of information (S.4); the reputation, integrity, experience and capacity of the directors and significant shareholders; the mechanism to integrate, gather, input and validate the data (S.5); suitability of the premises for bureau operations; adequacy of the management information system; administrative and operational processes and the internal control systems; and the security of information (S.6). The activities of the CRBs were restricted to: obtain and receive customer information; store, manage, evaluate, update and disseminate the customer information to subscribers; compile and maintain

database and generate reports from customer information database; assess the creditworthiness of a customer; sell to institutions specialized literature and other informational materials related to its activities; carry out market and statistical research; and carry out any other activity as may be approved by the CBK from time to time under the Act (S.13). However, the information held by the CRBs remains the property of the CBK and reverts to it where a CRB winds up (S.26).

Negative information means any adverse customer information relating to a customer including but not limited to: dishonor of cheques other than for technical reasons; accounts compulsorily closed other than for administrative reasons; proven cases of frauds and forgeries; proven cases of cheque kiting; false declarations and statements; receiverships, bankruptcies and liquidations; credit defaults or late payments on all types of facilities; tendering of false securities; and misapplication of borrowed funds (S.2).

Credit rating has implications. Brown & Zehnder (2007) found that CIS exposed the lenders to increased competition because they released private information about their existing clients. However the benefits of CIS outweighed the costs of increased competition: accurate prediction of loan defaults, selection of good loan applicants; improved availability of credit; easier access to credit; reduced misapplication of borrowed funds; increased repayment rates; and reduced information search costs. Positive credit information contributes to the building of information capital useful in negotiating competitive interest rates for credit facilities (CBK 2010). In contrast, negative credit information leads to an adverse action notice conveying denial or cancellation of, an increase in any charge for, or a reduction or other adverse or unfavorable change in the terms of coverage or amount of, any loan, existing or applied for, or any other action or determination adversely affecting the customer, based on customer information obtained from CRBs (S.28.b). However, the purpose of credit information is to enable lenders to evaluate credit risk and price financial products accordingly (CBK 2011).

## **METHODOLOGY**

Due to the confidential nature of banking activities, it was not possible to get the exact number of customers for each bank. Convenient sampling was used to identify 81 respondents; 3 customers from each of the 27 banks operating in Nakuru town including Co-operative Bank, Barclays Bank, NIC Bank, Family bank, National Bank, Kenya Commercial Bank, Standard Chartered Bank, Bank of Baroda, Equity Bank, Chase Bank, ABC Bank, Diamond Trust Bank, K-Rep Bank, Commercial Bank of Africa, Dubai Bank, Credit Bank, Oriental Bank, CFC Stanbic Bank, Investment & Mortgage Bank, Post Bank, Transnational Bank, Consolidated Bank, Bank of Africa, ECO Bank, First Community Bank, Fina Bank,

and Imperial Bank. These banks were operationally represented at branch level in all the 47 counties of Kenya.

Data was collected through unstructured interviews. The researchers asked questions directly to the customers, probed their answers, and recorded their opinions, feelings and expressions by way of written notes. The primary data extracted was about what the customers really knew and or didn't know about CIS in Kenya. The data was analyzed qualitatively through: editing for omissions and errors; theme identification, coding and content analysis; presenting in tables, charts and graphs; and the generation of frequency and percentage statistics to describe and examine relations and trends in the data.

**RESEARCH FINDINGS AND DISCUSSIONS**

Table 1: Customers’ awareness of CIS in Kenya

Customers’ awareness of CIS in Kenya	Aware		Unaware		Total	
	No.	%	No.	%	No.	%
The meaning of CIS and existence of CIS in Kenya	31	38	50	62	81	100

**Customers'**

Figure 14: Customers’ awareness of CIS in Kenya

**Customers’ who were unaware of CIS in Kenya**

The researchers found that 62% of the respondents were unaware of the meaning of CIS, its existence in Kenya, the rights of customers, the obligations of CRBs and Banks, the information that trigger negative credit rating, and the effects of credit reports even in general terms due to:

Firstly, illiteracy was a barrier to understanding financial issues as exemplified in the quotation below:

*“Mimi sijasoma shule. Sijui hiyo kitu unauliza. Ni nini hiyo.”* (R24)

Secondly, non banked customers were not exposed to the developments in the banking sector such as CIS. These include customers served by Credit Co-operative Society (SACCOs) and other non-bank financial institution including the Kenya Farmers Association (KFA) which specializes in serving farmers at flexible and preferential terms. This is exemplified by the quotation below:

*“Banks put so many conditions before they lend, for example collateral yet many farmers don’t have title deeds.”* (R1)

Thirdly, some channels of communication did not appropriately reach respondents as exemplified by the quotation below:

*“I don’t read newspapers, may be that is why I don’t know” (R35).*

*“... wachapishe makaratasi ya maelezo kuhusu hiyo kitu na wapeane kwa watu wengi...pia wangeweka kwa mabenki makaratsi mengi yenye maelezo ...radio ni ngumu kwasababu kuna station nyingi sana...SMS itasaidia kwa sababu watu wengi sana wako na simu siku.” (R67)*

The respondents recommended the use of pamphlets in public places and mobile phone short messages (SMS) because SMS instantly alerted the phone user and many customers had access to mobile phones than Newspapers and radios. Newspapers were less accessible and readers focused on personal interests like sports ignoring business sections where C.I.S information was likely to be. It was difficult to pick the most appealing radio channel given the customers’ diverse interests.

Fourthly, some respondents perceived financial information to be of interest only to the middle class or wealthy people as exemplified by the quotation below:

*“Hii watu wengi hawaijui, labda wale wako na mapesa mengi kwa benki ndio wanaijua...” (R67)*

Fifthly, there were gender disparities in financial transactions. Respondents (3%) stated that men handled financial matters for their families thus fewer women than men had information about CIS as exemplified in the quotation below:

*“My husband handles all bank matters, so I don’t know whether I can answer you much” (R44)*

### **Customers’ who were aware of CIS in Kenya**

The researchers found that 38% of the respondents were aware of CIS in Kenya. However there was asymmetry in their knowledge of the rights of customers, the responsibilities of CRBs and Banks, the information that trigger negative credit rating, and the effects of credit reports due to:

Firstly, the respondents got the CIS information through: seminars sponsored by their banks; letters written by banks; bank officials especially credit officers; and through persons affected by negative credit reports as exemplified by the quotations below:

*“I belong to Barclay’s business club. At one of the clubs meeting we were educated on CRBs” (R4)*

*“My bank gave me a letter...I don’t remember everything. It was a while ago” (R59)*

*“I delayed paying my loan...the credit officer ring me to follow up the matter. He informed me that I will be taken to CRB...I was afraid... I don’t want that CRB thing, it is terrible.”(R12)*

*“I heard my dad talking about CRB... his name was in CRB because he was yet to pay land rates. This got him in trouble since he was not able to access loans from the bank” (R39)*

These are institutions and persons with interests in the CIS which they could advance through biased information to customers. Secondly, the respondents considered financial issues too technical to comprehend thus requiring expert analysis which they lacked as exemplified by the quotation below:

*“Hapana sijui hiyo ni ya watu wa finance” (R11)*

Thirdly, the perception that the CIS benefited banks through credit risk reduction by locking out potential defaulters and wealthy customers through bank concealment/misrepresentation of negative information at the expense of ordinary customers caused customer apathy in CIS as exemplified by the quotations below:

*“This thing was for the banks to safeguard themselves, not for the ordinary people” (R3)*

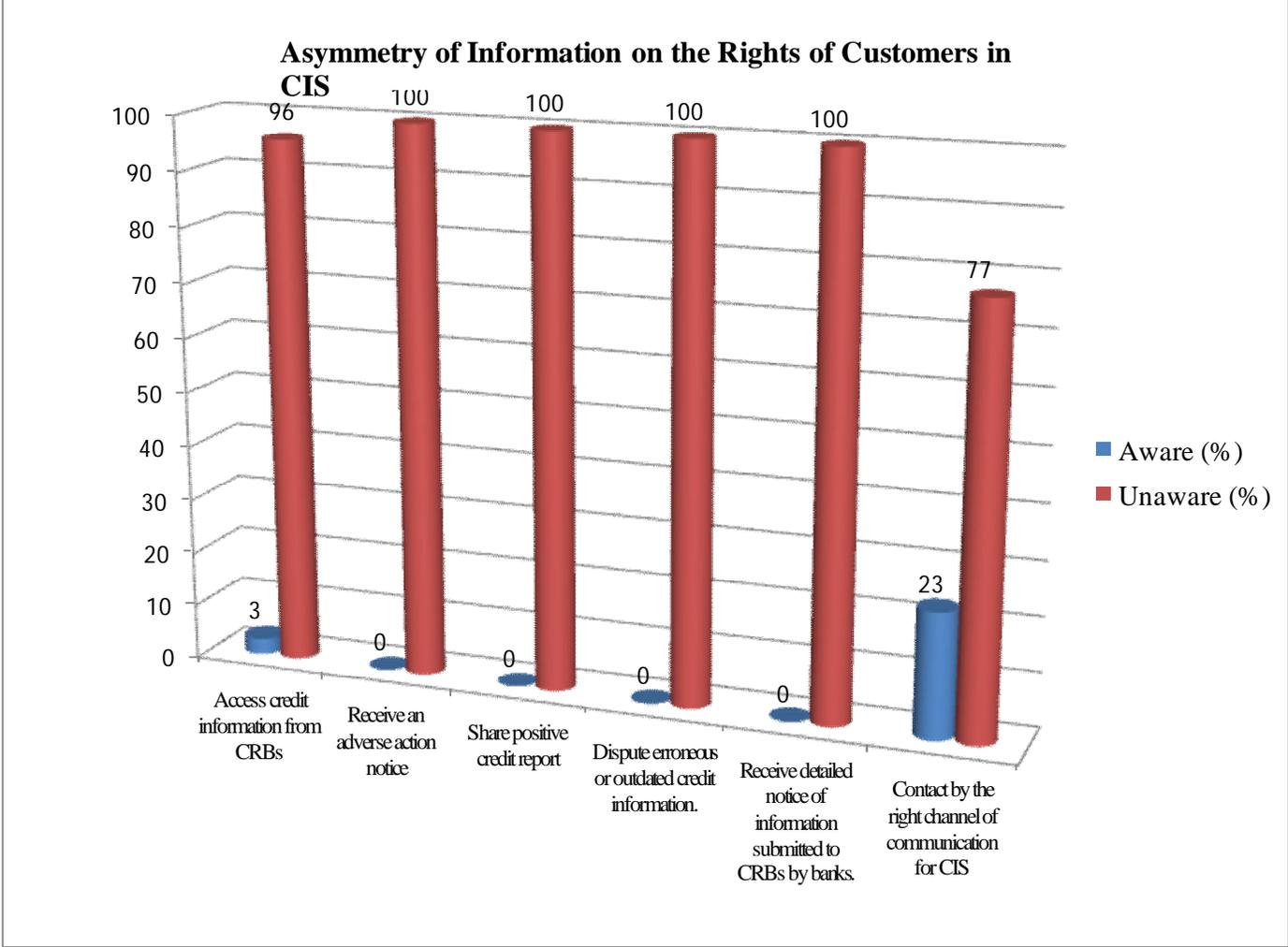
*“Oh yes...CRB only affect the common mwananchi, ‘Wanjiku’...Bank managers cannot submit big savers or they lose work.... So they have to find a way of helping them out” (R65)*

Among the 38% of the respondents who were aware of CIS, the researchers found that in respect of rights of customers, obligations of CRBs and Banks, information that triggers negative credit rating, and the effects of credit reports, the asymmetry of information was as follows:

#### Asymmetry of Information on the Rights of Customers in CIS

Table 2: Asymmetry of Information on the Rights of Customers in CIS

Rights of Customers in CIS	Aware		Unaware		Total	
	No.	%	No.	%	No.	%
Access credit information from CRBs	1	3	30	96	31	100
Receive an adverse action notice	0	0	31	100	31	100
Share positive credit report	0	0	31	100	31	100
Dispute erroneous or outdated credit information.	0	0	31	100	31	100
Receive detailed notice of information submitted to CRBs by banks.	0	0	31	100	31	100



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<sup>3</sup>Wanjiku or common mwananchi means ordinary people.

Figure 15: Asymmetry of information on the rights of customers in CIS

The researchers found that only 3% of the respondents were aware of the customers’ right to access credit information from CRBs, and none of the respondents was aware of the customers’ right: to receive an adverse action notice; share positive credit report; dispute erroneous or outdated credit information; and receive detailed notice of the information submitted to CRBs by banks. In general customers were unaware about their rights in the CIS, which suggested that customers’ rights and benefits in CIS were not well publicized of CIS despite being clearly provided for in the law. This could suggest a weaker voice of the customers in the implementation of the CIS compared to the other participants’ namely banks, CRBs, the regulators (CBK) and policymakers hence the perception that the CIS was designed to benefit banks and wealthy investors at the expense of ordinary customers. It could also give credence to

the respondents' view that the CIS message was delivered to customers through inappropriate communication channels; 77% of the respondents did not access publicity of the CIS message.

### **Asymmetry of Information on the Responsibilities of CRBs and Banks in CIS**

The researchers found that 100% of the respondents who were aware of CIS were also aware of CRBs' obligations to gather and monitor customers' credit information, to maintain an accurate and updated credit information database, and to generate and share credit information with banks and other authorized persons. However, only 16% of the respondents were also aware that CRBs and banks were obligated to preserve the security and confidentiality of the credit information database as exemplified by the quotation below:

*"Like my personal information to be treated with confidentiality unless I authorized..."* (R2)

*"...your information should be true and they should discuss with you before spreading out"* (R3)

The customers considered the right to confidentiality to be absolute. However the law obligated banks to share with CRBs customers' negative credit information without seeking their consent. Customers' consent was only required when sharing their positive credit information. On the other hand, 84% of the respondents were unaware that CRBs are obligated to keep their credit information confidential; they believed that CRBs were at liberty to disclose all their credit information to any interested person without their consent. A related finding was that 100% of the respondents were unaware that CRBs and banks were obligated to use a system that allowed continuous audits and supervision by the regulators (CBK). This could explain the concern by 6% of the respondents that banks could misrepresent credit information not to implicate their valued customers in whom they had long-term business interests. Furthermore, 3% of the respondents expressed concern that where the loans were deducted through the Check-Off System<sup>4</sup> and employers failed or delayed to remit the loan installments to the financiers, customers were unfairly exposed to negative credit rating as exemplified by the quotation below:

*"...Do the CRB counter check the information they have or just take it as they are given?"* (R77)

*"Higher Education Loans Board (HELB have penalized me for the mistake of my employer who failed to remit the loan payments for HELB loan"* (R61)

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<sup>4</sup> Check-off system means an arrangement of recovering loan on monthly basis from the borrower through the payroll system by the employer who in turn remits to the lender directly.

Table 3: Asymmetry of Information on the Responsibilities of CRBs and Banks in CIS

Responsibilities of CRBs and Banks in CIS	Aware	Unaware	Total

	No.	%	No	%	No	%
Gathering and Monitoring Customers' Credit information.	31	100	0	0	31	100
Maintaining an accurate and updated credit information database.	31	100	0	0	31	100
Generating and sharing credit information with banks and authorized persons.	31	100	0	0	31	100
Keeping credit information database secure and confidential.	5	16	26	84	31	100
Providing a system that allows continuous audits and supervision by the regulators (CBK).	0	0	31	100	31	100
Faithful representation of customers' credit information	29	94	2	6	31	100

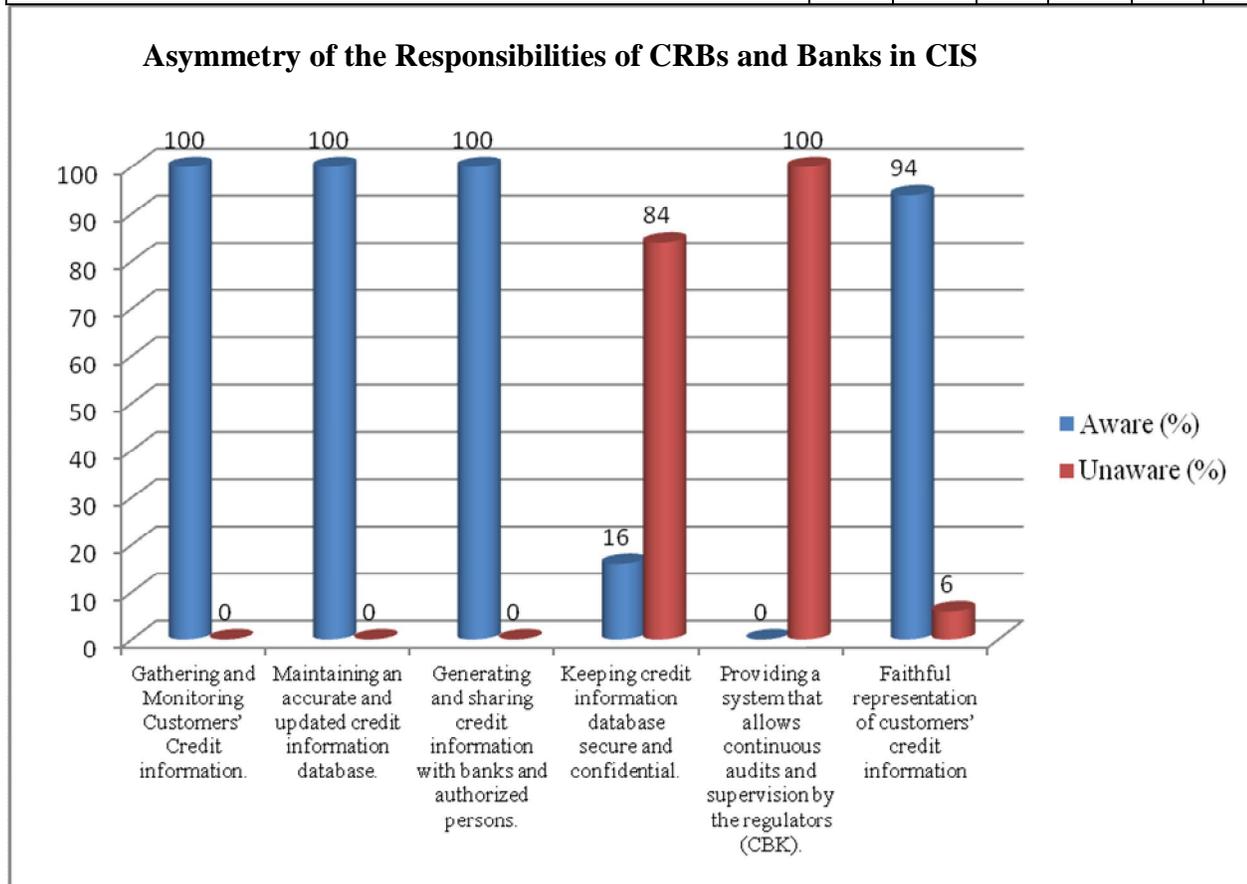


Figure 16: Asymmetry of Information on the Responsibilities of CRBs and Banks in CIS

### Asymmetry of Information that triggers Negative Credit Rating

The researchers found that the reasons for negative credit rating, which the respondents were aware of, were credit default or late payments (87%); and dishonor of cheques (81%). Possibly these were the

issues that affected the customers mostly due to cash flow and liquidity problems. Other reasons were; fraud and forgeries (10%); tendering false securities (10%); and false declarations and statements (6%). These later factors were relatively fewer than the former possibly because banks usually employed standard verification procedures including audits and searches before relying on the securities and documents presented- only few cases could pass unnoticed. A related finding was that the factors not considered by the respondents were: compulsory closure of bank accounts; receiverships, bankruptcy or liquidation; and misapplication of borrowed funds. A possible explanation for this could be that the respondents associated compulsory closure of bank accounts with fraud and forgeries, and associated receiverships, bankruptcy or liquidation with credit defaults because both factors arise from liquidity problems. Liquidity problems could also be caused by misapplication of funds. However misapplication of funds could be difficult to prove where the customers continued servicing the loans as per the terms of credit. Furthermore where funds were misapplied, credit default would be noticed first before misapplication of funds. To the extent discussed above, the respondents were aware of the information that triggers negative credit rating as exemplified by the quotation below:

*“They collect information on defaulters, creditors,...and even cooked statements.” (R74)*

*“Loan repayment history, defaulters, and bouncing cheques” (R3)*

*“...if you fail to pay loan...if you issue a cheque and it is not honoured. No other reasons.”(R13)*

Table 4: Asymmetry of Information that Triggers Negative Credit Rating

Information that triggers negative credit rating	Aware		Unaware		Total	
	No.	%	No.	%	No.	%
Dishonour of cheques other than for technical reasons.	25	81	6	19	31	100
Compulsory closure of bank accounts other than for administrative reasons.	0	0	31	100	31	100
Proven cases of fraud and forgeries.	3	10	28	90	31	100
False declarations and statements.	2	6	29	94	31	100
Receivership, bankruptcy or liquidation.	0	0	31	100	31	100
Credit default or late payments on all types of securities.	27	87	4	13	31	100
Tendering of false securities.	3	10	28	90	31	100

Misapplication of borrowed funds.	0	0	31	100	31	100
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Figure 17: Asymmetry of Information that Triggers Negative Credit Rating

#### Asymmetry of Information on the Effects of Credit Reports

The researchers found that 87% of the respondents who were aware of CIS were also aware that negative credit rating led to issuance of an adverse action notice to a customer as exemplified by the quotation below:

*“If you default then you cannot go to another bank ... pay your obligations, sit down with your financiers and reschedule your loans kuliko kuhepa, let them know what you are going through ... I think the bank should be able to talk with their clients first before posting their names” (R3)*

*“No bank will give you loan. It is unlawful and risky to give loan to a person who is not clean” (R4)*

*“Defaulters have been cornered Kabisa” (R13)*

The relatively high awareness rate of adverse action notice by customers suggested that information about the consequences of negative credit rating was generally available to customers. Possibly this was where the content of CIS publicity message was focused. This was supported by the finding that only 3%

of the respondents were aware that positive credit information was a basis for customers to negotiate better terms of credit. This could suggest that the promoters of CIS focused more on highlighting the consequences of negative credit reports on customers than how positive reports could benefit them. This imbalance in message content could have created the perception 19% of the respondents had that CIS was designed to benefit the banks and the wealthy but not the ordinary customers hence their disinterest in understanding CIS. Furthermore, while 87% of the respondents were aware that negative credit rating affected customers' character in relation to creditworthiness, none of them considered its effect on the ethics and integrity standards required of one to hold certain public and state offices in Kenya. This could partly be explained by the fact that the Public Officers Ethics Act was introduced hardly a year ago in Kenya. A related finding was that none of the respondents was aware that after the expiry of the time limit of 7 years, CRBs must by law delete customers' negative credit information to enable them to make a fresh start. The respondents believed that negative credit rating amounted to irreversible blacklisting of the affected customer from obtaining credit.

Respondents (3%) expressed concern that joint decisions by company board of directors or partners could impact unfairly on an individual director's credit rating if the joint decisions or company loans guaranteed by directors fail as exemplified by the quotation below:

*"...what happens to a group of people who have guaranteed others...."* (R74)

Therefore, it is necessary to clarify how a company's negative credit information affects the credit standing of the individual directors who make decisions in the company.

Table 5: Asymmetry of Information on the Effects of Credit Reports

Effects of Credit reports	Aware		Unaware		Total	
	No.	%	No	%	No.	%
Use of positive credit information to negotiate better terms of credit.	1	3	30	97	31	100
Issuance of an adverse action notice to a customer.	27	87	4	13	31	100
7 year time limit for maintaining customers' negative credit information.	0	0	31	100	31	100
Disqualification to hold certain public and state offices in Kenya on ethical and integrity grounds due to	0	0	31	100	31	100

negative credit rating.						
Perception that CIS benefits only Banks and the wealthy.	6	19	25	81	31	100

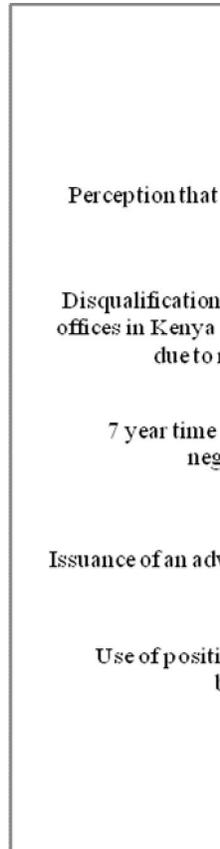


Figure 18: Asymmetry of Information on the Effects of Credit Reports

**SUMMARY, CONCLUSIONS AND RECOMMENDATIONS**

**Summary**

The researchers found that 62% of the respondents interviewed knew neither the meaning nor the existence of CIS in Kenya. All the respondents who knew what CIS was also knew the CRBs’ responsibilities to: gather customers’ credit information; maintain an accurate database; and share credit information with authorized persons. They also knew the causes of negative credit rating: default or late payments (87%), dishonor of cheques (81%), fraud and forgeries (10%), tendering false securities (10%), and false declarations and statements (6%). However they did not consider compulsory closure of bank accounts, receiverships, bankruptcy or liquidation, and misapplication of borrowed funds as factor affecting credit rating. However, they knew the consequences of a negative credit rating on the customers; 87% of the customers were aware of issuance of an adverse action notice. In general, the customers were aware of their obligations in CIS and the consequences of breaching them.

In contrast, most respondents were not aware of the rights of customers in the CIS. Only 3% of the respondents knew that positive credit information was a basis for customers to negotiate better terms of

credit. None of the respondents was aware that after the expiry of the time limit of 7 years, CRBs must by law delete customers' negative credit information to enable them to make a fresh start. 84% of the respondents were unaware that CRBs are obligated to keep their credit information confidential. 100% of the respondents were unaware that CRBs and banks were obligated to use a system that allowed continuous audits and supervision by the regulators (CBK). Only 3% of the respondents were aware of the customers' right to access credit information from CRBs. None of the respondents was aware of the customers' right to receive an adverse action notice, share positive credit report, dispute erroneous or outdated credit information, and receive detailed notice of the information submitted to CRBs by banks. In general most customers were unaware of their rights in the CIS.

### **Conclusions and Recommendations**

There was disparity in the information customers had about their obligations and rights in CIS. The researchers concluded that the customers' participation in CIS in Kenya was below the CBK's expectation because the customers were not aware of their rights in the CIS and how they could benefit from it. The researchers recommended that the policymakers should develop message content that highlights the benefits and rights of customers in the CIS. The message should: be simple enough for ordinary customers to understand despite their educational levels; promote gender parity in financial management; and be delivered through appropriate channels of communication. In light of the developments in information communication technology, the researchers recommended that a study be conducted to determine what the most appropriate channel would be to communicate information of financial, business and economic nature to the general Kenyan public given customers' diverse interests. The researchers also recommended that non bank financial institutions which serve most customers should be active in CIS to the level of banks to achieve information symmetry. Lastly, the researchers recommended that employers who default in the check off system should be reported to CRBs to discourage default rates.

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### **B2012-11: Effects of Table Banking On Micro Enterprise Performance. A Survey of Rongai Social and Economic Women Organization (ROSEWA)**

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### **B2012-12: Challenges to Strategy Implementation of ICT, Computer Based Management and Educational Support Systems in the University in Kenya**

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#### **Abstract**

Use of ICT and computer based systems to support learning, teaching and research is one of the key strategies in advancing training, innovation and technology in the university. Many universities in Kenya are laying down strategies of implementing computer based systems to support training and enhance service delivery. They have perceived the enormous benefits that accrue due to effective implementation of ICT strategies in meeting the students' need for learning, research and interacting with other institutions to increase knowledge. Some Kenyan universities have even gone ahead to initiate E-learning in their institutions. This has a twofold focus, to reach out to students that are too busy to be in class as well as supplementing traditional training methods to those that study within the campus. E-learning also leads to increased enrolment with less additional resources which is now vital considering the pressure that universities are experiencing due to increased number of students that get cut-off entrance points at ordinary level. To fully realize the benefits of ICT and computer based systems

effective strategy formulation and implementation are necessary. This will also require sufficient funding to obtain the necessary resources. Most of the universities are experiencing challenges in implementing these strategies particularly those university colleges that have been converted from middle level colleges to meet the demand of increased university enrolment. This paper investigates the challenges to strategy implementation of ICT and computer based systems in the university. The researcher did a survey on application and management of ICT in the university and purposively selected MPUC as one of the university colleges that were upgraded from national polytechnic. The paper empirically analyses the challenges and further offers recommendations on successful implementation of strategy to fully exploit the benefits of ICT and computer based information systems.

**Key words:** Strategy, ICT, IT

## **Introduction**

Universities in Kenya are currently constrained to expand their operations to handle the increasing number of students particularly due to increased enrolment following free primary and highly subsidized secondary education. All the public universities are addressing this challenge by collaborating with middle level colleges and offering their academic courses in these colleges. Others are opening new branches in all the big towns to capture students in all areas country wide. The challenges to university management include expanding their revenue base to provide facilities for increased enrolment, expanding the academic programmes to provide students with diverse career options, training personnel as well as research and innovation (Njuguna, 2012). Demand for better trained manpower in organizations and pressure to compete favourably in the labour market has caused many employees to rush back to the university to add qualifications and meet the industrial requirements. This has led to the emerging evening programmes to cater for working students. All these factors are putting pressure on the already strained capacities coupled with the demand for quality training as institutions seek ISO certification and benchmark with world-class universities. Rapid innovation becomes necessary to address the pressing issues and still provide better services to the customers. Use of ICT and computer based systems effectively can take the institutions mileage in meeting the training demands.

## **ICT and computer based management and educational support systems**

ICT or information and communication technology refers to the hardware, software, and telecommunications networks (Ward & Peppard, 2002). This includes both tangibles (e.g. computers, routers and network cables) and intangibles (software). IT facilitates the acquisition, processing, storing, delivery and sharing of information and other digital content.

Wanyembi (2002) noted that colleges and universities in Kenya, like other business organisations, have experienced the pressure to invest in computer-based information systems to manage their business processes and huge data that they handle. Accordingly, information and communications technology (ICT) resources in Kenya continue to increase in numbers, value and sophistication as more and more institutions invest in ICT.

In the universities, information resources and tools are integrated and made accessible to facilitate education, learning and teaching, research and management of all aspects of the institution (University of Bristol, 2008). Appropriate use of ICT can improve the quality and quantity of educational provision (Balasubramanian et al, 2009). Selwyn (2007) observed that despite all the potential benefits of ICT as a central tenet of university teaching and learning, many university students and faculty members make only limited formal academic use of computer technology.

Here in Kenya universities use ICT in management systems such as payroll, exams, enrolment and other management functions. Use of ICT as a pedagogical tool is limited. Kenyatta University has virtual university facilities and programmes but there is limited scope of E-learning in most of the universities in Kenya. Benefits of ICT application in the universities are enormous as outlined by Balasubramania et al (2009). The benefits include learning and course management systems that are used for generating learning support services and products such as course outlines, digitally recorded classroom material, laboratory manuals, lecture notes, live lectures for later viewing and reviewing, connections to specific course websites, online- tutorials, E-libraries etc. Virtual libraries support learning and reduce the cost of acquiring expensive textbooks, journals and reference materials (Balasubramania et al, 2009). ICT could enhance both academic and business research by university lecturers (Obeng, 2004). Through the Internet, researchers have the opportunity to access a lot of information for various assignments in a more innovative way. By a click of a mouse researchers can have access to wide spectrum of information and even know relevant areas of critical concern and interest. It also offers them the chance to know the requirements of industry and carry out research to meet industry's needs and expectations. It is worth noting that a Nation without systematic, coherent, innovative and well coordinated research culture rarely develops scientifically and economically. Doubtless the Universities are research centres and innovative research can best be accomplished by the effective use of ICT. Students also enjoy full access to all kinds of information for their study and writing of dissertations and thesis. Students encounter difficulties in getting the right study materials for their study programmes. Most students complete their studies without having a chance to read some of the internationally renowned articles and journals. It is also noteworthy that most dissertations and thesis by students are never implemented. They are rather kept on the shelves only to collect dust. This could be attributed to the fact that most of the research conducted by students is only meant for meeting the university requirements for award of degree certificates and the writing of these thesis and dissertations are not thoroughly researched into due to lack of access to relevant information. With advent of ICT, students during their learning process can have access to different information and even know the paradigm shift in most literature as this will make them current

and know the dynamics of industry. It could also offer them a chance to be trained in way that meets the requirements of the labour market. The final project could be carried out in a more innovative manner so that it becomes more practical than before.

IT strategy for application in universities should include (University of Bristol, 2008); systems to support corporate, faculty and departmental needs, learning and teaching and to facilitate research. They also require services- support training, systems development and analysis and project management. Finally there is need for infrastructure-networking and IT facilities (machinery). Effective use of systems also helps to facilitate all the other business strategies of the university. Efficiency and effectiveness of organizational processes is improved (Bakos & Treacy, 1986). Communication systems such as intranet facilitate sharing information and quick access of data thereby enabling decision making in all the departments and harmony of objectives. Academic functions such as teaching, research and learning benefit a lot from ICT. Universities have passwords for accessing journals and research materials from other universities and research centres.

To expand knowledge lecturers and students can access notes and reference materials from highly established universities such as Oxford, Harvard, etc through internet. Universities such as MIT, Open University of Nigeria etc have courseware with lecture notes on almost every course and can be accessed without a password. Thus giving students and lecturers access to internet can facilitate their work and match their standards with those of renowned universities. All these systems require efficient servicing and maintenance to remain available and effective to the students and staff.

### **Challenges of implementing and managing ICT and computer based educational support systems**

To exploit to the full potential the perceived benefits of ICT and computer based systems in the University in furtherance of academic and management objectives, good strategy and careful implementation programme should be laid down. There are challenges to this effort which has made the potential use of ICT limited in universities.

The challenges include the high cost of acquiring, installing, operating, maintaining and replacing ICTs. Universities in Kenya have computer centres that they use for teaching computer subjects. These are far from being enough for enabling the students to acquire all the benefits available from effective use of IT in the university. This may require every student to have a laptop for uninterrupted access to technology. This is usually not the case. Most students depend on the institutions' facilities which are limited. This limited accessibility limits the lecturers' use of the internet in supplementing the traditional lecture methods. Another impediment to effective use of IT in learning in Kenyan institutions is misuse of the

internet. Other than students using internet for their academic needs, they use it for social networks such as face book. Many hours are wasted in computer rooms as students do irrelevant things with computers.

In addition to the initial cost of acquiring the facilities for IT, maintenance is also challenging. It is common to see very many computers in a computer room that are not operational. There should be very strict procedures of procuring computer hardware and soft ware to curb this problem (selecting dependable vendor). Internet security e.g. antivirus should be provided and duly updated to protect the systems from internet attacks. Efficient and highly committed personnel is needed to keep the IT facilities working and available to staff and students. Another challenge to ICT application in the learning institutions includes some members of teaching staff not sufficiently proficient in the use of computers. Useful applications such as power point, email, e-books and other web based reference materials are ignored.

Chacha (2004) while contributing on ICT training in higher educational institutions in Africa noted that there has been insufficient training and re-skilling of end users as well as technical staff that support the systems in higher educational institutions. This is coupled with the inability of many institutions to recruit and retain qualified information systems staff-

In some institutions, technological complexity is an overwhelming challenge to be countered with critical issue being the security concerns for the data and the systems, especially where students have to access the institutional systems. Nyandiere (2006) noted that without proper controls, students can hack into the system and a change on examination grades, fees balance status or other modifications which could have serious ramifications on the institution.

Another challenge in the application of ICT is the institutions not having sufficiently high bandwidth. In some institution the data traffic is so high that the system is down most of the time and thereby offering limited internet access to the users.

O'Brien (1999) noted that system implementation is far from being just a software project: it is a serious organisational change project. The projects requires co-operation, teamwork, and planning for organisational change and are difficult to implement when senior management is too busy to give the project adequate attention. The projects involve major organisational changes as they consist of many functional modules that can span the whole organisation and yet use the same database.

The current study explored the challenges faced by MPUC in facilitating effective use of ICT and the possible hindrances in the key perspectives of IT strategy implementation which include systems, services and infrastructure.

## Research methodology

This is a descriptive study. The researcher used this design to capture the challenges that the university colleges face in implementation of ICT, computer based management and educational support systems. The case of MPUC was chosen as among the largest university colleges in Kenya and strategically placed in coast region with opportunity of offering courses not offered in other universities such as Marine Engineering and maritime studies. The researcher collected both qualitative and quantitative data to exhaustively obtain all the pertinent information and draw valid conclusions and offer recommendations.

## Target population

The target population for the study was all the academic departments of MPUC. The MPUC has thirteen academic departments namely Mechanical and Automotive Engineering department, Building and Civil Engineering, Electrical and Electronics Engineering, liberal studies and community development, Business Studies, Hospitality and Tourism, Medical Engineering, Pure and Applied Sciences, Mathematics and Physics, Computing, Environment and Health Sciences ,Media and Graphic Design and Medical sciences department. The population include members of staff and students about 7500 people.

**Table 1 the population for the study**

	POPULATION	SAMPLE SIZE	PERCENTAGE
Staff	500	30	6
Students	7000	50	0.7
Total	7500	80	1.1

## Sampling frame

Using simple random sampling the following five departments were selected for the study; Mechanical and Automotive Engineering, Computing, Electrical and Electronics Engineering, Building and Civil Engineering and Business studies. All the academic departments are crucial in establishing the study programmes undertaken in the university college and shoulder the challenges that the university contend with in implementing its objectives. Five departments are representative bearing in mind that funding and resource distribution is done across all the departments and they face similar challenges though extent may differ depending on the courses undertaken in each department.

## Sample and sampling technique

The researcher used stratified sampling technique to select six members of staff and ten students in each of the departments selected for the study. This gives a total of eighty people. This is a good sample size since statistically a sample size should not be less than thirty for a large population (Anthony & Michael, 1999).

**Table 2 Sample for the study**

<b>SAMPLE</b>		
<b>Department</b>	<b>Students</b>	<b>Staff</b>
Mechanical and Automotive	10	6
Electrical and Electronics	10	6
Computing	10	6
Building and Civil	10	6
Business	10	6
Total	50	30
Grand total	<b>80</b>	

## Data collection instruments

The study used primary data obtained by use of structured and semi structured questionnaires with the selected members of staff and students. Both closed and open ended questions were used and a four point assigned number questionnaires. The four point scale was an improvisation of likert scales (Oppenheim, 1982). The survey measurement scale of 1-4 was used to indicate the extent to which each of the variables under test has been accomplished. Part I was to identify the general information about the respondent. Part II featured the challenges that are encountered in the departments. The questionnaires were self administered.

## Data collection procedure

The questionnaires were distributed by a field assistant to the respondents in the selected departments, namely Mechanical and Automotive Engineering, Electrical and Electronics Engineering, computing, business studies and Building and Civil Engineering. The questionnaires were issued to the respondents and collected later.

## Findings of the challenges of ICT application and management in MPUC

The objective was to establish the extent to which the challenge of ICT application and management affects strategy implementation at MPUC. The researcher explored inherent management and application difficulties and possible success factors to gather students and staff's views to understand the challenges posed to strategy implementation by this independent variable. The results of the findings were as in tables 3 and 4 in the appendix.

### **Discussion of the findings**

The results showed that 46.9% of the students confirmed that their departments do not have sufficient computers for student training and research. 20.4% of the students agreed that to some extent their departments have sufficient computers. Only a meagre 10.2% of the students confirmed to have sufficient computers in their departments. The mean score was very low being 1.96 indicating that the computers are not enough. Some departments have enough computers and hence the variability indicated by the large standard deviation of 1.060. It was also evident that most lecturers don't use internet and email in training the students. 53.1% of the students confirmed this. Only 8.2% acknowledged that their lecturers use internet. The mean score was 1.73 which is very low indicating that most of the students affirm that their lecturers don't use internet. The standard deviation of 0.953 shows agreement across the board. The students would not accept to acknowledge their misuse of internet except 30.6% which still serves to indicate students' common usage of internet in social sites such as face book.

It was noted that the computer centre experience operational problems such as internet failure this being confirmed by 57.1% of the students. A good percentage still accepted experiencing minimal problems. The researcher noted that some department have small computer centres and this could be the reason for the variability indicated by the big standard deviation of 1.146. In regard to library use of internet 36.7% of the students confirmed not having access to digital library facilities. Still 32.7% confirmed access. This resulted to the large variability in consensus indicated by the large standard deviation of 1.29. Mean score of 2.41 impress low use of digital library facilities. 44.9% of the students agreed that the computers in their departments have maintenance problems such as viruses. Only 14.3% confirmed no maintenance problems of their computers. Again this may vary depending on each department. 53.1% of the students agreed that their departments provide sufficient computer training. 20.4% said to no extent showing that there are some departments that don't offer sufficient computer training to their students.

26.9% of the staff uses internet technology in doing research. 38.5% use internet for research only to some extent. These figures indicate low use of internet as a tool for research which may further impress low level of research. The mean score of 2.81 is low showing low use of internet. 30.8% of the lecturers agreed that they don't use internet in giving lecture notes to their students. Only 3.8% of the respondents who confessed to apply internet in giving notes. The mean score was a low one of 1.92 and there was no

variability in this issue as seen in the low standard deviation of 0.796. This indicates unanimity among members of staff on their negligence of internet facilities or lack of it thereof. 84.6% of the members agreed that MPUC does not have dependable internet providers. No one agreed that they don't experience internet failures. There was a consensus on poor internet service provider as shown by low standard deviation of 0.628. It was as well clear that no single lecturer that accepted that MPUC lecturers have access to computers and use them for their day today teaching activities. Only 34.6% confirmed moderate access to computers. The findings show that lecturers don't have challenges of using IT due to negative attitude to computers. Only one member of staff submitted to negative attitude to computers i.e. 3.8% of the members. It was also clear that most of the members of staff are familiar with the soft wares applied in teaching. However 11.5% of the members of staff submitted to unfamiliarity with the soft wares commonly applied in teaching. Most of the members confirmed that use of internet in MPUC is hindered by poor maintenance of the facilities, 30.8% acknowledging this absolutely and 53.8% submitting to some extent and moderately. 38.5% of the members of staff agreed that to no extent does MPUC library give lecturers access to digital library facilities and electronic teaching materials. Only 15.4% of the respondents that confirmed use of electronic library facilities.

## **Conclusion**

The research findings explicitly reveal the challenges to strategy implementation of ICT, Computer based management and educational support systems in the university college.

The results revealed that most of the lecturers don't use internet and browser technology in facilitating their work. Accessibility to computers among lecturers and students is also limited showing insufficient resource capabilities. The library has not updated to the modern digital library facilities and most of the respondents attested to this. It was also clear that there is a problem with the internet servers most of the respondents reporting frequent internet failure. The maintenance of the IT facilities was also found wanting with most respondents reporting computer breakdowns and virus interference. Members of staff are familiar with use of IT and have positive attitude to computers, all that is needed is to resource the institution with the facilities.

## **Recommendations**

The challenge of ICT application and management can be addressed by investing more in IT facilities and employing more efficient servers (better vendors). This can be an expensive project that may involve approaching donors and industrial partners to fully equip the institution with all the IT facilities required for training. Just as students who do engineering are required to start their studies with equipments such as drawing instruments there should be a requirement for students to have laptops. Government can

subsidize this for students to have uninterrupted access to computer facilities. The library should be updated to modern digital capabilities including interacting with other universities to have their passwords and help lecturers and learners access journals, e books etc as happens in JKUAT library. Maintenance of facilities to improve their availability and performance can be enhanced by employing qualified technicians and streamlining management to be more sensitive to internet lapse and other technical hindrances. Issues of viruses can be handled by installing internet security and antivirus to all the computers e.g. Norton. Lecturers should also be inducted on use of IT in training and research. To improve service delivery lecturers need to join hands and prepare good course ware with well researched course materials for all the units offered. These can be put in a college intranet for students to access and supplement class work. Live lectures videos can also be included for the students to review. Interaction with the students can also be enhanced by providing a forum in which students can send queries of areas that need further explanation and lecturers can respond on line. Tutorial fellows can be hired for interacting with students online and assisting students in doing calculations and other technical areas that pose difficulties to the students. This is actually extending the ordinary work of tutorial fellows to include on line interactions.

## Appendix

**Table 3 Students' response data on the challenge of ICT application and management**

VARIABLE	SCALE ITEM	To no extent		To some extent		Moderate		To a large extent		Mean	Standard deviation $\sigma$
		1		2		3		4			
		F	Rate %	F	Rate %	F	Rate %	F	Rate %		
ICT1	Our department has sufficient computers for student training and research	23	46.9	10	20.4	11	22.4	5	10.2	1.96	1.060
ICT2	Our lecturers use internet and email in giving lecture notes and	26	53.1	14	28.6	5	10.2	4	8.2	1.73	0.953

	assignments											
ICT3	Students in our department use computers for other purposes such as face book, U-tube etc other than academic purposes	20	40.8	7	14.3	7	14.3	15	30.6	2.35	1.300	
ICT4	The computer centre that students use for browsing has minimal problems of internet failing ( network failure)	18	36.7	10	20.4	12	24.5	9	18.4	2.24	1.146	
ICT5	MPUC library gives us access to internet material ( digital libraries) and we have a list of sites and passwords by which we can access additional course materials	18	36.7	9	18.4	6	12.2	16	32.7	2.41	1.290	
ICT6	Some of the computers in our department are not operational or	7	14.3	12	24.5	8	16.3	22	44.9	2.92	1.134	

	have viruses and offer limited use in the learning process										
ICT7	Our department provides sufficient computer training to all the students in the department	10	20.4	13	26.5	16	32.7	10	20.4	2.53	1.043

**Table 4 Staff response data on the challenge of ICT application and management**

VARIABLE	SCALE ITEM	To no extent		To some extent		Moderate		To a large extent		Mean	Standard deviation $\sigma$
		1		2		3		4			
		F	Rate %	F	Rate %	F	Rate %	F	Rate %		
ICT1	Most lecturers use internet and browser technology in doing research	2	7.7	8	30.8	9	34.6	7	26.9	2.81	0.939
ICT2	Most lecturers in MPUC use email and internet to give lecture notes	8	30.8	13	50	4	15.4	1	3.8	1.92	0.796
ICT3	MPUC has dependable internet providers and rarely do we have internet lapse or failure	6	23.1	16	61.5	4	15.4	0	0.0	1.92	0.628

ICT4	All lecturers have access to computers and use the facilities for their day today teaching activities such as presenting lectures using power point	6	23.1	11	42.3	9	34.6	0	0.0	2.12	0.766
ICT5	Some lecturers have challenges of using information technology due to negative attitude to computers	15	57.7	8	30.8	2	7.7	1	3.8	1.58	0.809
ICT6	Some lecturers fail to use IT due to unfamiliarity with the soft wares that can help them in teaching and learning activities	11	42.3	9	34.6	3	11.5	3	11.5	1.92	1.017
ICT7	Use of IT is hindered by some of the computers being rendered ineffective by viruses and breakdown	4	15.4	11	42.3	3	11.5	8	30.8	2.58	1.102
ICT8	MPUC library has given the lecturers access to digital libraries and passwords for accessing useful	10	38.5	9	34.6	3	11.5	4	15.4	2.04	1.076

sites for journals and teaching materials											
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### Abbreviations

IT...Information technology

ICT...Information and communication technology

MIT... Manchester institute of technology

MPUC... Mombasa Polytechnic University College

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**B2012-13: Impact of Electric Fence on Pastoralists Movement in Ol Pejeta Eco-System in Laikipia, Kenya**

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**Abstract**

The challenge of human- wildlife conflict (HWC) in Ol Pajeta eco-system has been there since early 1980s. An electric fence was erected as a mitigation strategy to resolve HWC 2006. However, some parts such as southern boundary of Mutara ADC farm had not been fenced. By 2009 electric fence was installed on the southern boundary of Mutura ADC farm. The fencing closed out migratory corridors of elephants, interfered with pastoralists' movement patterns and morans' cultural rite activities. Persistent

drought and increased elephants aggression in the eco-system has compounded the problem of HWC due to dwindling natural resources particularly water, vegetations and mineral licks. Consequently, tempering of fence by pastoralists and morans' rites activities rendered electric fence ineffective hence elephants had easy access to farms. This led to increased farm raids incidences by elephants. These farm raids have consequently resulted to escalation of threats to human life, leading to low school retention rates and food insecurity. Moreover, food insecurity spread of zoonotics, livestock diseases and pests were a great source of concern to the major stake- holders. Hence, the problem of HWC related to threats on wildlife conservation, safety of human and their livelihood had continued to persist. The purpose of the study was to establish the impact of electric fence on pastoralist movement in Ol Pejeta conservancy. The general objective of the study was to assess the impact of electric fence on pastoralists in Ol Pajeta conservancy. Cross-sectional descriptive survey and purposive sampling were used to identify the respondents. Interviews and focused group discussions were used for data collection. The conservancy communities could conduct awareness campaigns on the benefits of local communities' participation in conservation efforts and eco-tourism and address the water problem; introduce school feeding programs, pest control mechanisms. The community could be involved as key stakeholders in the conservancy by restoring and maintaining migratory corridors in partnership with the government among other stakeholders in OLpajeta ecosystem. This approach enhances acceptability of the electric fence because it upholds the communities values and priorities, thus eventually mitigating human- wildlife conflict in Ol Pajeta resulting to peaceful co-existence between the communities and wildlife. If this approach of community participation and involvement is enhanced and sustainably managed, such conservancy strategies can be replicated nationally and international as a creative and innovative mitigation strategy for restoration of peace and reconciliation in areas experiencing human- wildlife conflict hotspots. The approach of this magnitude can contribute immensely in biodiversity management, conservation of wildlife resources in Kenya and the rest of the world for socio-economic development now and in future.

**Key words:** *Human Wildlife Conflicts, Electric Fence, pastoralists, movement*

## **1.0 Introduction**

Human-wildlife conflict (HWC) in Kenya and world over focuses on threats posed to wildlife, human and their livelihoods. Conservation of wild species, the security human and their livelihoods play a critical role in sustainable biodiversity and socio-economic development as well as peaceful co-existence (FAO, 2007; Hill, 2004; Muchane et al, 2012 and Madden, 2006). HWC occurs as when demands for more space caused by human population explosion interfere with habitats leading to wild species' contact with humans as they compete for space and natural resources (Animal on the edge, 2010 and Hoare and Du Toit, 1999). HWC is also caused by encroachment on wild species habitat leading to animals straying into human settlements (Fearn, 2010 and Laverdire, 2007). When wild animal interact with humans there is spread of pests (such as ticks, flea, and lice), animal-related injuries (such as bruises, stings and bites) (Langley, 2012), spread of infectious diseases to human and their livelihoods (like swine fever, African swine fever, swine influenza (Carlson, et. al., 2012), foot and mouth as well as and rabies. The feeding habits of large mammals (like elephants, hippos and buffaloes) in over 70% parts of the world are a major threat to food security. For example, in 2005 alone, crops for 12000 families were ravaged and three (3) villagers killed by elephants in the vicinity of Chinese nature

reserves in Xishuangbanna, Southwest Province of Yunnan since wild elephants' population had exploded from 80 to 300 over the past twenty years (Laverdier, 2007). Although HWC had political, biological, ecological and socio-economic significance, the issues on optimization and creative strategies of human wildlife interactions had not been fully exploited. Hence, the need for the current study is justified.

Human-elephants conflicts (HEC) in Africa and Asia are associated with cultivation taking place just next to protected areas (Graham, et al., 2009). Africa alone is home to over 70% of the world population of the large mammals like elephants. (Sitati and Walpole, 2006). Yet, in Africa, elephants invade human settlements and raid crops, cause damage to personal belongings, injure or kill livestock and in instances even injure and kill people (Omondi, et al., 2004). The conflict lead to decline of African elephants (Douglas-Hamilton, 1987). In Ghana, 117 elephant crop damage incidences involving 58 farms belonging to 43 framers were reported (Danquar, Opong and Sam, 2006). In Namibia, 3,194 farm-raided incidences and crop destruction by elephants were reported (Graham & Ochieng, 2008 and Jones and Elliot, 2006). Lions in Tanzania attacked and killed 120 people who were guarding their crops at night (Lavedier, 2007). The global wildlife conservation policy since mid-1990s had been no compensations. If the human felt that their interest were ignored or wildlife had priority over their lives and livelihoods when compensation after attacks or raids were not forthcoming, retaliation was inevitable (Emerton, Bishop, and Thomas, 2006). Human in retaliation, killed wild species indiscriminately, poisoned or engaged in poaching. Rebel militia killed 400 hippos within two weeks in Virunga National Park in Democratic Republic of Congo. In Africa, majority (60%) of the large mammals involved in farm raids and food crop destruction included elephants, hippos and buffaloes causing food insecurity, poverty and injure or kill people as they guard their food crops.

The large mammals' dietary needs serve as a major threat to food security. In Kenya, over 90% of crop raiding incidences of wild animals involve elephants (Gore and Kahler, 2006) and elephants kills people (Omondi, et al., 2004). When elephants stray into food crop farms, they cause heavy losses to farmers (Koch, et al., 1995). Animals destroy food crops and sometimes kill farm owners who try to protect their crops (Hill, 2004). The staple foods' (like Maize, bananas, cashew nuts, pumpkins, sugar canes and onions) time of maturation coincides with the elephants farm raids and crop destruction (Hoare 1999 and Kiiru, 1995). In their rampage, elephants also destroy infrastructure like artificial water points, grain stores, kill or injure livestock apart from interrupting functions like going to school, religious functions and market activities. Yet only 5% of the total claims were compensated in the last 12-years in Kenya

(Ngiro, 1995). Traditional methods did not scare away elephants from their farms. As humans tried to scare away elephants from their farms, 108 people were killed by elephants in Kenya in 1993 (Kangwana, 1995 and Kiiru, 1995a). Lethal elimination (or legal killing) is used to deal with defiant, aggressive and crop raiding elephants to ease human temper while sometimes, illegal killing of elephants occur (Omondi, et al., 2004). In some other instances, elephant translocation was used. In the year 2000, ten elephants were culled from Laikipia which had the highest incidences of conflicts and taken to Meru National Park (Gore and Kahler, 2006). The troublesome elephants could have caused a stir in their new locations. Electric fences were constructed to separate humans from elephants. Some of challenges to that option were uprooting by elephants, tampering, vandalism and theft by local residents or pastoralists on transits or morans in rites of passage activities and higher construction and maintenance costs. The issue of human wildlife conflicts (HWC) around Ol Pajeta eco-system had been there since early 1980s. An electric fence was erected in 2006 as a mitigation strategy to deal with HWC. However, fencing could have confined elephants and densities increased in their habitats (Litoroh, 2002 and Madden, 2004) as well as interfering with pastoralists' movement. Thus biodiversity destruction was likely to increase. Despite the efforts, elephants still raided farms and destroyed crops. That was because as one problem was being resolved new ones emerged. For example, pastoralist communities had their animal movement routes closed leading to tampering and damage to the fence. Hence, creative and innovative biodiversity management strategies are desired.

## **2.0 Problem**

Although heavy investments for construction of electric fence around Ol Pajeta Conservancy as a mitigation strategy had been incurred, the electric fencing interfered with pastoralists' movement patterns and morans' cultural rites activities. Persistent drought and increased animal population in the eco-system has compounded the problem of HWC due to competition for dwindling natural resources like water, vegetations and mineral licks. Consequently, pastoralists' movement patterns and moran rites activities were interfered with by erection of electric fence which acted as barrier that hindered their movements into ,through and from the conservancy. Pastoralists traditionally move into the conservancy during drought seasons in search of pastures and water. While the morans from the same pastoralist communities in the northern use the conservancy as hiding ground and escape route from their cultural moran rites activities which include cattle rustling from farming communities in the southern side of the conservancy. The erection of the electric fence did not serve the interests of the northern pastoralists communities .This perhaps accounts for the high incidence of fence tampering by human beings in the conservancy. The purpose of the study was to establish the impact of electric fence as a mitigation strategy of HWC in the conservancy and its effect on pastoralists' movement patterns and moran rites

activities. The general objective of the study was to assess the impact of electric fence as a mitigation strategy to HWC and its effect on pastoralists' movement patterns.

### *3.0 Literature*

Human wildlife conflicts (HWC) in Kenya and world over is a persistent threat to food insecurity apart from endangering wildlife, human and their livelihoods. Only 11.5% of the all the wild animals in the world can be found in protected areas. That suggested that about 88.5% of the animals had their habitat in the unprotected areas (Gore and Kahler, 2012). Besides, a study by Norton-Griffith (2000) had found that African elephants' population was decreasing. If the humans can live with 88.5% of wild species, then the 11.5% should not cause HWC when wild animals stray into human settlements. Hence, there is need for creative and innovative mitigation strategies to deal with human wildlife conflicts through participatory approaches. In Africa, HWC risks perceptions of elephants' farm raids and crop destruction was also considered and involvement in inclusive approach to research and stakeholders' decision making processes was important. Besides HWC resulting from elephants' farm raids and crop destruction was considered a major threat to food insecurity in Africa (FAO, 2007). Assessment of the threats posed to wildlife and livelihoods in the process of using wildlife deterrence interventions like "bombs" and fences because of smell from chili placed in bombs, ropes that create barriers around the crop field (Graham & Ochieng, 2008 and Gore & Kahler, 2012). Other inventions included communication to reinforce or maintain desirable behavior or restrain people from taking the law into their hands. Although the above strategies were used to scare elephants, electric fencing as a barrier that discourages elephants from conducting farm raids and crop destruction was considered a better option (Hoare, 1995). Electric fence can be thought of as a psychological measure because using wooden poles and electrified wires for fencing off elephants is not a 100% effective besides the cost involved in maintenance.

Kenya has over 1200 Km of game proof fences in various elephant and wildlife ranges and plans to develop another 1300Km are underway. Electric fencing has been done in Laikipia Plateau in Sweet Waters Sanctuary where 105 km<sup>2</sup> is fenced to protect over 150 elephants in wildlife sanctuaries in Nanyuki areas of Oljogi and Elkama. One of the policies of KWS is to protect people and property from injury or damage from wildlife (KWS, 1990). As such, KWS strives to reduce the level of human wildlife conflicts (HWC) in areas where the protected area has high conservation values, (Butynski, 1989) and has used electric fencing, elephant translocation, and establishment of sanctuaries at various pressure points (Bitok *et al.*, 2004). KWS maintains three major fence categories; simple, intermediate and comprehensive fences. Simple fences have (2 – 3) strands designed to restrict elephants.

Intermediate fences are multi-stranded ideal for confining many animals' species in Savannah ecosystems. Comprehensive fences are designed for high potential agricultural areas, (Bitok *et al.*, 2004).

A study by Graham et al. (2009) sought to establish the effectiveness of electric fencing on separating elephants and people to reduce HWC in Ol Pejeta conservancy. The work by Graham et al. (2009) found that farm raid incidences reduced by 43% from 692 in 2005 to 392 in 2007. Initially, the problem of farm raid incidences continued due to unfenced area around southern part of Mutara ADC farm. Later it was fenced also making it possible for elephants to be completely separated from humans (Graham et al, 2009). The same study also indicated that elephants' migratory corridors to Mt. Kenya and the Northern part of Laikipia are accessible. Although Graham et al. (2009) found that electrified fence was a better option in significantly reducing HEC, the cost of maintenance is high.

The study by Graham et al (2009) consider Laikipia plateau as mainly absentee savannah grassland. Besides, the small-scale farming communities and pastoralist communities have a difference in perception about natural resources (Mwajefa, 2012). The pastureland and other land resources might be in unfenced areas but it belongs to the communities. Besides the pastoralists depend on pasturelands for 'shifting grazing' that ensure that grass is not diminished and the land is protected from soil erosion due to overgrazing. As such, the current study sought to establish the impact of the electric fencing on pastoralists' movement.

## 4.0 Results and discussion

The results obtained were analyzed discussed to establish the impact of electric fencing on pastoralist movement. Several hypotheses were tested and discussed as shown below.

### 4.1 Test of hypotheses

$H_{01}$ : **Electric fence has no effect on the socio-cultural fabric of the communities**

Table 1 shows the views of the non-cultivating communities (pastoralists)

Table 1: **Pastoralist Communities' View of Electric Fence**

Electric fence:	Agree		Disagree	
	F	%	F	%
a) Helped the community from wildlife farm raids	4	17.4	19	82.6
b) Helped deal with crops destruction	3	13.0	20	87.0
c) Affected Moran rite movements	23	100	0	0.0
d) Affected Pastoralist movements	21	91.3	2	8.7
e) Affected inter-community interactions	21	91.3	2	8.7
f) Protects government's wildlife	23	100	0	0.0
g) Is a project to benefit the rich	20	86.9	3	13.1
h) Is beneficial to the community	2	8.7	21	91.3

i) Is donor funded project for wildlife benefits	22	95.6	1	4.4
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n = 23

The results in Table 1 show that the pastoralist communities view the fence as an obstruction and an intrusion to the communal activities with over 70%(n=23) in favor of nomadic lifestyle and disinterested with protection of cultivated food crops or wildlife at over 70%(n=23). Results of Pearson’s correlation ( $r_{12} = 0.874$ ,  $p = 0.05$ ,  $n = 23$ ) indicated a strong positive relationship between the pastoralists’ attitude and tampering of the electric fence in Ol Pejeta. Therefore the researchers rejected the null hypothesis  $H_{01}$  and accepted the alternate. As such, the electric fence affected the socio-cultural fabrics of the pastoralists’ communities. The pastoralists perceive that the “rich man” dominates over them, by shrinking their grazing land and watering points. Cultivation is perceived as “kuharibu nyasi” (interfering with grazing land). Their need for green pasture and water from the natural resources available whether in protected areas or open grassland is more important than conservation of wildlife. The current study found that the agro-pastoralists and pastoralist communities have differences in perception of the role of natural resources name pasture, water and land. The current study concurred with what Muthoni et al (2012) found that scarcity of pasture and water fuel conflicts, Laikipia plateau is a water scarce locality, improved technologies lead to use of more water for irrigation hence tilling of more land that was formerly pastureland deplete pasture-land and reduce grass for pastoralist and consultation of local communities and local communities participation in bio-diversity planning and management can lead to development of increased willingness to participate in conservation effort.

$H_{02}$ : Electric fencing **in Ol Pejeta conservancy has no impact on pastoralists’ movement**

Table 2 shows the opinion of the pastoralists’ community on the impact of electric fencing in Ol Pejeta conservancy on their movement

Table 2: Men and Women Opinion on impact of electric fencing on pastoralists’ movement in Ol Pejeta ecosystem

0-Unsure, 1-Strongly Disagree, 2- Disagree, 3-Agree, 4-Strongly Agree

Statement	Male	Female
Electric fencing blocked routes to certain parts of the pastureland	3.50	3.70
Occupied and unoccupied grassland belongs to the community	3.60	3.80
Elephants belong to the government while livestock belongs to people	3.10	4.00
Cultivation of pastureland “nikuharibu nyasi”	3.80	3.60

Pastoralists need large space to graze without causing soil erosion	3.20	3.80
Pastoralists move from one place to another in search of water and greener pastures	3.10	3.80
Green pasture is suitable for multiplication of livestock and production of milk	3.20	3.40
Electric fencing prevent pastoralist from accessing certain part of pasture in protected areas	3.20	3.90
Drought is a major threat to pastoralists livelihoods	3.10	3.80
Pastoralists co-exist with elephants if they do not injure, kill people or livestock	2.30	3.50

$N_1=45$  men and  $N_2=65$  women

The results in Table 2 showed that the level of agreement with opinions of men and women on the impact of electrified fencing on pastoralists' movement was high. Hence, the null hypothesis was rejected and alternate accepted. The current study concurred with what Kimuyu (2012) asserted that movement of pastoralists and their livestock is important due to the socio-economic benefits of livestock rearing. Kimuyu (2012) noted that savannah ecosystems have supported thriving pastoralist economies for over 3000 years, the livestock raised by pastoralists is worth US\$800 million per year and Kenya's livestock production accounts for 24% of total agricultural output. Similarly, the current study concurred with what Mwenzwa (2012) had found that arid and semi-arid areas like the Laikipia plateau is home to two-third of Kenya pastoralists and agro-pastoralist total population who lack basic human development indexes and register higher poverty indexes, yet they contribute about 5% of the Gross Domestic Product (GDP) through livestock production.. The current study agreed with the findings by Mwenzwa (2012) and Chesire & Mwenzwa (2012) that pastoral-nomadic communities face challenge such as extended drought, low literacy levels, unemployment and shortage of water. The challenges are compounded by the practice of accumulation of livestock for customary practices and payment of fines if found guilty of an offence. Hence, there is need to consider providing pastoralists avenues to gain access to the conservancy with out discrimination to allow sustainable use and provide the movements of pastoralist which can encourage bio-diversity management (Kimuyu, 2012) and encourage co-existence.

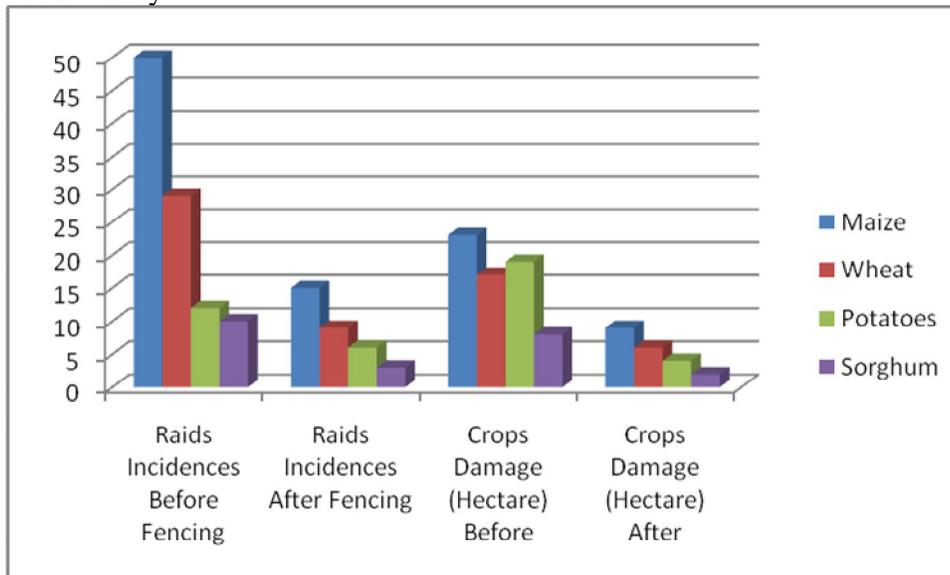
**$H_{03}$ : The electric fence in Ol Pajeta conservancy is not effective in mitigating human wildlife conflict**

The results of Table 3 shows farm raid incidences and crop damages before and after the electric fence of Ol Pajeta conservancy

Table 3: Results on farm raid incidences and crop damages before and after the electric fence of Ol Pajeta conservancy

Crop	Raids Incidences Before Fencing	Raids Incidences After Fencing	Crops Damage (Hectare) Before	Crops Damage (Hectare) After
Maize	50	15	23	9
Wheat	29	9	17	6
Potatoes	12	6	19	4
Sorghum	10	3	8	2
Totals	111	33	77	21

Fig1: Farm raid incidences and crop damages before and after the electric fence of Ol Pajeta conservancy



The results in table 3 and figure 1 show the opinion of the cultivating communities that the electric fence played an important role in reducing farm raid incidences and crop damages. The Pearson's correlation analysis of farm raids incidences and crop damages before and after the electric fence was a high positive relationship ( $r_{12} = 0.908$  at 0.01 level (2-tailed)). Over seventy nine percent of the farmers interviewed acknowledged that elephants' raids were frequent before the installation of the electric fence ( $n=110$ ). 79.4 % of them reported that the electric fence had reduced raids by elephants, (Table 1, Table 2 and Figure 1). The finding of this study agrees with what Knickerbockers and Waithika (2005) and Madden (2004) that electric fence can be a solution to HWC with both positive and negative consequences' to local communities. One of the negative impacts of the electric fence relates to the lifestyles and life

patterns of the pastoralists communities. Their feelings and welfare was completely overlooked. Electric fence interfered with their socio-cultural fabrics. As such, the view of the fence and an intrusion and obstruction to movement and social interactions results in tampering with the fence.

The cultivating farmers observed that the electric fence did not fully deter elephants from farm raids and crop destruction. There are still some instances of raids and crop destruction. Although villagers guard their farms against the few incidences of farm raids and crop damage, it is difficult to do so especially after the fence was put up because it is difficult to know where the elephants aim at. The villagers would like to get the support of the conservancy guards in taking care of their farm produces from damage. However, this suggestion could be explained by what Jones and Elliots (2006) found that it may be equally difficult for the guards to know where the elephants aimed. The challenges associated with constants elephants farm raid incidences include noise as farmers try to scare them, tearing of roofs of grain stores, property damages, breaking of fences and inflicting fear and insecurity to resident. In the event that elephants become adamant and aggressive the local don't have authority to carry out lethal elimination. KWS is officers can be called but sometimes take time to respond due human and logistical obstacles. Further more, Lervedire (2007) observed that restrictive laws prevent people from hunting problem animal species. The conservancy management among other conservancy agent may need to appreciate the agreement of findings of this study that in Kenya, elephants are responsible of three quarters of crop damages on crops (FAO, 2009). Furthermore, staple food-crops such as maize, millet and potatoes are constantly destroyed in Ol Pejeta conservancy and farmland around protected areas. Hence, ownership of large animals associated with the government-rural population demand wildlife authorities and government to protect them from animals menace.



## **4.2 Other pertinent issues raised by local communities**

In the interview and focused group discussions, some of the issues raised on HWC by the local communities that directly or indirectly impact the OI Pajeta eco-system included the following

### **4.2.1 Peace and reconciliation in OI Pejeta**

The communities' peace has from time to time been interrupted by the morans' rite raids by the communities from the northern side of the OI Pejeta conservancy. The conflict is caused by the morans because they come carry out cattle rustling of the few domestic animals belonging to the crop farming communities around OI Pejeta as a prerequisite condition for young men to pass the rite of passage and recognition by the community as a warrior hence qualification for marriage. The conservancy serves as hiding ground when they are spying, immediately after they execute the rustling raids. However, the electric fence acted as distracter to morans' movements with cattle that are stolen from southern community. It sealed off the exit routes of the morans' rite raiders. Hence the raiders could tamper with the electric fence in their flight and this has significantly resulted more farm raid incidences and crop damage by elephants which get easy access to farms. The current study findings concurred with what Mwenzwa (2012) had found that pastoral-nomadic communities engage in cattle raiding for accumulation of livestock among other cultural rites that require that their forested hide-outs during rites such as circumcision are available. Besides, their increased demand for pasture and water calls for construction of livestock watering points to cater for livestock water needs.

### **4.2.2. Pastoralists overgrazing and presence of IDPs**

From time to time, drought force the communities from the north to migrate to the eco-system hence causing an over strain on the vegetation and water sources because of over-paddocking. If the by-laws in place can be followed, they can be encouraged to ensure that a low number of animals can be better to co-exist with non-original-pastoralist communities. In the recent past, the internally displaced persons (IDPs) who were victims of post election violence of 2007/2008 are in the process of being settled. Their settling down may increase the strain on wildlife resources. This is because conversion of range land to small-scale farming holdings and land fragmentation had been cited as a major cause of human wildlife conflicts (FAO, 2009). The individuals to be settled were formerly in rich agricultural areas and as such their desire is to practice small-scale farming. Although their farming activities might not look economically viable, their effort to gain a decent living will propel them to work hard. The agencies

concerned can attempt to ensure that their settling is complete and harmonious to prevent a possibility of causing a threat to the bio-diversity conservation

#### **4.2.2 Health Services and Shortage of water in Ol Pejeta**

The local communities usually walk for long distances to access health care. Some of them travel as far as Nyahururu, Nyeri or Nanyuki to access maternity services and basic medical consultancy. What the people desire is health care at whatever cost. The source of water is a major cause conflicts with wildlife and between the locals. Hence, alternative water point to elephants away from the main source for livestock and domestic use could be availed. Shortage of water in Ol Pejeta has been a major set-back to the mitigation strategies used to deal with HWC and support co-existence through sustainable use and socio-economic development in the eco-system. The problem of water shortage escalates due to over-use of river water for irrigation at the source of River Uaso-nyiro, while existing dams are few and some are non-functional, the cost of bore-hole pumps, maintenance is high for the local communities to poor management and persistent drought. Burning of grass to control pests and its effects on pasture for livestock

Burning of pastureland by some pastoralists to control pest like ticks has been found to be a disaster especially when the rains are not forthcoming. Apart from that burning in savanna grassland if not controlled can cause a big loss to lives and property. The effect of burning to the bio-diversity conservation can not be overlooked because when wildlife does not get grass in the protected areas, will cause damage to the fence as they get out finding pasture. Alternative ways of dealing with pest can be identified and implemented.

#### **5.0 Summary, Conclusion and Recommendations**

The cultural activities of the morans like their rites can be incorporated into the schemes that enrich the eco-tourism. To increase their participation in creative and innovative conservancy management, inclusive consultation is encouraged and envisioned. Conservation authorities could make the communities accept that the benefits derived from the conservancy outweighs the perceived losses incurred as a result of HWCs. Provision of alternative water points for elephants away from the main source of livestock and domestic use could be constructed. The harvesting of rain and storm water and initiating water projects could be done. The conservancy could work with local leaders to source for funding to initiate quality health care projects. Making the communities benefit from the income by construction of schools and school feeding programs, pest control mechanism by KWS and the Ol Pajeta Conservancy. The conservancy could be encouraged to conduct awareness campaigns on the benefits of local communities' participation in conservation efforts and eco-tourism. The involvement of the community in decision making processes, restoring and maintaining migratory corridors in partnership

with the government and other stakeholders could be encouraged. This approach enhances acceptability of the electric fence because upholds the communities' priorities eventually mitigating human wildlife conflict in Ol Pajeta resulting in peaceful co-existence between the communities and with wildlife. When sustainably managed, it can be replicated as a creative and innovative mitigation strategy for restoration of peace and reconciliation in human wildlife conflicts.

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### **B2012-15: Assessment of Competitive Intelligence in Research Institutes in Kenya**

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#### **Abstract**

This paper gives understanding of competitive intelligence in relation to research and innovation for sustainable development in Africa. The process of competitive intelligence analyzes the external business environment to ensure that managers get the right information about the competitors in the business industry. The statement of the problem was to find out the awareness, attitudes among the competitors and monitoring of information in external environment by research institutes in Kenya. The objectives of the study was to establish extend of competition in the business environment, the challenges facing competitors in research and innovation and to establish if firms adopted information technology in decision making. The methodology used was simple random sampling to collect the data from the participants. Target group of the study were mainly scientists who had a population of 180. The sample population of the study were 60 participants. The data collected was analyzed using the SPSS programme. In the study, the researcher found out that most of the research institutes were not aware that competitive intelligence is important technique in the business environment. In conclusion, competitive intelligence is a unique programme that requires operators of the business environment to understand and keep a close watch with external environment and new innovations for business sustainable development. In recommendation, the study found out that the stakeholders in the business environment to undergo capacity building to acquire skills for effective competitive intelligence access of information in external environment.

**Key words:** *Environment, innovations, ICT, techniques, sources of information and government policy.*

#### **Introduction**

Competitive intelligence is a technique that enables enterprises to know how the competitors perform in the external environment. This is the new area where the business will get information from the external environment. It is essential for firms to get required data, analyze and interpret in order to make informed decision especially to remain competitive and improve the innovation process.

The statement of the problem was to find out the awareness, attitudes of other competitors and monitoring of information in the competitive environment. The research objectives were:

- (a) To establish extend of competition in the business environment
- (b) To establish the challenges facing the competitors in research and innovation
- (c) To establish how firms adopt information technology in decision making.

The research questions were as follows;

- (a) How extend was competition in the business environment?
- (b) What challenges were facing the competitors in research and innovation?
- (c) Do the firms adopt information technology in decision making?

### **Literature review**

Competitive intelligence is a systematic process that involves planning, gathering of information, analyzing and disseminating information on external environment for opportunities or developments that have the potential to affect the enterprise's competitiveness situation (Calof and Skinner, 1998). Calof (2006) further noted that competitive intelligence is not restricted to data on competitors, but extends to suppliers, customers and legal, technological and political environment in which the organization operates. It stressed that all sources should be legally and ethically identified and accessed. It is not about market research or business scanning, rather it is a process of knowing what the competition is upto and saying one step ahead of them, by gathering information about competitors and ideally applying it to short and long term strategic planning. Joynal (2009) narrated that it is the government policy to ensure that there is fair play ground in competition that create conducive business environment and enhances the business to utilize the gathered information ethically for the benefit of end users. For intelligence to succeed, the information collected must be actionable and contain enough information to help the business to develop better products, better deliverables, better marketing and better customer service.

The business environment embraces information and communication technologies to sustain its operation. McClurg (2001) noted that ICT offers support to competitive intelligence by gathering and analyzing information about one's competitor activities and general business trends to further one's own company's objectives. It is employed at all levels of the business in strategic decision making for instance use of the internet facility. It supports specific methods for identifying, storing and disseminating strategic information needs for the business environment.

Competitive intelligence provides business information from the external environment that requires be analyzed and interpreted. Therefore, innovation creates the business to get new ideas, new methods of

production, processes of high quality products or service and new organizational structure which relates to doing things differently to the satisfaction of customers needs. Research Institutes are required by the government to use available means to generate new technologies to improve food sustainability in the country (KARI ISO 2008 Certification). Every year budget for instance 2012-2013, has allocation for the ministry of Agriculture which includes research institutes that spells out what they are required to achieve within the time frame of the utilization on the available funds.

A successful business strategy requires that awareness about the company's environment including the customers both internal and external, industry structure, competitive forces, and suppliers among others. Competitive intelligence enhances information collection which the research institutes requires much attention. It lacks its mandate that information from the environment needs to be utilized to sustain research and innovation sustainability in decision making. Competition is healthy in an environment where competitive intelligence is really considered as important tool for innovation and improving the company process of products or service. Strategic plan for most research institutes ranging from 2010 to 2015 stipulate that they improved technologies to increase production for the benefit of end users. To address the constraint of lack of information, attitudes of competitors and monitoring of information in the business environment, the study was initiated to understand the situation in relation to competitive intelligence in research institutes.

### **Use of Information and Communication Technology (ICT)**

It is important in the business environment to use ICT facility for a competitive intelligence process. Rouibah and Ould-ali (2002) noted that organizations need to be careful in selecting and implementing ICT applications for intended purposes. It gives the direction in the sense that the organization determines its strategic information requirement, aspects in the environment data should be collected, source of data collection, analysis of data to determine whether they are useful for strategic purposes and dissemination of processed information to managers of the business to make strategic decisions and used to formulate their strategic plans. To make such events successful, the business should implement the so-called "intelligence infrastructure". This is the aspect of technological part of the infrastructure that supports the competitive intelligence activities. Examples of ICT include the use of internet for direction or collection activities that CI requires for successful implementation. ICT can be employed at all levels of the business functions for instance at operational levels e.g aiding sales representatives in asking questions to customers and storing the answers, at the tactical level supports the management to analyze the environment information and at the strategic level, it represents overviews of trends and their effects on the current or projected strategy.

Therefore, ICT clearly defines an exact classification according to these dimensions where it is meant to support strategic decision-making process in the competitive business environment. These include the use of intelligence software that analyze the collected data and interpret to aid managers in decision making for the business sustainability. The ICT also defines the techniques used by competitors in CI in order to remain competitive in the business environment. Strength, weaknesses, opportunities, and threats (SWOT) analysis is one of the most popular competitive intelligence analytic techniques. This defines both internal and external environment in the business operation.

### **Sources of information**

For effective CI, it is important to understand the sources of information in the competitive environment. It includes both internal and external sources. Internal sources is required to understand the business needs for instance what really the company requires from the competitive intelligence programme by involving staff at all functions at the beginning to get support and manage expectations and uncovering latent knowledge about the competitors. Competitors sources includes publications, patents, advertising, web sites, customer service and PR departments, direct interview with employees at trade shows or other events, product purchases, evaluation and observation. No business operates in isolation, hence release information during promotion, image, and regulatory purposes. Competitors share customers, dealers, and suppliers who can be interviewed. Fuld (2002) noted that where money is exchanged, so information. Also he further noted that every business has many employees with loose lips who can release information about the competitors. He divided the sources of information into direct sources namely; company sites, portals, search engines, press releases, industry (market) analysts, government, financial analysts, employment adverts, trade shows, technical conferences, employment interviews, meetings and panels. For indirect sources it includes; customer interviews, sales force, representative and distributors, suppliers and partners and former employees. These information guides the business managers in relation to strategic decision making that bring the company into a situation that can improve its serving delivery or product development process.

To sustain such information, business identities needs to operate within the law. The government guides the business through legislation and therefore, they are required to adhere to the provision provided by the law. It is the government policy that for effective competitive intelligence, it must operate within the law. Any policy passed by the parliament have direct impact on business for instance in research institutes, almost 90% of the funding for research and development is from the government. The research

institutes are mandated to collect information, analyze it and make recommendation to the government for further action. Therefore, the research institutes needs to be aware of the external environment, attitudes of the competitors and monitoring of information for research and innovation for sustainable development. The study collected information from research institutes that give the solution of the problem under study.

### **Theory review**

During the process of the study, the researcher used two innovation models namely, private and public sectors innovation models. In the private sector model, the end users were linked with non research institutions for instance ILRI, Kenya Seed Company and non government organizations who are also engaged in competitive intelligence in the business environment. The process involved that the private sector innovation normally has to register their latest innovation with the government through National Council of Science and Technology for further verification. For the public sector model, the end users are linked with government institutes like KARI, Kephis, Kefri, Kevevapi, Coffee Research foundation, Tea Research Foundation in order to get latest information and innovation in various specialization fields. For instance, the KARI Scientific Conference to be held in October, 2012 which has its theme as “Agricultural Innovation system for improved productivity and competitiveness in pursuit of vision 2030. Such benchmarking of the two models gives competitive edge to the end users in the business environment. Innovations strengthen the information availability through creating norms of the business organization by targeting potential customers. They have to practice the best culture in operating their business ethically and legally according to the government policy.

The research institutes and the private organizations are required to operate with the law by inventing new innovation that gives the best quality or service to the end users. In Kenya, most of exhibitions of new innovations by either public institutions or private organizations are normally done through a competitive process and normally conducted by the Ministry of Higher Education. The research institutes and private research organizations generates new innovations which characteristics are to internalize with external environment. Due to targeting the same marketing environment, the competitors still lack information, attitudes of other competitors and even monitoring the external environment for research and innovation for sustainable development.

## **Empirical review**

The research institutes occasionally had workshops, seminars with stakeholders to deliberate on the latest technologies in the external environment. These are government institutes which are required to work towards achieving vision 2030 in terms of competitive intelligence. The research institutes involved in the study were Kenya Agricultural Research Institute (KARI), Kenya Forest Research Institute (KEFRI), Coffee Research Foundation, Tea Research Foundation, Kenya Sugar Research Institute. The research institutes hold key information to research in the country. Despite their performance contract targets, there are also private sectors in the same service industry for instance International Livestock Research Institute, Kenya Seed Company, non-government organizations who competes with government institutes in research and innovation sustainable development. Competitive intelligence participatory approach was used in the research institutes for identification of awareness, attitudes of other competitors and monitoring of information in the external environment.

## **Research Methodology**

This entails the research designed used to achieve the objective of the study. These covered the research design, population, sample population, instruments used to collect data, and data analysis.

### **The research design**

The researcher used descriptive research design to achieve the objective. The researcher used the method in order to describe the events in the study. The data collected were analyzed and tabulated in tables and pie chart.

### **The population**

The study was conducted at research institutes namely Kenya Agricultural Research Institute (KARI), Kenya Forest Research Institute (KEFRI), Coffee Research Foundation, Tea Research Foundation and Kenya Sugar Research Institute. The study targeted mainly researchers in the institutes which had a population of 180.

### **Sample population**

The researcher used a sample population of 60 in the study. Since they were mainly scientists, the data collected were based their mandate in research and innovation in respective fields.

### **Instruments used in data collection**

The population under study were 60 participants but the returned questionnaires were 35. Given the strong strengthening element and model evaluation aspects imbedded in the participatory approach, the competitive intelligence requires monitoring process with the external environment for research and innovation for sustainable development. The instruments used were questionnaires and interview guides

to collect data for the study. The researchers and stakeholders were involved to understand extend of competition in the business environment, challenges facing the competitors in research and innovation and adoption of information technology in decision making. Most of the researchers generate new technologies which are useful to the farmers and ensure that it produces high quality products or service. The management evaluates those technologies while making their decisions in implementing the business strategies. The government which is the main stakeholder usually requires the research institutes to put in place measures that give healthy competition in the market. It gives guidelines in terms of policies to be followed by relevant ministries. Competitive intelligence (CI) enables research institutes to utilize the knowledge gaps and improves the production activities or service delivery.

The researcher identified staff of the research institutes mostly researchers as key participants to give information about competitive intelligence that influence their decisions in respective fields. To achieve the study, pilot test was conducted to enable the researchers understand why it was necessary to gather information about the external environment. A strategy was developed to ensure that researchers were available in their departments in order to participate in the process. The stakeholders were also informed to understand why there is need to collect data, analyze and interpret it for the benefit of the business environment especially in decision making. During the briefing, the participants were made aware that the external environment keeps on changing in terms of innovation and technology. This requires that the research institutes need to cope with situation for the research and innovation for sustainable development in Kenya.

### **Collection of data from the scientists**

Using a simple random sampling procedure, a pilot test was first conducted before data collection to establish the pre-adoption social-economic situation and willingness of participating researchers. During the test, participatory analysis of needs and constraints of competitive intelligence in the business environment and practices of research institutes in monitoring the use and current innovation was also undertaken. This formed the basis of subsequent activities including mobilization of researchers, involvement of management in the process and time framework to get the data using the questionnaire, interviews and observation methods were developed for the study.

For effective utilization of the resources available, questionnaires were distributed to scientists for research institutes in Kenya to enable data collection required for competitive intelligence on the awareness, attitudes with other competitors and monitoring of information in the external environment. A training curriculum was organized for interviewers to enable them understand what was required on the problem under study. Training of trainers covered the technical aspect of competitive intelligence including scanning of environment, competitors in the same industry, current technology used, new

innovations and the need for improvement. This involves 60 scientists in various research institutes in Kenya. They were 35 women and 25 men. The overall essence was whether scientists in research institutes often utilize competitive intelligence by collecting data, analyzing and integrating for their business strategy focus. Since the research institutes hold vital information to the end users, but need to be improved to enhance research and innovation for sustainable development in Kenya. Those who participate in the process were to disseminate the information to their line managers to factor in the aspect of competitive intelligence in decision making process. They used the acquired knowledge and skills to improve their research activities that will benefit the country as whole and eventual achievement of Kenya Vision 2030. At the end of the programme, each participant was given questionnaire to give honest answers to the questions pertaining to competitive intelligence in research institutes. The other method used was interview guide to get first hand information on the areas to address the problem under study.

### **Data analysis**

This involved interpreting of data collected from the participants. Once questionnaires were completed and collected from each departments of scientist, the researcher compiled them. The information was then analyzed using SPSS programme.

### **Findings and discussions**

- Most of the research institutes scientists were not aware that competitive intelligence is important in their business environment. There are other private sectors who also do research on the same, target the same market or customers, hence increasing chances of high competition.
- Most of the scientists are potential in new innovations but does not consider the other competitors in the same business environment. They worked as partners or stakeholders for the generation of technologies to create competitive edge in the field of research. They need to work in collaboration for the benefit of end users.
- The linkage between the private sector, public sector and end users has enables the competitive intelligence to be the most relevant field in business environment for research and innovation for sustainable development.
- To succeed in the competitive environment, the researchers uses available means to gather information through public, media, internet, launching of new products, sharing of customers, dealers and suppliers and interviewing of employees.
- It was established that the data collected, analyzed and interpreted are required by the managers and use such information legally and ethically in decision making.

- The type of co-operation among the competitors creates competitiveness in the business environment. Competitive intelligence creates the business environment more unique and proactive in the management style.
- Success of the instruments used to collect the data has lead scientists to gain more knowledge about the changes from the business perspective. They scrutinize the external environment if there is any new innovation that can improve their products or services.

### Discussions

From the baseline survey, it showed that competitive intelligence has not been addressed adequately by research institutes in Kenya. It is important to note that scanning the business environment helps the competitors to access vital information about current market share and innovation in the competitive environment. It therefore meant that competitive intelligence involves frequent monitoring of information; assess the needs of both internal and external customers, suppliers and general public. It also enables the competitors to improve their process by involving the stakeholders in decision making to avoid any resistance in implementation stage.

The following table shows the number of participants in the process to address the problem under study. They were 35 women and 25 men who were involved in the study.

**Table1.** The number of research institutes involved in the process

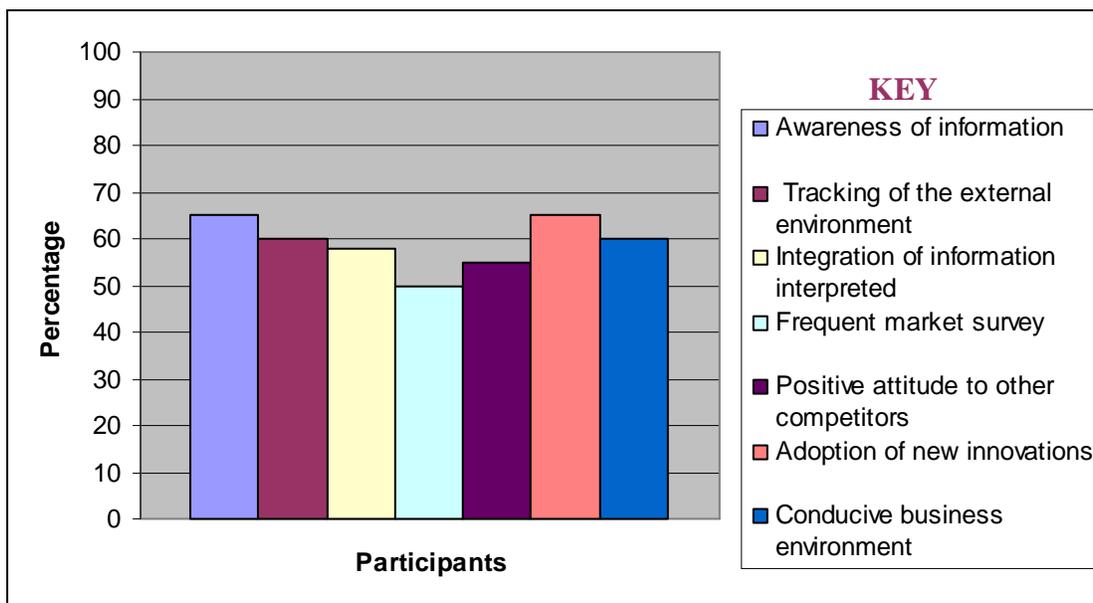
Description	No. of participants	%
KARI	20	33.3
KEFRI	15	25
Tea Research Foundation	5	8.3
Coffee Research Foundation	10	16.7
Kenya Sugar Research Foundation	10	16.7
<b>TOTAL</b>	<b>60</b>	<b>100</b>

**Table 2. Participants who returned the questionnaires**

Item	Distributed	Returned
Male	35	20
Female	25	15
<b>Total</b>	<b>60</b>	<b>35</b>

**Table 2.** Improvement of collaboration by the scientists after awareness (N= 60)

Description	Scientists (%)
Awareness of information	65
Tracking of the external environment	60
Integration of information interpreted	58
Frequent market survey	50
Positive attitude to other competitors	55
Adoption of new innovations	65
Conducive business environment	60



**Figure 1: Improvement of collaboration by the scientists after awareness (N= 60)**

In Table1 above, it showed that there were more participants from KARI who wanted to know the importance of competitive intelligence in terms of awareness, attitudes with other competitors and monitoring of information about the business environment. These research institutes normally does various specialize fields in collaboration with other stakeholders to fulfilled their mandate. These research institutes normally does various specialize fields who are mandated to assist the farmers as the ultimate end users. Their inputs are very important as they release latest breakthrough to the market for adoption and evaluation. During the study, it was noted that competitive intelligence plays a key role in research and innovation for sustainable development in Kenya. This is derived by the fact that there are other competitors in the same service industry hence are required to analyze external environment in order to remain competitive in the business operation.

In the above table 2, it showed that the number of respondents who gave in their inputs during the study. This contributed to the success of the study

In table 3 and Fig. 1, the researcher noted that after analyzing the questionnaires, the scientist increased understanding about competitive intelligence in the business environment. It was realized that there was need to keep close watch with other competitors to ensure sustainability of the business. It was also noted that collecting such information is very important as it aid the management decision making process. It increases chances of awareness as well as know who other competitors offers the same service or product to the same target market. The scientist appreciates the importance of the data collection instruments since it shaped skills and knowledge in discharging their normal duties and responsibilities in the business operating environment.

### **Summary, conclusions and recommendations**

Through testimonials by participating scientists of research institutes in Kenya, such forum has made significant contribution in data collection, analyzing and interpreting the information in external competitive environment. Such available information has made the competition in the environment more informative and keen to the new innovation and adoption for sustainable development. Through increased knowledge, the scientists moved ahead to monitor information to ensure that the end users get right quality of products or service.

For instance, scientists after interviewing them gained understanding that more exchange of information is vital and key to the business operation. The available information contributes to the business strategies innovation and frequent moderation of information that keeps in line with customers' satisfaction. Competitive intelligence awareness contributes to assessment of quality products or service at the right time and place. The essence of data collection was to enlighten the scientists for the need to ensure that they operate under competitive environment. The scientists were optimistic that the information collected from the external environment was crucial in decision making in formulation of business strategy. The management supports the idea of external sourcing of information for the benefit of the enterprise sustainability. Since they were government agencies, the scientists formulated policies that ensure that competitive intelligence is carried out and used ethically and legally. The stakeholders and the organizers built a positive culture that enhances awareness of the need to make references to the external environment. It was established that competitive intelligence plays an important role in building co-operation with the competitors in the business environment. Most of customers prefer innovations that give best results for their end use.

## **Conclusions**

There is limited availability of awareness, attitudes and monitoring of information, which is attributed to lack of technical knowledge in competitive intelligence. It is a unique programme that requires operators of the business to understand and keep a close watch with external environment and new innovations for business sustainability. It is an eye opener to the business strategies and competitive environment. The business environment is so unique that requires understanding and utilizing the available resources to gather information for decision making for the benefit of business sustainability.

## **Recommendations**

The stakeholders in the business environment need to have constant consultations on areas that require their attention. They are required to undergo training to acquire skills for effective competitive intelligence performance. The managers' needs to make decisions from the information collected, analyzed and interpreted for the business' innovation and competitiveness in the external environment. It requires involvement of all stakeholders when such decisions are undertaken for the business strategic plans. The customers, suppliers, competitors, creditors, employees and government need to collaborate for the business research and innovation. Conducive environment is required for the research and innovation that reengineer competitive intelligence process and makes the business sustainable. The managers need to be taking into account the element of information from internal and external environment. It is vital to the business and awareness of the competitors in the external environment for research and innovation for sustainable development.

## **Acknowledgement**

The authors wish to acknowledge the research institutes scientists who gave their inputs and time to avail required information to achieve the problem under study. Their participation and co-operation with interviewers during the process made the study to accomplish its objective.

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## **B2012-16: Recruitment and Development of Academic Staff in Public and Private Universities and university colleges in Tanzania**

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### Abstract

This paper investigate how academic staff are recruited and developed in public and private universities and university colleges in Tanzania, the procedures followed by them to ensure their academic members of staff are developed through academic ladder and how effective is these procedures bear fruits in raising teaching, research and community services, which are core functions of university. Seven

universities and university colleges, these are, one public university with two of its constituent colleges and four private universities were chosen as case studies. Criteria of recruitment in public universities were used as the standard to compare as public universities in Tanzania had strict and well defined criteria for recruitment and development of its academic staff. Data were gathered from recruitment and development policies as well as academic staff profiles. This study reveals that public universities and university colleges has and followed well defined recruitment criteria and on staff development compared to private universities on which inconsistency, one's tribe and religion dominate the process of recruitment, promotion as well as academic staff development.

## **B2012-17: Policy Responses and Models In HRM: Creating Optimism in People Management in Tourism Industry**

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### **Abstract**

The quality of service is an important factor of successful business. Employees are an integral part of the service process and are a critical element in enhancing perceived quality and therefore the achievement of quality service depends to a great degree on human resource which depends majorly on the implementation of HRM policies and practices. This paper examines the human resource management (HRM) policy responses and models that are used in the hotel industry in Eldoret town, Kenya. It is a survey of three hotels in Eldoret town. A total of 30 respondents were drawn from the employees of the three hotels using a random sampling technique. Questionnaires were used to collect data which was analyzed using SPSS, ANOVA, and descriptive statistics then presented using tables and charts.

The findings from this survey reveal that both the 'best fit' and 'best practice' practices are practiced by the hotels and at the same time, elements of both hard and soft models are present in the HRM policies of the hotels under study. The elements of the soft model suggests that there is hope for creating optimism to people management in the industry leading a better service quality and customer care.

**Key words:** *Human resource management; Human resource management policy and practices; Hotel industry; Service quality*

### **INTRODUCTION**

Human Resource Management (HRM) means different things to different people. For instance, Senyucel's (2009) defines HRM as a combination of people-centered management practices that recognizes employees as assets and geared to creating and maintaining skillful and committed workforce for achieving organizational goals. Beardwell, Holden, and Claydon (2004) see HRM as the philosophy, policies, procedures, and practices related to the management of people within an organization, while Monody and Noe (2005) argue that HRM is the utilization of employees to achieve organizational goals.

Two approaches/models to HRM have also been identified: the hard and soft models. The hard model is an instrumental and economically rational approach to human resource management and is driven by strategic considerations to gain competitive advantage, maximizing control while achieving the lowest possible labor-cost. The soft model on the other hand is more consensual and is based on a high level of

managerial commitment to employees, which is intended to lead to mutual high commitment from employees, high trust, high productivity and so on. This approach sees employees as being proactive, capable of being developed and worthy of trust and collaboration and is focused on human resource management (Storey, 1987). This study attempted to establish the type of model being employed in the hotel industry.

Regardless of the definition of HRM or the model selected, HRM remains an important element in quality service delivery and especially in the service sectors such as the hotel industry. Proper management of employees is therefore crucial precisely because employees interface directly with customers who make evaluative judgment of the quality of service delivered by employees (Dzansi and Dzansi, 2010).

### **The Problem**

The World Travel and Tourism Council (WTTC) suggest that travel and tourism related activities account for over 230 million jobs or 8.7 per cent of jobs worldwide (WTTC, 2006). In Kenya, Tourism significantly contributes to both the formal and informal jobs which is estimated at 130,000 and 360,000 jobs respectively and it is the leading foreign Exchange earner (Statistical Analysis of Tourism Trends, 2006).

However, despite the quantity of these jobs, their quality is of great concern to academics and policy – makers alike (Nickson, 2007), as it is frequently considered a satisfying career choice by people who have never held one (Coupland 1993; Lindsay and McQuaid, 2004). According to McDonald and Sirianni (1996), the challenges of living and working in a service society is characterized by two kinds of service jobs; large numbers of low-skill, low-pay jobs and a smaller number of high-skill, high-income jobs, with few jobs being in the middle of these two extremes.

Tourism and hospitality industry are not exempt from this as it is seen as one of poor conditions, low pay, high staff turnover, problems in recruiting skills in a number of key areas, a high level of labor drawn from socially disadvantaged groups, poor status and the virtual absence of professionalism. Additionally, organizations and managers in the tourism and hospitality industry face real challenges in recruiting, developing and maintaining a committed, competent well-managed and well motivated workforce which is focused on offering a high-quality “product” to the increasingly demanding and discerning customer (Nickson, 2007).

Concerning the nature of the workforce in the tourism and hospitality, the International Labour Organization (ILO 2001) provides evidence to suggest that the industry globally is reliant on what Wood

(1997) describes as 'marginal workers' such as women, young workers, casual employees, students, relatively high numbers of part-timers and migrant workers.

Given the unappealing and unrewarding nature of work in the tourism and hospitality industry as discussed above, it is important therefore that proper Human Resource Management (HRM) be practiced hence the need to establish the HRM practices and models so as to create people optimism in the industry thus the need for this study.

Human resource practices include organizational design, staffing, employee and organizational development, performance management, reward systems, benefits, and compliance as well as communication and public relations. These are grouped into four key areas in HRM: recruitment, development, commitment, and motivation. In an attempt to carry out these human resource practices effectively, a number of HRM policies have been formulated which include attendance policy, recruitment policy, leave of absence policy, performance planning and evaluation policy, probationary period policy, compensation policy, compensatory leave policy, overtime leave policy, annual leave policy, and educational leave policy among others ([www.managementparadise.com](http://www.managementparadise.com))

This survey attempted to look at the HRM policies and practices as far as recruitment & selection, induction, training & development and employee relations is concerned within the hotel industry.

Boxall and Purcell (2000) suggest that attempts to understand the way in which organizations approach the management of their human resource can be seen with regard to whether they aim for 'best fit' which is fully integrated with the specific organizational and environmental context in which they operate or 'best practice' which argue for a universalistic approach to HRM where all firms who adopt a range of agreed human resource policies and practices are more likely to create a high-performance workplace, as organizations aim to compete on the basis of high quality and productivity.

Nickson (2007) suggest that the aspect of attracting, maintaining, and developing a workforce are constant despite the debate about soft and hard and best fit and best practices and that organizations and managers, both specialist human resource and line managers, are wrestling with human resource issues on a day-to-day basis.

The hotel industry as a whole has a relatively poor reputation for HR related matters. The jobs especially the lower level ones, are characterized by long, irregular and unsocial working hours, low pay rates and few overtime payments, heavy workload, poor job security, few opportunities for promotion and unprofessional management of employees (ILO 2001; Whitley et al., 2007).

The tourism and hospitality industry has negative perception about employment practices and conditions and Keep and Mayhew (1999) identified a number of personnel problems in the industry including the following:

- Generally low wages
- Unsocial hours and shift patterns that are not family friendly
- Overrepresentation of women and ethnic minorities in low-level operative positions, with better paid, higher status and more skilled jobs filled by men, pointing to undeveloped equal opportunities in the sector
- Poor or no-existent career structures and use of casualized seasonal employment
- Over reliance on informal recruitment methods
- Lack of evidence of good practice personnel/HRM practices
- Little or no trade union presence
- High levels of labour turnover
- Difficulties in recruitment and retention of employees

A look at the current HRM practices in the tourism industry reveals the following: Concerning recruitment and selection, employers in the tourism and hospitality industry find it very difficult to recruit and retain competent and committed personnel, particularly at entry level position, which must have something to do with the characteristics of employment, poor HR practices and poor image of the industry. It seems that attracting talented people to the industry at all levels is the number one concern of all executives globally (Enz, 2001). Hoque (1999b) suggests that recent studies indicate that recruitment and selection even among large scale firms are not conducted professionally in the tourism and hospitality industry. Many studies show that in many establishments, personnel selection is rather an 'intuitive process', candidates' prior academic achievements do not count, and the process is not carried out in a professional manner (Ansastassova and Purcell 1995; Hoque 1999b; Ineson and Kempa, 1997; McGumingle and Jameson 2000; Rowley and Purcell 2001).

Induction and training is another process that is very important in the hiring process as it is crucial for the employees to have the knowledge and skills to deliver excellent services but seems to be one of the neglected areas of HRM in the tourism and hospitality industry. Boella (2000), O'Neill (1996) and Pizam (1999) argue that employers are reluctant to invest in training and development due to high turnover, large numbers of transitory employees, and tight budgets. However, recent empirical studies point to an increase in training and development initiatives, particularly in large and low turnover establishments as service quality, customer satisfaction and loyalty are becoming more important (Bwick and Muthu 1997; Harington and Akehurst 1996, ILO 2001; Watson and D'Anninzin-Green, 1996).

As far as career development and promotion is concerned, it is argued that as a result of the temporary employment and high turnover in the tourism and hospitality industry, there is very little opportunity for

career progression and promotion for many employees entering the industry. As a result of this, many qualified and talented employees leave the industry and others do not take up employment in the industry (Lucas, 1996).

The industry is also seen as a low paying industry when it comes to pay and benefits as a HRM practice. Poor remuneration of employees, particularly in the lower and operational level positions is one of the outstanding characteristics and conditions of employment in tourism and hospitality industry. Boella (2000) and Ryan (1991) concur that among the many reasons offered for the widespread existence and persistence of low wages in the industry are low levels of productivity, added value, and skills of employees, reluctance of managers to raise prices by raising labor costs, lack of trade union influence, and a weak internal labor market drawn from the secondary labor market such as students, housewives, and school leavers. Wood (1994; 1992) suggest that it is often claimed that as a compensation for the low wages, employees in tourism and hospitality receive tips from customers, subsidized food and accommodation from employers, and they are engaged in pilferage.

Employee empowerment and participation is another very important HRM practices. However, it has been revealed that employee empowerment and involvement, autonomous workgroups and quality circles are not widespread and that employees rarely have a say in issues such as pay, conditions, discipline and dismissals compared to other industries (Lucas, 19996). ILO (2001) observes that employee involvement is rare and where present, it is aimed at improvement of day-to-day business operations and communication between employees and management and among employees.

Leadership and management style affects to a great extent the way frontline employees do their job. Hartline (2008) argues that managers who are committed to service quality and employ empowering leadership style can create a transformational climate that conveys their commitment to quality service to their frontline employees. This in turn leads to employees who are more likely to share the organization's values, who understand their role in the organization, who are more satisfied with their jobs, and who perform at a higher level of quality in serving hotel guests. Unfortunately, there is almost unanimous agreement that the tourism and hospitality industry is characterized by "hierarchical and 'autocratic' styles of management, also variously expressed as 'unitarist,' 'directive,' arbitrary,' 'paternalistic,' 'impulsive,' 'unpredictable,' 'amateur,' and 'despotic' (Anastassova and Purcell, 1995; Lucas1996; Wood, 1994). Guerrier and Deery (1998) suggest that one of the reasons leading to this style of leadership is that the managers in tourism and hospitality organizations are said to be poorly equipped to manage professionally. Additionally, there is 'unbridled individualism' that is, a high level of management prerogative due to lack of a strong internal labor market and unionized labor force (Lucas, 1996).

Other poor HRM practices that have been cited include monotonous jobs, harassment and bullying, low job security, low promotional opportunity, long and unsocial hours of work, demanding managers and supervisors, poor co-worker attitude, night and weekend schedules, heavy workload and stress, labor shortages and poor staff, lack of time for family and low quality of life (Guerrier 1999; Iverson and Deery 1997; Mullins 1995;; Pavesic and Byemer 1990; Simons and Enz 1995; Zacerelli 1985).

### **Objectives**

1. To establish the HRM policies practiced by the hotels
2. To find out the differences in HRM policies practices by the different hotels
3. To find out the HRM models used by the hotels
4. To analyze the nature of the workforce in Eldoret hotels

### **Methodology**

This study was a survey that was carried out in Eldoret town, Kenya to investigate the HRM practices and policies practiced by hotels within Eldoret town. A sample of 30 participants was drawn from the hotels within the Eldoret central business district through random sampling technique.

### **Data collection tools**

Data was collected using a structured closed questionnaire.

### **Analysis**

The data collected was analyzed using SPSS program, descriptive statistics and ANOVA and presented using tables and charts as presented below:

Figure 19: Age

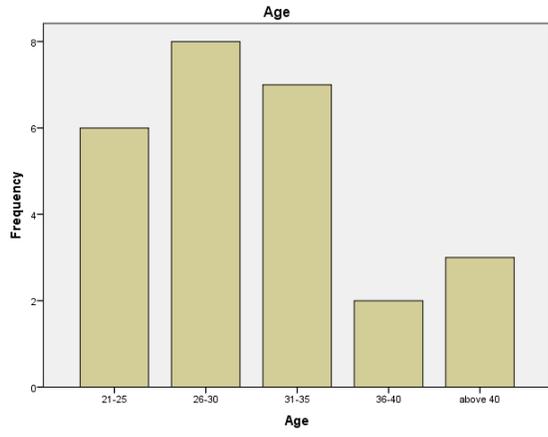


Figure 20: Gender

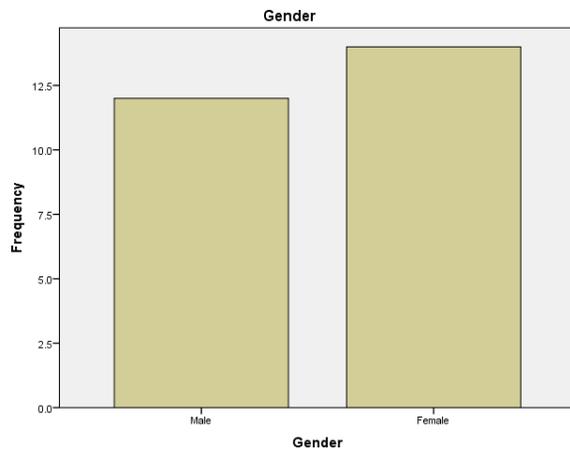


Figure 21: Education

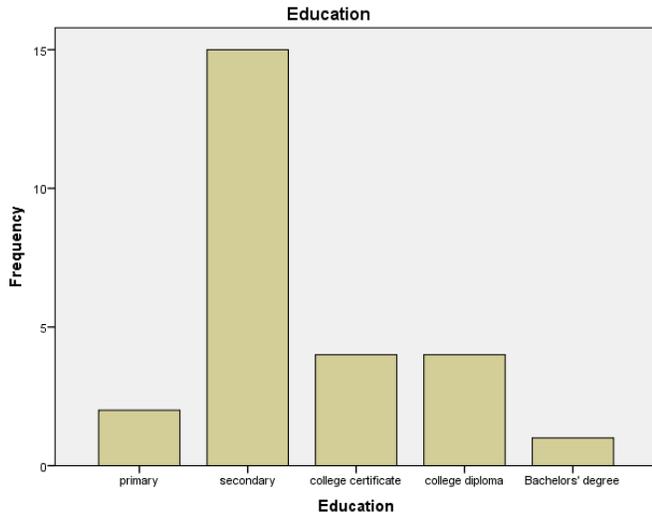


Figure 22: Training

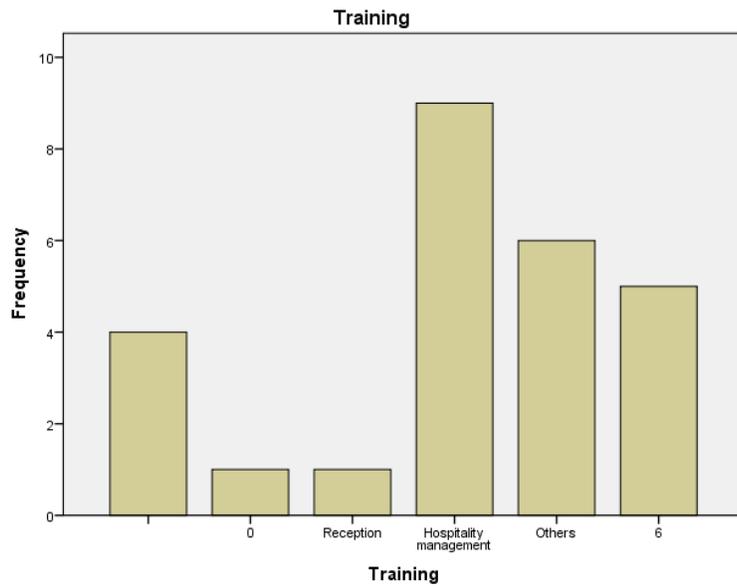


Figure 23: Position

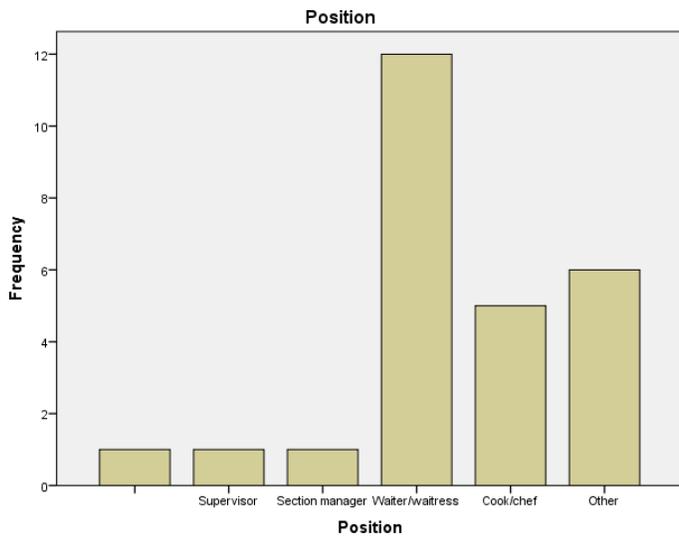
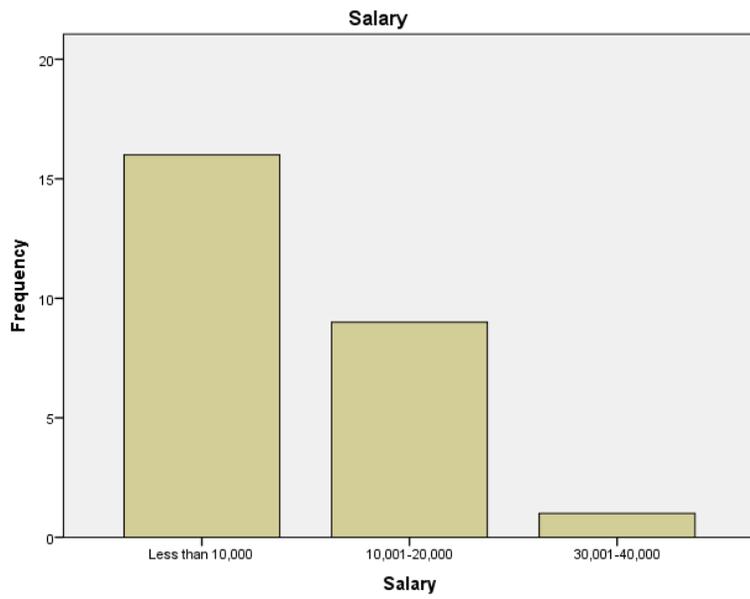


Figure 24: Salary



**Table 1: Recruitment and Selection**

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Recslect1	Between Groups	1.135	2	.567	.696	.512
	Within Groups	14.675	18	.815		
	Total	15.810	20			
Recselect2	Between Groups	2.593	2	1.296	1.136	.343
	Within Groups	20.550	18	1.142		
	Total	23.143	20			
Recselect3	Between Groups	.860	2	.430	.706	.507
	Within Groups	10.950	18	.608		
	Total	11.810	20			

**Table 2: Training and Development**

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Traindev 1	Between Groups	33.618	2	16.809	.412	.668
	Within Groups	898.622	22	40.846		
	Total	932.240	24			
Traindev 2	Between Groups	.403	2	.201	.175	.841
	Within Groups	24.222	21	1.153		
	Total	24.625	23			
Traindev 3	Between Groups	3.840	2	1.920	1.790	.190
	Within Groups	22.680	22	1.032		
	Total	26.520	24			

Table 3: Participation and Involvement  
ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Partinvolv 1	Between Groups	9.444	2	4.722	5.393	.013
	Within Groups	18.389	21	.876		
	Total	27.833	23			
Partinvolv 2	Between Groups	3.556	2	1.778	1.663	.214
	Within Groups	22.444	21	1.069		
	Total	26.000	23			

Table 4: Appraisal  
ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Appraisal 1	Between Groups	11.939	2	5.970	7.052	.005
	Within Groups	16.931	20	.847		
	Total	28.870	22			
Appraisal2	Between Groups	9.553	2	4.777	7.317	.004
	Within Groups	13.056	20	.653		
	Total	22.609	22			
Appraisal 3	Between Groups	6.647	2	3.324	2.744	.088
	Within Groups	24.222	20	1.211		
	Total	30.870	22			

**Table 5: HRM policies and practices****ANOVA**

		Sum of Squares	df	Mean Square	F	Sig.
PP1	Between Groups	4.549	2	2.275	1.968	.170
	Within Groups	19.651	17	1.156		
	Total	24.200	19			
PP2	Between Groups	10.016	2	5.008	7.255	.005
	Within Groups	11.734	17	.690		
	Total	21.750	19			
PP3	Between Groups	.599	2	.300	.490	.621
	Within Groups	10.401	17	.612		
	Total	11.000	19			
PP4	Between Groups	9.816	2	4.908	4.395	.029
	Within Groups	18.984	17	1.117		
	Total	28.800	19			
PP5	Between Groups	4.971	2	2.485	2.370	.124
	Within Groups	17.829	17	1.049		
	Total	22.800	19			
PP6	Between Groups	6.193	2	3.096	2.685	.097
	Within Groups	19.607	17	1.153		
	Total	25.800	19			
PP7	Between Groups	2.943	2	1.471	4.461	.028
	Within Groups	5.607	17	.330		
	Total	8.550	19			

PP8	Between Groups	.061	2	.031	.584	.568
	Within Groups	.889	17	.052		
	Total	.950	19			
PP9	Between Groups	.971	2	.485	1.415	.270
	Within Groups	5.829	17	.343		
	Total	6.800	19			

## Findings

From the study it emerged that most of the employees are between ages 26-30 years old (30.8%), with majority of them being female (53.8%). Most of the employees in the hotel industry have attained secondary education (57%) and most of them have undergone relevant training that is related to hospitality management (61.5%) and at the same time, majority (46.2%) are at the low level of employment. This is in line with Wood's finding that the hospitality industry is characterized by low pay and workers coming from marginalized sections and majority of low paying jobs as outlined by Keep and Mayhew (1999).

When it comes to the implementation of the HRM policies and practices as far as recruitment and selection, training and development, participation and involvement, appraisal and HRM policies and practices in general, the results were as follows:

Majority of the respondents indicated that one's education background is always considered in recruitment and selection. However, most of the participants feel that the recruitment process is not always the same for all the employees and that once employed, the employees are rarely placed to work in the areas that match their training. This study differs with previous studies which suggested that one's prior academic achievements do not count during recruitment and selection (Anastassova & Purcell 1995; Hoque, 1996b).

Concerning training and development, most of the participants agree that induction is always done with adequate duration though there is no deliberate development plan for workers upon employment. This concurs with previous studies by Bwick&Muthu (1997) who found out that employers are reluctant to invest in training and development.

Contrary to the observation of ILO (2001) that employee involvement is rare, and where present, it is aimed at improvement of day-to-day business operations and communication between employees and management and among employees, this study found out that employees' participation and involvement is always encouraged and that they are always involved in setting performance targets for their individual work with minimal supervision leading to autonomy and employee empowerment.

Most participants agreed that appraisal is done and feedback is given from time to time, however, the results of the appraisals are never used for actions such as promotion, reward and recognition and as a result, ranking of employees is rarely done fairly despite their achievement/performance and workers are never rewarded fairly when done. Additionally, recreation activities are never available to the employees. This creates demotivation on the employees leading to low quality performance. This corresponds with Nickson (2007) who found out that the tourism and hospitality industry faces real challenges in recruiting, developing and maintaining a committed competent well-managed and well-motivated workforce which is focused on offering a high-quality 'product' to the increasingly demanding and discerning customer. Also the HRM policies, despite the fact that they are designed to attract and retain employees, they rarely enhance commitment of employees due to poor implementation.

However, most of the employees indicate that there is always a clear chain of command and always understand their role in the organization which is very important in quality service provision.

### **Conclusion**

From this survey I can conclude that both the 'best fit' and 'best practices' are practiced in the hotel industry since there are elements of both in the analysis of HRM practices within the hotels under studied. This is because there are some HRM practices that are similar in the hotels studied while there are significant differences in others. This shows that the hotels implement the HRM practices selectively to fit the specific nature of the hotels.

Another conclusion to be drawn from this study is that both the hard and soft models are being implemented since you find elements of both models present. The aspect of the soft models creates therefore creates optimism in people management in the tourism industry despite the fact that it is looked at an industry which practices a lot of professionalism in HRM matters. For instance, education background is considered during recruitment and selection, appraisals are done with feedback given to the employees and also employee participation and involvement is encouraged.

### **Recommendations**

The following recommendation can be given from this study:

1. Recreational activities should be provided to the employees since lack of this can lead to burn out which can in turn interfere with quality service.
2. Employees should be assigned responsibilities that match their training to as to exploit their full potential in their areas of specialization leading to quality service.
3. Employers in the hotel industry should try to reward workers fairly on their achievements as this is one way of motivating the workers to work hard and achieve quality service.
4. Appraisal feedbacks should be used for action to bring about improvement in performance so as to ensure constant quality improvement.
5. Employers in the hotel industry should have deliberate training and development plans in place so that they can be able to attract and retain competent workers who are committed to quality.

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## **B2012- 20: Service Quality & Customer Care in the Public Sector in Kenya**

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### **Abstract**

Process orientation approach has been used in managing performance including service delivery and customer care .in public sector in Kenya prior to reforms initiated in 2004. This paper highlights the impact of; Results Based Management, Institutional Capacity Building, Rapid Results Initiative & Change Management on service delivery and customer care. Desk top research including analysis of policy documents, appraisal and evaluation reports has been undertaken in compiling this paper. The public sector includes 42 Ministries & 5 departments, 178 State Corporations, 175 Local Authorities and 74 Tertiary Institutions as at 30<sup>th</sup> June 2012. Findings based on the said reports and customer survey carried out in 2009, indicate that, efficiency & effectiveness in service delivery has improved as evidenced in commitments to Service Charters & International Standards Organization (ISO) certification, transparency, accountability, timeliness, staff competence, courtesy towards customers, fairness, automation, workplace environment and service outcome. The overall Customer Satisfaction Index was 63.5% which compares well with 68% of New Zealand in 2007 and 67% of Canada in 2005 (Customer Survey 2009). It can therefore be concluded that public sector reforms have led to improvement in quality of service delivery and customer care. It is recommended that, the gains made and lessons learnt should be used to attain excellence in service delivery, facilitation, sustainability and impact of the reforms in realizing Millennium Development Goals by 2015 & Kenya Vision 2030. Constant review of appraisal tool should be undertaken to make it relevant to dynamism in organizations. Key Words: Results Based Management, Institutional Capacity Building, Rapid Results Initiative, Change Management, Service Charter & International Standards Organization (ISO).

## **B2012- 23: Natural Capital for Sustainable Development: Optimal Outcome in Environmental Resources Use and Management**

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### **ABSTRACT**

The sustainability crisis facing us today has come about because we are consuming the world's stock of natural resources faster than it is being produced. Unless we efficiently use and manage these vital resource stocks, we will not be able to sustain them for future generations' needs. Economists have been working on attaching monetary value to components of natural systems and evaluating the cost of damage on them by human activities since the 1960s.

This paper analysis the idea of Sustainable Development in terms of optimal outcome in environmental and natural resources use and management as factor inputs in the production of goods and services (Gross Domestic Product – GDP). GDP gives a measure of the value of goods and services including: man-made capital (physical and financial), human capital (education and health), and natural capital (for example, ecosystems).

Conventional national statistics on GDP, however, do not account for natural capital, hence gives a distorted indicator of human welfare or Development Index.

This paper will highlight the concept of Total Economic Value (TEV) as a method of valuing natural resources to ensure optimal outcome in terms of sustainability and durability; and how these values can be integrated into GDP accounts to give a comprehensive estimate of a country's human welfare.

**Key words: optimal outcome, natural assets, total economic value, sustainability, durability**



## SYMPOSIUM 2

### S2012-01: Cod Removal Mechanism through Electrocoagulation Process

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#### Abstract

Electrocoagulation (EC) is electrochemical water and wastewater treatment technology which in its simplest form uses an electrochemical cell where a dc voltage is applied to the electrodes, usually made of Iron or Aluminum, and the electrolyte is the water or wastewater. Current theory of EC has not been able to explain all the phenomena associated with the process, among others the differences in COD removal efficiency in wastewater. In this paper we discuss the facts associated with COD removal using EC and develop a mechanism that explains them. To do so first, a review of the technology is done. Second, the concept related to Oxygen Demand is discussed, next, the results from a pilot plant relative to COD removal efficiency using EC are shown. Last, two set of experiments and a mechanism for COD removal are presented. This mechanism fits data and observations, is congruent with the Iron Pourbaix diagram. Finally the factors affecting COD removal are mentioned.

#### 1. Introduction

##### 1.1- EC Comments & challenges

The mechanisms of EC are yet to be clearly understood. There has been little consideration of the factors that influence the effective removal of ionic species, particularly metal ions from wastewaters from this technique.[3].

EC is a complex process with a multitude of mechanisms operating synergistically to remove pollutants from water. A wide variety of opinions exist in the literature for key mechanisms and reactor configurations. A systematic holistic approach is required to understand EC and its controlling parameters. [1]

There has been relatively little effort spent to better understand the fundamental mechanisms of EC, particularly those that could provide design parameters to optimize the performance of this relatively simple and inexpensive technique. [4]

Given the time scale over which EC technology has been utilized it is somehow surprising that the available literature doesn't reveal any systematic approach to EC reaction design and operation. The reason for this failure to drive toward some agreed best solution seems to be the lack of any quantitative understanding of the many interactions that occur within an EC reactor, and in particular the ability to predict the relative importance of these interactions for a given situation. The key driver for of any particular application of this technology has generally been the removal of a specific pollutant. Such centered studies have characterized almost all the published research into EC. Consequently, despite more than a century of application, many of them deemed successful, the science and engineering behind EC reactor design is still largely empirical and heuristic. These studies invariably prove the viability of the technology, but singularly fail to capitalize on its potential by being incorporated within a broad-based understanding of EC technology. [6]

EC is an enigmatic technology. Despite having been widely used for over a century, there appears to be no real consensus on the most appropriate approach for any given application, little in the way of systematic reactor design rules, and almost nothing in the way of a generic a priori modeling

approach. The root cause of this situation seems to be that EC is a technology that lies at the intersection of three more fundamental technologies – electrochemistry, coagulation and flotation. However it is clear from the published literature that what is lacking is a quantitative appreciation of the way in which these technologies interact to provide an optimum EC system so that EC can play a wider role as an accepted and dependable water treatment technology. Research is required to focus on explaining and quantifying the key interactions and relationships between electrochemistry, coagulation and flotation.

## **1.2 COD**

COD (Chemical Oxygen Demand) is a measure of the amount of the Oxygen used in the chemical oxidation of inorganic and organic matter present in wastewater. COD is also an indicator of degree of pollution in the effluent, and of the potential environmental impact of the discharge of wastewater in water bodies. COD results do not necessarily correlate to BOD because the chemical oxidant may react with substances that bacteria do not stabilize. Although BOD and COD are not specific compounds, they are considered as conventional pollutants under the federal Clean Water Act, and also they have been widely used by regulatory agencies worldwide to gauge overall treatment plant efficiencies.

### **1.2.1 Compounds that contribute to COD**

Among the compounds that contribute to COD we can find: biodegradable organic compounds, non biodegradable compounds and inorganic oxidizable compounds.

*Biodegradable organic compounds.* A "biodegradable" product has the ability to break down, safely and relatively quickly, by biological means, into the raw materials of nature and to disappear into the environment. The biodegradable compounds can be dissolved or suspended solids, colloids, organic matter, etc.

*Non-biodegradable compounds.* Sometimes non-biodegradable compounds are also called xenobiotics. They are not capable of being broken down naturally into environmentally harmless products. They are released into the environment in higher amounts than are present in nature. These compounds, for example, pesticides, herbicides, halogenated solvents, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons and toxins, are often very toxic or recalcitrant because of their molecular structure, excessive molecular size, their very stable bonds (C–Cl), and their limited bioavailability (e.g., hydrophobic compounds bound into organic matter are not available to microbes).

*Inorganic oxidizable compounds.* This group is comprised of metal/metalloid cations such as iron, arsenic; and anions such as cyanides, nitrites, sulfites, and sulfides.

These three kinds of compounds can also be classified as follows, and this classification is more convenient for the electrocoagulation process.

*Organic compounds,* which encompasses: Suspended solids and liquids such as micro organisms, emulsions, colloids, and fat, oil & grease (FOG); Miscible liquids such as alcohols, benzene, glycerin, oils, etc.; and Dissolved solids and liquids such as acids, salts, sugars, etc.

*Inorganic compounds,* mainly dissolved such as metals like Fe, metalloids like As, and some anions such as CN, NO<sub>2</sub>, SO<sub>3</sub>, and S.

## **2. Electrocoagulation mechanism for COD removal.**

This study is based on the tests that Kaselco Electrocoagulation, a manufacturer of EC units, has been doing at its laboratory for its consumers from 1997 to 2005. Most of the tests are for wastewater treatment, and complete analysis of water not always known.

## 2.1 Removal efficiency

Removal efficiency for Organic Compounds, BOD and COD from the Kaselco available data is summarized in Table I (consider number of tests for standard error).

**Table I.** Organic compounds Removal Efficiency (%) with EC.

	# of tests	Min. removal Effic. (%)	Max. removal Efficiency (%)	$\mu$ mean	$\sigma$ Std. dev.
<b>Fecal Coliform</b>	9	88.90	100.0	98.20	3.60
<b>Surfactants</b>	1	96.16	96.16	96.16	0.00
<b>TPH</b>	4	67.90	99.80	91.0	15.40
<b>Turbidity</b>	38	32.40	100.0	82.20	22.90
<b>Clarity</b>	17	31.10	100.0	81.10	21.80
<b>TBX</b>	7	63.40	93.30	76.00	11.20
<b>Fats, Oil &amp; Grease</b>	9	0.3	100.0	75.4	24.8
<b>TSS</b>	18	7.40	100.0	73.30	31.80
<b>MTBE</b>	11	15.0	95.90	47.00	25.50
<b>Methyl Chloride</b>	2	28.10	65.60	46.90	26.60
<b>BOD</b>	49	0.00	98.40	40.70	27.10
<b>COD</b>	65	0.50	86.40	38.90	27.30
<b>Acetone</b>	3	20.70	33.60	28.10	6.60
<b>TOC</b>	4	8.30	22.50	14.60	6.60
<b>TKN</b>	5	3.60	28.80	13.60	10.30
<b>2-Butanone</b>	2	3.90	1410	9.0	7.20

It can be seen from the results that there is an extremely high variability in removal efficiency of organic compounds. This is one of the reasons why EC hasn't always been accepted as a conventional technology and why it is considered enigmatic. COD removal efficiency may vary from nearly 0% to a surprising 100% depending on the solution tested. Questions arise immediately first; why can EC work extraordinarily well in some cases and fail completely in others; second, why are some compounds more easily removed than others?

A mechanism for EC will have to explain differences in COD removal as well as fit the current EC theory. To reach this goal we have to take a look at the current theory of EC, and review some of the proposed mechanism:

## 2.2 Electrocoagulation Mechanism.

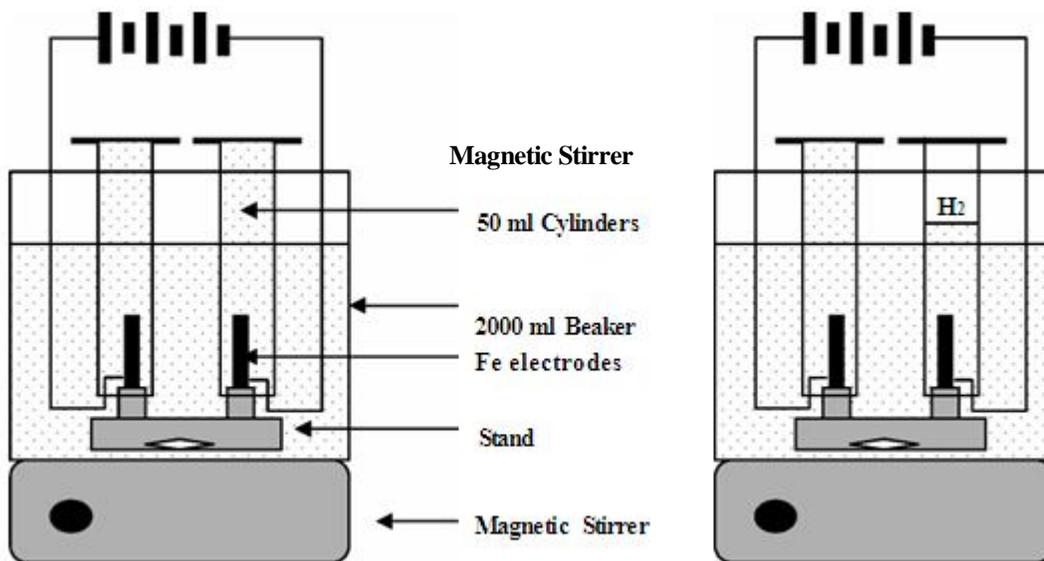
Current theory of EC states that it involves several successive stages:

- 1) *Generation of metal ions.*
- 2) *Hydrolysis of metal ions and generation of metal hydroxides and polyhydroxides.* This is beyond question, it has been studied and explained for coagulation process in water treatment.
- 3) *Water is also electrolyzed in a parallel reaction, producing small bubbles of Oxygen at anode and*

*Hydrogen at the cathode.* Although the presence of magnetite and maghentite identified in EC sludge can suggest Oxygen evolution at the anode this does not happen. To examine whether there is O<sub>2</sub> evolution, an EC cell was prepared using two cylindrical iron electrodes supported on a PVC stand and covered with graduated cylinders full of water to observe the displacement of water if any gas is generated. The solution used had 170 ppm of ZnCl<sub>2</sub> and 1000 ppm of NaCl to increase the conductivity of water. Electrodes were connected to a 50 Volts DC source. The experiment began at a pH of 5.2 and continued up to a pH of 10.74. The experiment showed that there is no oxygen evolution at the anode using iron electrodes, but hydrogen evolution at the cathode. (See diagram of the reactor in Figure 1).

4) *Destabilization of the contaminants, particulate suspension, breaking of emulsions, and aggregation of the destabilized phases to form flocs.* This part relative to colloids and suspended matter can be accepted because suspended solids and colloids in small quantities are not a problem for EC.

5) *Current theory of EC consider that chemical reactions and precipitation can occur during the EC process or that other cation or the hydroxyl ion (OH) form a precipitate with the pollutant.*



**Figure 1.** Diagram of the EC reactor used to probe oxygen evolution at the cathode

In the Electrocoagulation cell the reactions are:

pH	Anode	Cathode
water & pH < 5	$\text{Fe} \rightarrow \text{Fe}^{+2} + 2 \text{e}^-$ $2\text{Fe}^{+2} \rightarrow 2\text{Fe}^{+3} + 2 \text{e}^-$ <p>In fact Iron also undergoes hydrolysis</p> $\text{Fe} + 6\text{H}_2\text{O} \rightarrow \text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2 (\text{aq}) + 2\text{H}^{+1} + 2\text{e}^{-1}$ $\text{Fe} + 6\text{H}_2\text{O} \rightarrow \text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3 (\text{aq}) + 3\text{H}^{+1} + 3\text{e}^{-1}$	$2\text{H}^{+} + 2 \text{e}^{-} \rightarrow \text{H}_2(\text{g}) \quad 1'$
<p>Electrochemistry depends on thermodynamics and kinetics. The rate of reaction will depend on the removal of <math>[\text{H}^{+}]</math> via <math>\text{H}_2</math> evolution, this reaction will proceed fast for low pH values for a strong acid. For a weak acid the rate will depend on the pKa of the acid. Electro neutrality principle has to be kept in any step.</p>		
pH	Anode	Cathode
5 < pH < 7	$\text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3 (\text{aq}) \rightarrow \text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3 (\text{s})$ <p>More hydrogen evolution and Fe(III) hydroxide begin to precipitate floc with yellowish color.</p> <p>Formation of rust: <math>2\text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3 \rightsquigarrow \text{Fe}_2\text{O}_3 (\text{H}_2\text{O})_6</math></p>	$2\text{H}^{+} + 2\text{e}^{-} \rightarrow \text{H}_2(\text{g}) \quad 1'$
6 < pH < 8	$\text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3 (\text{aq}) \rightarrow \text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3 (\text{s})$ $\text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2 (\text{aq}) \rightarrow \text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2 (\text{s})$ <p>Hydrogen evolution continues and precipitation of Fe(II) hydroxide also occurs presenting a dark green floc. The pH for minimum solubility of <math>\text{Fe}(\text{OH})_n</math> is between 7 – 8</p> <p>Formation of rust. Oxides are dehydrated hydroxides</p> $2\text{Fe}(\text{OH})_3 \leftrightarrow \text{Fe}_2\text{O}_3 + 3\text{H}_2\text{O}$ $\text{Fe}(\text{OH})_2 \leftrightarrow \text{FeO} + \text{H}_2\text{O}$ $2\text{Fe}(\text{OH})_3 + \text{Fe}(\text{OH})_2 \leftrightarrow \text{Fe}_3\text{O}_4 + 4\text{H}_2\text{O}$ <p>Polymerization of iron oxyhydroxides to form the floc.</p>	$2\text{H}^{+} + 2\text{e}^{-} \rightarrow \text{H}_2(\text{g}) \quad 1'$
<p>This mechanism follows the Pourbaix diagram, Figure 2 for hydroxides, and also the characterization of EC products made by Parga et al. Conditions throughout the cell are not constant. Potential, concentrations, species and pH are changing. It can be said that in the iron Pourbaix diagram we are moving to the right in a region parallel to the hydrogen evolution line as highlighted in Fig 7</p>		
pH > 8	$\text{Fe} + 6\text{H}_2\text{O} \rightarrow \text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2 (\text{aq}) + \text{H}_2(\text{g}) \quad 1'$ $\text{Fe} + 6\text{H}_2\text{O} \rightarrow \text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3 (\text{aq}) + 1 \frac{1}{2} \text{H}_2(\text{g}) \quad 1'$ <p>Sludge and rust generation continues. In fact iron oxides are dehydrated iron hydroxides, and some of this oxidation occurs on the surface of the floated sludge. It can also occur during filtration and preparation of the sample.</p>	

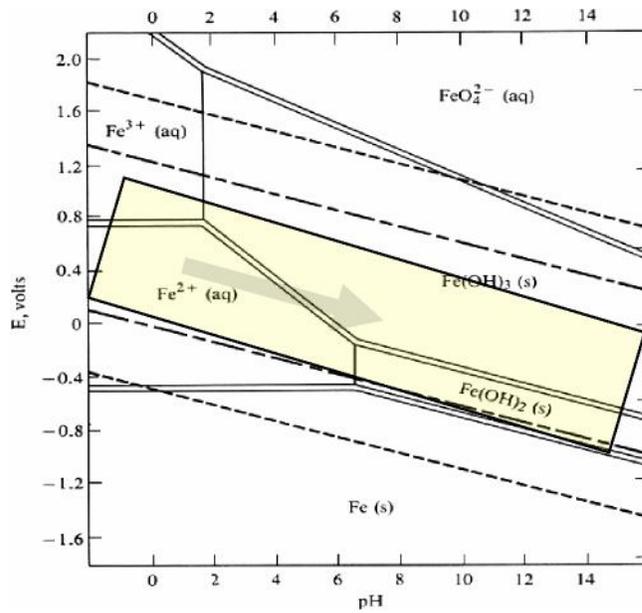


Figure 2. Fe Pourbaix Diagram, showing the region and direction in which the EC process proceeds.

### 2.3 Experiments and results.

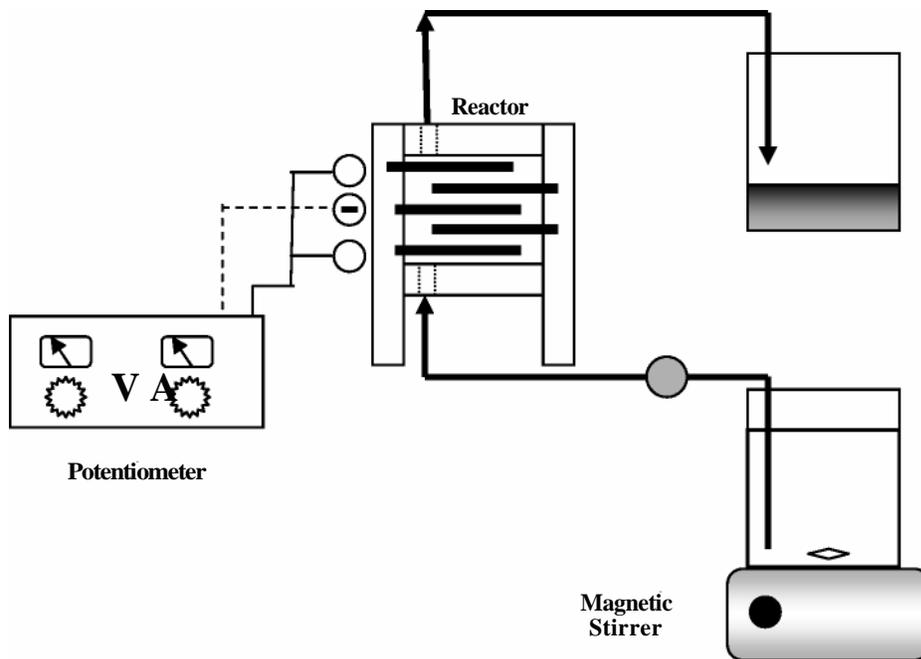


Figure 3. Diagram of the bench reactor

reversible pump with adjustable flow, a Corning pH meter 320, a Corning conductivity meter 441, a Perkin Elmer Atomic Absorption Spectroscopy Analyst 300 SE 3953, and reagent grade chemicals. The COD determinations were made by B-Environmental Laboratory in Victoria TX. Results are presented in Table II.

The electrode plates have dimensions of 4 x 4 x 1/4" for the exposed area. They can be made of Fe, Al or Ti. The separation between plates is  $\leq 1/2$ ". 2.2 L of water sample is passed through the reactor twice, and this is considered one pass in relationship to the full scale system. Complete treatment of wastewater can take more than one pass. (one pass takes approximately 6 minutes in the bench test).

Another set of experiments was conducted using a Beaker size electrochemical cell. Materials and equipment used were: 400 ml sample, rectangular iron electrodes with dimensions 3 x 6 cm, and with a submerged area of 12 cm<sup>2</sup> each, a 12 volts Interstate battery, an Ohmite potentiometer, a Fisher magnetic stirrer, an Oakton series 10 pH meter, a Cole Parmer conductivity meter, and reagent grade chemicals. Current was measured using a Cen Tech multimeter in series, and the potential with a Cen Tech multimeter connected in parallel. COD determinations were made using standard methods with: a DRB 200 Hach COD Reactor for digestion of the sample, and a DR 3000 Hach spectrophotometer for colorimetric determination. Electrodes were properly scrubbed, washed and rinsed prior to each experiment to make their surface clean and free from passive oxide layers. Results are presented in Table III.

**Table II** Results for 1<sup>st</sup> set of experiments. P Passes, I initial, F final, R removal.

Subst.	gr/L or ml/L	# of t	pH		Final Fe ppm	BOD (mg/L)			COD (mg/L)		
			I	F		I	F	R (%)	I	F	R (%)
EDTA	3	2	2.96	10.24	52.85	182	256	-40.7	173.5	302.5	-74.4
Acetic Acid	2	6	3.01	7.64	563.0	1599	1657	-3.6	2134	2162	-1.3
IPA	1,5	2	4.5	10.98	0.069	1599	1447	9.51	2498	2410	3.52
Sugar	2	1	4.59	11.19	0.178	1539	1254	18.5	2272	<sup>2120.5</sup>	6.7
Sodium Oxalate	2	1	5.98	11.6	0.045	188	116.5	38	216	182	15.7
Milk	3	1	5.72	10.92	0.029	364	93.5	74.3	572	148	74.1
Oxalic Acid	2	3	2.07	7.12	76.6	146	27	81.5	216	5	97.7

**Table III.** Results for 2<sup>nd</sup> set of experiments

Substance	Residence time (min)	COD (mg/L)		
		Initial	Final	(%) Removal
Acetic Acid	60	961	1083	-12.7
Glucose	60	983	1012	-2.95
Lactose	60	969	948	2.17
Phenol	60	1158	1125	2.85
Citric Acid	60	1081	515	52.36
Salicylic Acid	60	982	370	62.32
Tartaric Acid	90	1027	135	86.85
Oxalic Acid	90	1029	131	87.27

For a first set of experiments the following equipment was used: a Kasselco electrocoagulation bench unit (Fig 3), which has a rectifier with capacity up to 50 Volts or to 10 Amps and a peristaltic

### 2.3.1 Combined results.

In table 4 the combined results of the 2 set of experiments relative to COD removal are presented. Initial iron in the samples was 0 ppm. From these results it can be seen that depending on the organic compounds present in water and after the EC process, COD can be increased, remain nearly the same, be partially removed, or be almost completely removed. From these results we can determine the EC COD removal mechanism.

## 3 Discussion and conclusions

### Increased COD

Compounds (usually acids) which react with Fe(II) or Fe(III) to form soluble products will remain in solution. This can be concluded for the final iron concentration and the pH increment. This is even more pronounced in the case of sequestrants or complexing agents such as EDTA. When they react, mainly with Fe(II), in the corresponding experiment, we can say that most of the iron was Fe(II) because the final pH was 10.24 (see Table II), and in cases such as this COD can be increased due to further oxidation of Fe(II) to Fe(III).

**Table IV.** Combined results of the 2 set of experiments

Substance	In water	Reacts with Fe(II)	Reacts with Fe(III)	COD removal (%)	Final Fe (ppm)
EDTA	Soluble	To form soluble compound	To form soluble compound	-58.5 to -87.5	52.85
Acetic Acid	Soluble	To form soluble compound	To form soluble compound	-3.4 to 0.8	563
Glucose	Soluble	No	No	-3.2 to -2.7	
Lactose	Soluble	No	No	1.3 to 2.9	
Phenol	Miscible	No	No	2.8	
IPA	Miscible	No	No	2.7 to 4.4	0.069
Sugar	Soluble	No	No	3.6 to 9.6	0.178
Sodium Oxalate	Soluble	*	*	11.8 to 19.3	0.045
Citric Acid	Soluble	<b>To form insoluble compound</b>	To form soluble compound	51.9 to 52.8	
Salicylic Acid	Soluble	<b>To form insoluble compound</b>	To form soluble compound	61.8 to 62.8	
Tartaric Acid	Soluble	<b>To form insoluble compound</b>	Decomposes in water	86.7 to 86.9	
Oxalic Acid	Soluble	<b>To form insoluble compound</b>	To form soluble compound	87.3 to 87.7	76.6
Milk	Suspension	No	No	73.7 to 74.5	0.029

### ***COD not removed***

Soluble and miscible compounds that do not react with Fe(II) or Fe(III) will not be removed with EC and they will remain in solution. This is the case of glucose, lactose, IPA, phenol, sugar and similar compounds. A small amount can be adsorbed or absorbed on the floc and consequently be removed incidentally.

### ***COD partially removed***

\* Sodium oxalate and similar organic salts are another case. The EC process generates Fe ions that hydrolyze to form Fe(OH)<sub>2</sub> and/or Fe(OH)<sub>3</sub>, together with H<sup>+</sup> ions, since Fe(II) and Fe(III) are more acidic than Na<sup>+</sup> then (OH)<sup>-</sup> ions will preferentially stay with them to form insoluble iron hydroxides and the acetate ion will be only removed in a low proportion.

Compounds which react with Fe(II) or Fe(III) to form insoluble compounds will be partially removed. This is the case of citric, salicylic, tartaric and oxalic acids. COD removal efficiency for these compounds will depend on the final pH.

### ***COD highly removed***

It can be expected that compounds that react with both Fe(II) and Fe(III) to form insoluble compounds will be completely removed.

On the other hand, from table I it can be seen that suspended solids and liquids, in small amounts, such as fecal coliforms, turbidity, fats oil & grease, suspension such as milk, and TSS are not a problem for EC and are easily removed. This is due to the in situ generated coagulants. The portion not removed will be the soluble portion of those parameters that does not react with Fe(II) or F(III) to form insoluble compounds.

In some cases Al electrodes show higher COD removal efficiencies at lower pH values for two reasons, the first a difference of Iron, Aluminum only has one oxidation state, so when an organic compound reacts with aluminum to form an insoluble compound it will react almost completely, and second the solubility of Aluminum Hydroxide [Al(OH)<sub>3</sub>] has its minimum at a lower pH, close to 4.

Anyway every compound that contributes to COD is different, and also every wastewater. It will be better to try both, Fe and Al electrodes and even a combined system in order to get the best results.

EC can be considered as an accelerated corrosion process that follows the Pourbaix diagram. An EC mechanism for COD removal was developed. This model fits data and observation of Kaselco tests. It is also congruent with the iron Pourbaix diagram, the Solubility diagram, and with the characterization of EC products, and fully explains the causes of the great variability in the results for COD removal efficiency. Summarizing, we can say that COD removal efficiency and its variability will depend on the: formation of floc, which usually occurs at values of pH higher than 7.5 for Iron electrodes, reactivity of organic compounds with Fe(II) and Fe(III), the solubility of the compounds formed, the final pH (especially for acidic compounds final pH is an important factor for COD removal), the pH increment, and consequently on the acidity of the wastewater rather than on the initial pH, and on the electrodes material.

### ***Acknowledgments:***

We are greatly thankful for financial support from USDA (2004-38899-02181), the U.S. Agency for International Development (TIES, Project No. 96860), and the Welch foundation (Grant No. V1103). ATP (grant 00358 1-0033-2003) and to Douglas Kaspar and Kaselco Company for the information supplied and for permitting the use of their facilities

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### **S2012-03: Mapping of Human-Elephant Conflicts for Mitigation and Biodiversity Conservation Management in Aberdare National Park**

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#### **Abstract**

Electric fence of Aberdare National Park is a conservation strategy to protect wildlife from poaching. The electric fence blocked the movement of elephants in and out of the park. Hence, human elephant conflicts within the areas adjacent to the park occurred. Farm raids and electric fence tampering and damages threatened humans, their livelihood and elephants. The purpose of this study was to map and establish frequency of conflicts around the park. Purposive sampling was used to identify study areas. Farm raid incidences data was collected by field measurements. GPS coordinates of conflict incidences were taken. Elephant's raided farms destroyed 36 hectares (SPSS (version 11) used to data analyze generated regression, ANOVA and Spearman correlation coefficient. The GPS data was analyzed by GIS-Arch view (version 9) generated GIS maps. Farmers with farms long the park could be advised to minimize cultivation near the electric fence and establish tree buffer zones. This could mitigate conflicts; hence encourage local communities' co-existence with wildlife. GIS maps obtained could be useful tool for biodiversity conservation by KWS.

Key words: *Electric fence, Human-elephants conflicts, Mitigation*

#### **1.0 Background**

Human elephant conflict (HEC) is a major problem that undermines biodiversity conservation and human-wild species co-existence in Kenya and world over. HEC have been of a major conservation challenge in Africa and Asia despite the heavy investment in electric fencing among other mitigation strategies, the problem has persisted over the last decades (Ahlering et al., 2010; Graham et al., 2011; Graham et al., 2007). The frequencies of human elephant conflict incidences, the nature and extent of damages inflicted on farms are increasingly becoming a management conservation

challenge and a concern in the entire Aberdare ecosystem. The need to sustain the rapidly growing world population in terms of provision for food, shelter, space and fuel led to encroachment of all the major forests in the world resulting to deforestation, de-vegetation and destruction of water catchment areas, destruction of ecological habitats and loss of biodiversity through extinction of plant and animal species (Gore and Kahler, 2012). The human and elephant populations increase in Africa leading to loss of elephants' habitat to agriculture (Ahlering, et al., 2010 and Beyers, et al., 2011). Hence the problem of human elephant conflicts continues unabated affecting farmers livelihood. The situation is of concern to local farmers, wildlife conservation managers and the Kenya government. This is because peoples' lives and their properties must be protected as well as the biodiversity in the park (Beyers, et al., 2011). Elephants are particularly important in tourism and in the balance of the ecosystem within the park. Despite that, the local communities are bound to retaliate either by injuring or killing the elephants when they raid their farms further aggravating the human elephant conflict (Chartier, 2010; Graham et al., 2011 and Walpole, et al. 2007). But this can lead to a double tragedy with the humans getting injured (Langley, 2012) in the process or loosing their lives altogether. This problem of human-elephants conflict was to be reduced through an electric fence (Hoare, 2003). Heavy investment in put up mitigation measures such as electric fence among other strategies, elephants continue to conduct farm raids, crop and destruction, loss of livelihoods and loss of human lives continue to be experienced. Hence, mapping of human-elephant conflict spots is necessary and urgent for planning, mitigation and biodiversity conservation management.

### **1.1 Purpose of the study**

The purpose of this study was to map and establish frequency and intensity of HEC in ANP.

### **1.2 Study Objectives**

The general objective of this is to map and establish frequency and intensity of human-elephant conflicts in ANP. The specific objectives of the study were:

- i. To establish the extent and nature of HEC incidences in Aberdare National park ecosystem.
- ii. To determine the influence of rainfall patterns on HEC in ANP
- iii. To assess the effectiveness of community-based deterrent strategies in mitigating HEC in ANP

The null hypotheses of the study were:

- i. There are no HEC incidences in Aberdare National park
- ii. There is no significant relationship between rainfall patterns and HEC in ANP

- iii. Community-based deterrent strategies are not effective in mitigating HEC in ANP

## 2.0 Materials and Methods

Document analysis of Kenya wildlife service (KWS) occurrence books (OB) in the field stations in the Aberdare National Park (ANP) was carried out. This provided information was used to purposively sample the study areas experiencing HEC incidences. Crop damages by elephants during the wet and dry seasons were collected through field measurements in the study areas. The GPS was used to map HEC incidences of crop damages by elephants in ANP.

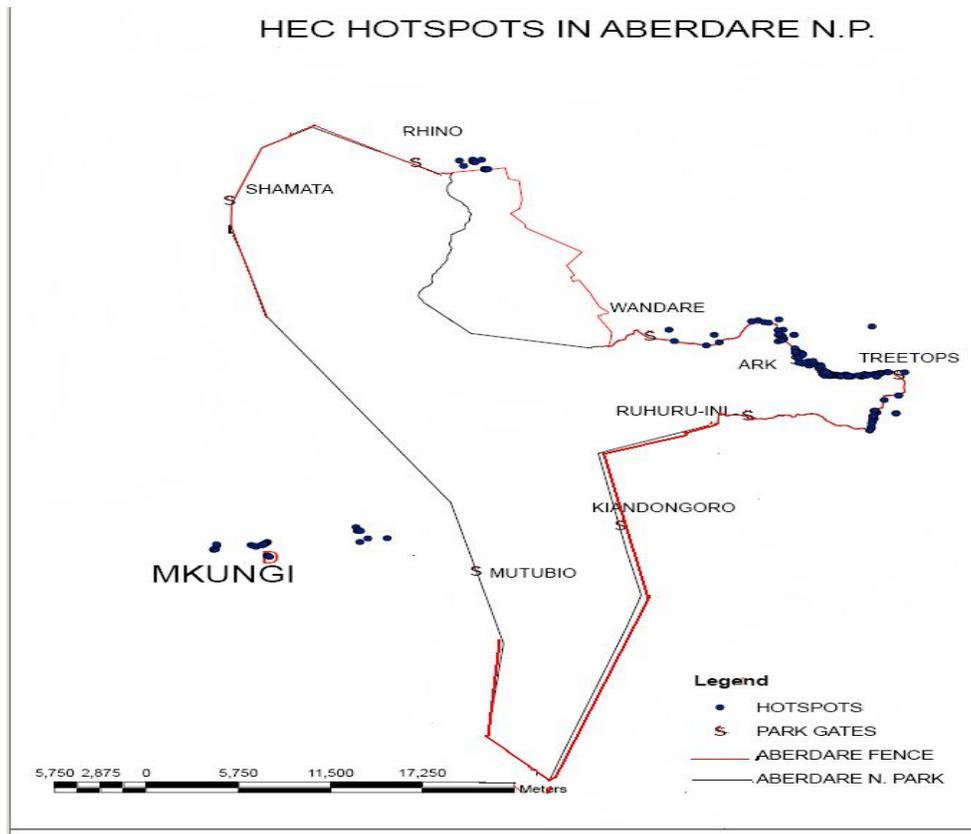
## 3.0 Literature

Globally the main objective of electric fencing is to control and minimize the movement of large mammals in regard to wildlife conservation and management. In Asia, electric fence has effectively been used to stop farm raids by mammals (Fernando, et al., 2007). In Sri Lanka electric fencing is widely used to mitigate HEC in preventing of both human and crops from elephant encroachment (Khalid, 2007, Perera, 2009). In Africa electric fencing is known to have been tried and proved effective in South Africa, Namibia, Malawi and also Zambia by wildlife conservation society, (Lewis *et al.*, 2005).

Kenya has over 1200 Km of game proof fences in various elephant and wildlife ranges and plans to develop another 1300Km are underway. Electric fencing has been done in Laikipia Plateau in Sweet Waters Sanctuary where 105 km<sup>2</sup> is fenced to protect over 150 elephants in wildlife sanctuaries in Nanyuki areas of Oljogi and Elkama. One of the policies of KWS is to protect people and property from injury or damage from wildlife (KWS, 1990). As such, KWS strives to reduce the level of human wildlife conflicts (HWC) in areas where the protected area has high conservation values, (Butynski, 1989) and has used electric fencing, elephant translocation, and establishment of sanctuaries at various pressure points (Bitok *et al.*, 2004). KWS maintains three major fence categories; simple, intermediate and comprehensive fences. Simple fences have (2 – 3) strands designed to restrict elephants. Intermediate fences are multi-stranded ideal for confining many animals' species in Savannah ecosystems. Comprehensive fences are designed for high potential agricultural areas, (Bitok *et al.*, 2004). \*\*\*\*\*Explained that electric fencing can be a solution, partial solution and part of the problem to HWCs in their study in Shimba Hills. They observed that where an electric fence that was installed in 1980 had both negative and positive consequences to the local communities. On one hand it was effective on reducing crop raiding and deaths of people

killed by elephants while negative consequences were high maintenance costs and increased challenges by baboons jumping over the fence using wooden posts and bush pigs and other small mammals burrowing below the electric fence. The completed the electric fence would separate the Aberdare national Park from the other parts and block migratory corridors. Lack of emigration is likely to result in overpopulation of large animals (Hoare, 2001). Electric fences have been used in a number of places in Kenya including: Lake Nakuru NP partly ANP, Shimba Hills NR, Ruma NP and Tsavo NP as conservation measure for wildlife and protection of ecosystem and have proved to be effective on solving HWC. Electric fences have been used in a number of places in Kenya including: Lake Nakuru NP partly ANP, Shimba Hills NR, Ruma NP and Tsavo NP as conservation measure for wildlife and protection of ecosystem and have proved to be effective on solving HWC. Consequently elephants habitats are being fragmented, thus causing compression of the elephants ranges and hence emergence of the isolated habitats which will in turn lead to increased frequent human-elephant interactions which eventually led to serious HEC (Omondi *et al.*, 2002). In Kenya a number of conflicts management strategies have been initiated by KWS such as constructing of electric fencing and moats, creating of elephants sanctuaries and elephants drives, shooting of problematic animals and even elephants translocation ,(Omondi *et al.*, 2002).

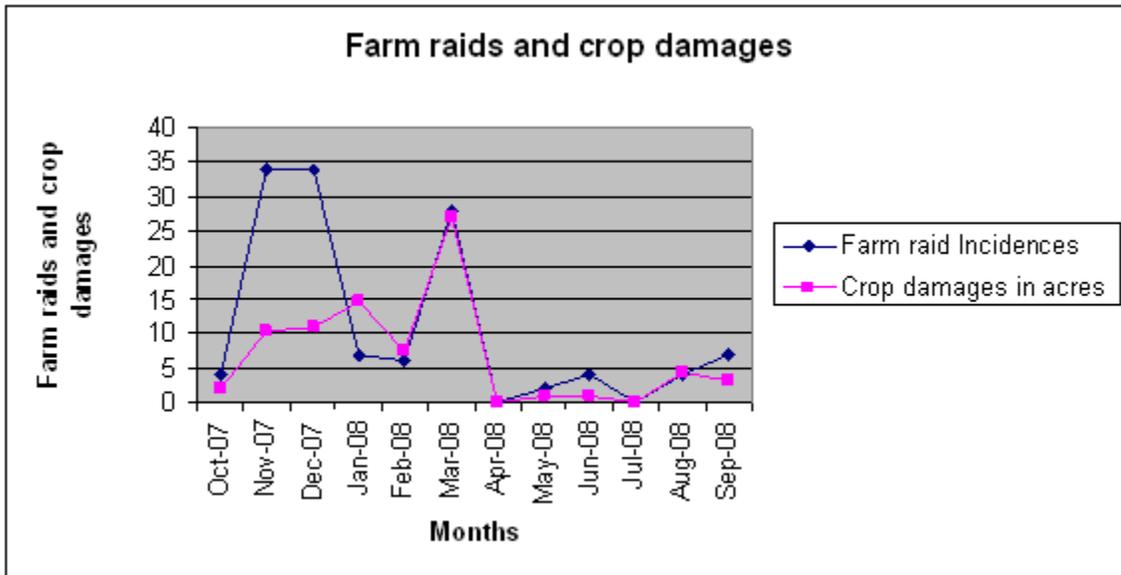
#### **4.0 Results and Discussions**



**Map 1: HEC incidence areas**

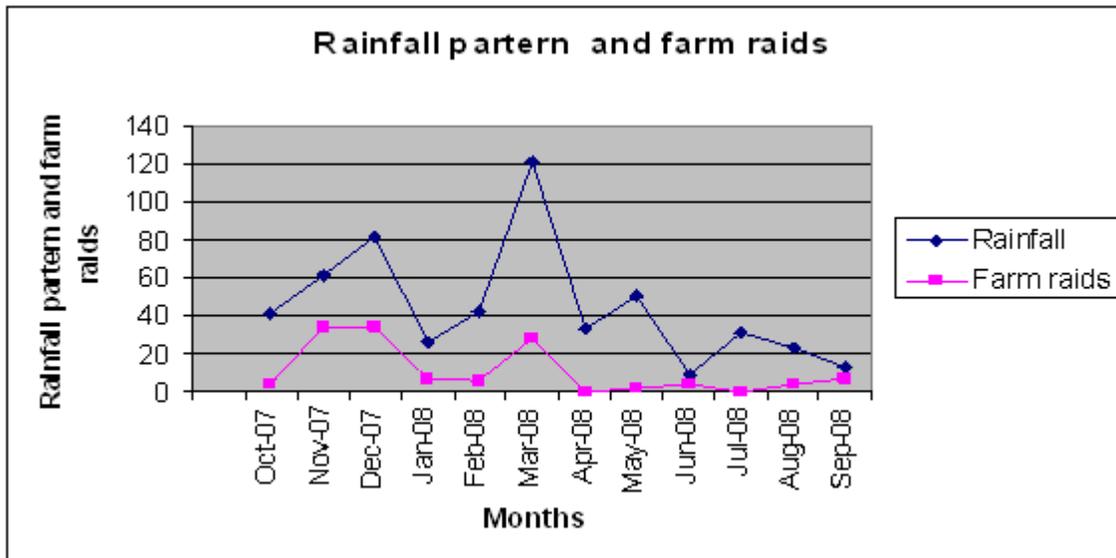
The above map shows HEC incidence areas which were concentrated and widespread on the eastern side of Aberdare National Park. The side of concentration of HEC incidences in the current study might suggest the window points to Laikipia or Mt. Kenya elephants' dispersal areas. The elephants' dispersal areas and habitats have been affected by intensified land uses culminated to degradation, fragmentation and loss of elephants' habitats leading to elephants contact with people in cultivated areas. The end result is feeding on crops, farm destruction, injures or kills people as they try to deer them from farm raids. Consequently, people retaliate against these losses by killing or poisoning or harm the elephants. Hence, the findings of the current study concurred with studies by Chartier, et al. (2010), Graham, et al. (2011) and Graham, et al. (2007).

The study findings revealed that 74% farm raids occurred during the months of November, December and March as shown in Figure 1. There was a positive correlation ( $r_{\text{md}}=0.963$ ,  $p<0.01$ ,  $df=1$ ) between the farm raids and crop damages. The results implied whenever elephants raided the farms, the probability was high that they damaged crops. Figure 1 shows graph of the frequency of farm raids and corresponding crop damages.



**Fig.1: Graph of farm raids and crop damages**

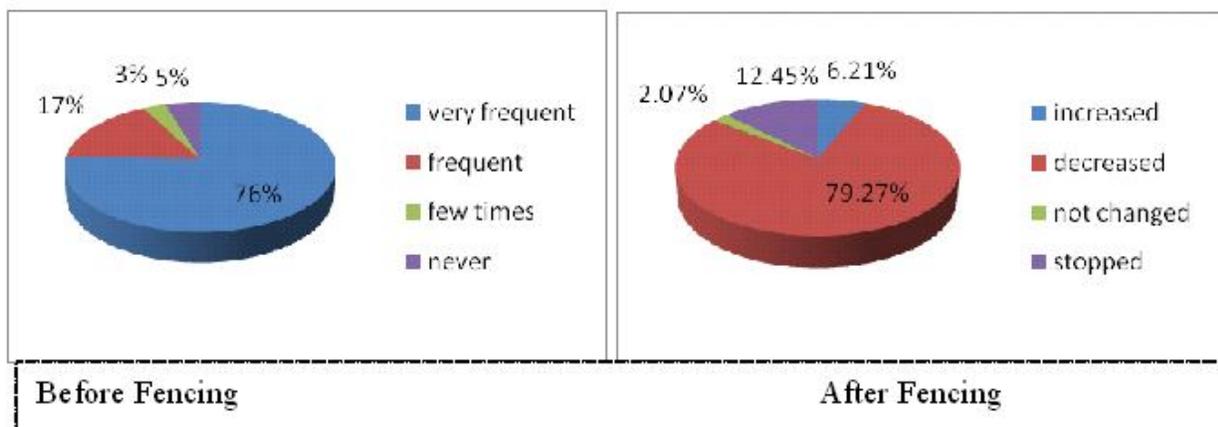
There were 26.22 % of the farm raids incidences recorded in the months of November and December during the short rainy season. 33.07 % of the farm raids occurred in the month of March during the long rain season.



**Fig 2: Rainfall amount and farm raid incidences**

One way ANOVA was used to compare rainfall amount received against the farm raid incidences showed there was a high significant ( $F_{[1, 10]} = 12.982; P < 0.01$ ) difference between farm raid incidences and rainfall. Hence, the study findings revealed that more farm raids and consequent

crop damages occurred during the wet seasons. The study results were similar to those of the study by Pastori et al. (2010) carried out in on Asian elephants in southern Sri Lanka were elephants raids occurred more frequently in wet seasons. Figure 3 shows the occurrence of farm raids by elephants before the installation of the electric fence.



**Fig 3: Frequencies of farm raids before and after installation of the electric fence**

The results indicate that farm raids were 97% before fencing. The frequency of farm raids drastically reduced at a high margin of 91.72% after electric fencing. However, farm raids were observed to occur at 8.28% after fencing. Studies by Gubbi (2012), Hoare (2007), Hoare (2003) Litoroh (2002), Madden (2004) and Walpole & Linkie (2007) revealed that electric fencing significantly reduce farm raid incidences an observation that concur with the results of the current study.

The current study results showed that 99% of the farmers were guarding their farms before the installation while 75.8 % were no longer guarding their farms. The guarding strategies used by farmers depended on whether it was on the fenced or unfenced section of the national park.

**Table 1: Guarding strategies used by the farmers in the fenced area and unfenced areas**

	Fire	Noise	Fire and Noise	Bows & Arrows	Others
Fenced	27	34	94	30	9
Unfenced	51	28	94	20	1
Total	78	62	188	50	10

Fire and noise were the commonly used guarding strategies (n=94, 75%) in both areas. There was a positive [ $r_{\text{md}}=0.921$ , at 0.05 level (2-tailed)] relationship between the guarding strategies used to repel elephants by farmers in both fenced and unfenced areas Table 1. Other community-based approaches of guarding include fire-bombs made from worn-out *sufurias* and a cracker that sounds like gun shot (see photographs in plate: g). The guarding strategies used by farmers to scare off elephants observed in the current study were somehow similar to those identified by Gubbi (2012), Hoare (2007), Hoare (2003) and Walpole & Linkie (2007) in their work on elephants. Other guarding strategies featuring in the ongoing research include the use of chilli-based deterrent and bees (Hoare, 2007). Hence, the need for mapping the farm raid incidence areas in ANP. **Plates:(g-**

**i).Farmers ingenious guarding strategies**



**Plate.g:**

**A“Firebomb”sufuria used to scare off elephants.**





**Plate.h:**

**A farmer armed with a firebomb in readiness to scare off elephants.**

**Table 2: Farmers perception on electric fence**

		<b>Has fence been effective?</b>	<b>Are you happy with the fence?</b>
<b>Has fence been effective?</b>	<b>Pearson Correlation</b>	1	.400
	Sig. (2-tailed)	<b>p &lt; 0.05</b>	<b>p &lt; 0.05</b>
	N	194	194
<b>Are you happy with the fence?</b>	<b>Pearson Correlation</b>	.400	1
	Sig. (2-tailed)	<b>p &lt; 0.05</b>	<b>p &lt; 0.05</b>
	N	194	194

The farmers' perception on electric fence was considered significant in community involvement campaigns. In the unfenced section 98.5 % of the respondents were positive on the idea of electric fence. However, views of the farmers in the fenced area, on electric fence were satisfied with the electric fence. The results in table 2 showed that there was a significant ( $F_{[1, 192]} = 36.498; P < 0.05$ ) difference between farmers who were happy with the fence and those who were not. Pearson correlation showed there was a positive [ $r_{\text{md}} = 0.400$ , at 0.01 level (2-tailed)] relationship on their perception of whether the electric fence has been effective or not. The results of the current study on perception and local community participation in resolving HEC concurred with what was found by Gubbi (2012), Walpole & Linkie (2007), Qingcheng, et al. (2011). As such, the farmers are likely to support the HEC mitigation strategy involving electric fence if involved in planning and maintenance of the fence as a tool for biodiversity conservation and management.

## **5.0 Conclusion and Recommendations**

Almost the same herds of elephants causing farm raids in agricultural farm lands in Aberdare were observed to roam between the two water towers (Aberdare and Mt. Kenya forests) of Kenya and Laikipia plateau.

HEC areas mapped in the current study suggest that Mt. Kenya and Laikipia elephant dispersal areas are critical and significant in conservation and biodiversity management

The most commonly destroyed crops by elephants in Aberdare were maize, pumpkins, sugar canes and cabbages when they near maturation stage.

The HEC incidences were found to be more pronounced in ANP during the wet seasons unlike in the dry seasons. Hence the need to strategize on effective mitigation measures during the wet seasons.

The electric fence was observed to be instrumental and significant in mitigating HEC incidences compared to other strategies used.

### **5.1 Recommendations**

The mapping of HEC incidences in protected areas would be a critical tool for improving planning and management in biodiversity conservation.

The study made the following recommendations:

- i. The traditional migratory corridors seem to coincide with the major HEC areas in Aberdare forest
- ii. There is need to explore possibilities of restoring traditional elephants' migratory corridors connecting Aberdare, Mt. Kenya and Laikipia elephants ranges
- iii. The government should approach the individual small-scale and large scale holdings that has encroached on the migratory corridors, lease out their land, plant trees, restore natural vegetations
- iv. Community participation should be encouraged to carry out occupational activities compatible with elephants' conservation such as eco-tourism.
- v. The two approaches can restore and maintain bio-diversity conservation in the area.
- vi. A the two approaches mentioned in the current study can be replicated in other elephants ranges and dispersal areas.

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## **S2012-04: Development of a Web Based Electronic Procurement System for the Kenyan Public Sector**

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### **Abstract**

A well-functioning procurement system is an essential requirement for a developing country like Kenya. In order to promote development, proper management of scarce resources is vital. A system that ensures transparency, efficiency, cost effectiveness, easy to control and monitor can accelerate development to great heights. It will encourage fair competition and freedom of information amongst trading partners in a regional block. This can be achieved by using an electronic government procurement system realized as a web based internet portal. This paper explores the design methodology applicable to the design and implementation of an electronic Government Procurement System (e-GP). The paper further shows how Object Oriented technology can be applied to model the business artifacts of the system through the Unified Modeling Language (UML). The internet provides a lot of information through the web that makes better decisions to be made quickly.

**Key words:** *E-Procurement, UML, Web Application Portal*

## **Introduction**

Government procurement (GP) is the buying and selling of goods and services on behalf of a public entity or authority. Government procurement accounts for a substantial part of the global economy. In developing countries such as Kenya, it accounts for up to 20% of Gross Domestic Product (GDP) [1]. Because of this considerable size of procurement market, GP is an important aspect of international trade and therefore subject to international treaty under the auspices of the World Trade Organization (WTO). The process involves research to identify project or service and its preparation, requesting for proposals and for information, bid delivery and evaluation to awarding of contracts. Since public resources are scarce, the efficiency of the procurement process is a primary consideration of every procuring entity. Most countries therefore have laws that regulate GP more or less closely to prevent waste, corruption, fraud and local protectionism policies through tariffs and quotas. Government procurement in the European Union is regulated and harmonized by European Union Laws since the 1970s. European regulations also provide for electronic means in conducting a public procurement procedure for the purchase of goods, works or services. Russian Federal Law of 21.07.2005 require all federal, regional and municipal government customers to publish all information about government tenders, auctions and other purchase procedures on special public government websites. US government procurement is generally governed by the Federal Acquisition Regulation (FAR) which appears in the Code of Federal Regulations. In Kenya procurement is done according to the rules set out by the Kenya Public procurement and Disposal Act 2005.

## **Literature Review**

### **E-Government Procurement (e-GP)**

Electronic Government Procurement is the use of electronic Government platform over electronic resources such as the World Wide Web and Web-based applications to buy and sell goods and services on behalf of a public authority. This is a type of electronic commerce that takes place between governments, between government authorities, government and private organizations or government and the members of the public. The amount of trade conducted electronically has grown extraordinarily with widespread use of the internet. This kind of trade has facilitated many innovations in electronic money transfer, supply chain management, website marketing, online transaction processing, electronic data interchange (EDI), inventory management and automated data collection mechanisms. Modern electronic commerce typically uses the internet at least at one point in the transaction's life-cycle, although it may encompass a wider range of technologies such

as electronic mail, mobile devices and telephones as well. The benefits of e-procurement are enormous and include improved efficient monitoring and control, cost effective, reliable and convenient. Consequently these are the catalysts driving the growth in e-procurement.

E-GP in Europe accounts for about 16% of GDP [3]. The adoption of e-procurement in Europe lead to tremendous reduction in costs as well as improved operational efficiency in the procurement process which is largely been attributed to well established IT infrastructure, high levels of computerization and a robust internet and broadband penetration even in rural areas. A survey conducted in 2007 shows over 60% of German and British firms use online purchasing [Batenburg, 2007].

### **E-GP System for the Government of India**

According to Mr. Ramanathan Somasundaram in a report for UNESCAP [4], several State governments and public sector organizations such as Andhra Pradesh and Gujarat have already adopted e-procurement under a large umbrella program of e-governance. Using e-Procurement these governments have been able to save on procurement of goods and services. There is also a goodwill factor involved and a definite improvement in the governments' image and transparency. Included in these benefits are cost reduction, improved decision making, process efficiency, price and supplier-behavior forecasting, and supplier-performance monitoring which ultimately leads to vendor rationalization and standardization. The state of Andhra Pradesh launched the e-procurement initiative in 2001 at a time when the infrastructure was severely limited and very few computers existed in the government offices. Thus, Andra Pradesh serves as a valuable model for developing regions because it demonstrates that it is possible to establish an e-procurement system in spite of limited financial resources and IT infrastructure. The procurement system implemented in Andhra Pradesh was based on a public private partnership.. The paper-based procurement system was inefficient and severe challenges had to be overcome such as physical obstruction and intimidation of suppliers at the bidding site or corruption and destruction of bids.

### **E-GP System for the Korean Government**

The GePS of the Republic of Korea was selected as the best e-procurement practice model by the United Nations in November 2004. In a UNESCAP[4] report presented by Mr. Hyung-Jong Min, Director General, Public Procurement Service of Republic of Korea (PPS), the system was described to have the following well established modules:

- Electronic data interchange (EDI) with customers and suppliers in 1997

- E-shopping mall for commercially available products in 1998
- E-Tendering in 2000
- E-payment in 2001
- Government e-procurement system in October 2002 for use by all public organizations

The major functions of GePS include:

- Provides an “end-to-end” electronic procurement service where all procurement processes are conducted on-line
- Serves as a “Single Window” for public procurement – integrates and announces all public institutions’ bid information and shares all suppliers’ information
- Linked with 53 other institutions’ systems

GePS provides more sophisticated services such as wireless e-bidding, mobile information services and property management through radio frequency identification (RFID). Electronic customer relationship management (e-CRM) services include optimized services for each customer and consulting services via a web call centre. High value added services such as D/W services, cost analysis, evaluation of bidders and e-catalog based on ontology are also available.

The most notable achievements of GePS include:

- Used by about 30,000 institutions and 150,000 businesses
- Exchanges approximately 100,000 documents online a day
- World’s largest cyber market with an annual transaction volume of US\$ 43 billion in 2004
- Saves US\$ 3.2 billion worth of transaction costs annually
- Improves transparency in doing business with the government
- Leads the development of private sector e-commerce

## **Overview of Procurement Process in Kenya**

### ***Regulatory framework***

In Kenya Public Procurement Oversight Authority (PPOA) [5] is the sole body charged with the regulation of public procurement. It has the functions of ensuring that the procurement procedures established under the Kenya Public Procurement and Disposal Act 2005[6] are complied with and to monitor the public procurement system and report on its overall functioning. It also assists in the implementation and operation of the public procurement system.

The Public Procurement Oversight Advisory Board (PPOAB) advises the Authority generally on exercise of its powers and the performance of its functions; to approve the estimates of the revenue and expenditures of the Authority in accordance with Act.

The Public Procurement Complaints Review and Appeal Board (PPCRAB) and PPOAB are only watch dogs of PPOA

All public procurement is undertaken by a procuring entity (PE) as per threshold matrix as set out in the regulations as stipulated in the Kenya Public Procurement and Disposal Act of 2005[6]. For each procurement activity, the procuring entity can use open tendering, restricted tendering, direct procurement, request for proposals, and request for quotations, procedure for low-value procurement or special permitted procurement procedures.

All Government Procurement Entities (ministries, Parastatals, councils etc) follow a predetermined procedure of procuring commodities or services set out in the Kenya Public procurement and Disposal Act 2005[6]. The regulatory framework sets forth specific guidelines regarding competition requirements at various shilling thresholds. After a statement of needs is defined and a purchase request is processed, the procurement manager should determine the regulatory threshold that applies, and then determine the type of procurement method to be used. When the total transaction value of a purchase is equal or below Ksh.500, 000 this is considered a “micro purchase” and therefore do not require three quotations as long as the prices seem reasonable and purchases are spread out among various suppliers. The procurement manager may simply issue a purchase order to the vendor. Simplified acquisition procedures are supposed to promote efficiency and reduce administrative burden in the contracting process. For transactions equal or over Ksh.500, 000 a solicitation is used to collect at least 3 quotations from suppliers. Depending on the complexity of the procurement, the solicitation can be verbal or written. Solicitation can take the form of a request for quotation (RFQ) or a Request for Proposal (RFP). After receiving a reasonable number of offers (at least three), the offer that is most advantageous i.e. provides the best value based on delivery schedule, quality and price – wins the award. The whole procurement cycle involves many documents produces at each stage. All sound evaluations have a standardized set of procedures. These are:

- Establish an evaluation methodology. Conduct an administrative evaluation to ensure that the suppliers meet the minimum requirements
- Conduct a technical evaluation including evaluation of past performance
- Conduct a price and delivery schedule evaluation
- Obtain clarifications from vendors, if required or applicable
- Select the best vendor and value for the award of contract

- Ensure that the evaluation is properly documented for the procurement files and any debriefings

However government procurement Entities barely comply with the procedure as set out in the Kenya Public procurement and Disposal Act 2005[7]. Due to these, the government through PPOA often carries out investigations and publishes their evaluation reports in PPOA website. The website contains procurement review reports for among other cooperations: Egerton University, National Water Conservation and Pipeline Corporation, Tana Water Services Board (TWSB), National Social Security Fund (NSSF), Postal Corporation of Kenya (PCK) and others. Looking at these reports reveals that these corporations do not adhere to the following principles to ensure a successful evaluation [7][8]:

- Avoidance of conflicts of interest (actual or perceived)
- Clear and transparent evaluation methodology
- Fair, objective, and rational assessments and ratings
- Procurement integrity — no bribes, kickbacks, or unfair advantages
- Proper storage and Confidentiality of data
- Written narrative of offers/bids strengths, weaknesses, decisions, and procedures
- long delays in processing of documents

It is for these reasons that a proposition on a web based government electronic procurement systems is made that is reliable, transparent, efficient and cost effective.

For many years, the Kenyan government procurement procedure has been done manually by the process of inviting contractors to bid for projects (i.e. Invitation for Prequalification/Tender) to the selection of successful bidders. In this procurement procedure, purchase orders are not normally processed in a timely order and delivery dates are barely met. Kenya's public procurement system is also reportedly prone to corrupt practices, with as many as 45% of companies expecting to give gifts to public officials in order to secure a government contract. Analysis have shown that most contracts awarded by the government or its officials are awarded through corrupt means. Some of these contracts are awarded to contractors who have agreed to give the procurement official a certain percentage of the original contract amount. This encourages contractors to use substandard goods, render poor services or sometimes project abandonment [9]. These problems form the basis of the following research questions:

1. Can a system be developed that ensures contracts of government properties is made transparent for easy monitoring and control?
2. Can a system be developed to ensure a fair selection of bidders for government projects that is cost effective, efficient and reliable?
3. Can a system be developed that makes use of modern communication technology that is convenient and accessible by a majority of Kenyans?

E-procurement can be defined as applying electronic systems in procurement processes. It can also provide a fair and transparent environment for auctions and enables auction managers to easily handle auction issues. Managing an auction process through such a system, decreases paperwork and increases efficiency. Communication channels, process of receiving auction proposals, proposal evaluation process, and auction closing and opening processes should be considered in order to switch from traditional auction process to electronic and web-based systems. “One of the electronic systems that can be embedded in an e-procurement system is a portal. Portals, by providing integrated framework and connecting people and processes, have a key role in managing complexity, operational performance improvement and value adding processes. Portal technology allows the buyers and suppliers to log onto a portal site, and immediately access the structured and unstructured information. Suppliers can be given insight to the inventory levels of other partners and tune their product based on this information.

Buyers can check the status of orders and received offers from suppliers and select the qualified suppliers for obtaining required goods and services. In addition, procurement process can be harmonized and simplified, by some additional significant features of portal technology. By using portal technology, a company’s procurement strategy can be defined and certain administrative tasks can be automated. Additionally the number of un-provided purchases by pre-negotiated contracts is reduced and the traceability is increased.” [Seiran Alani Azar,et al]

### **Methodology**

Various Software development methodologies, models, techniques and approaches have been used over time to develop both off-the shelf and client-based software. In this paper, the software development methodology adopted is the Object Oriented Technique to develop the e-GP system. With respect to industry standards, Unified Modeling Language (UML) approach can be used to capture the system requirements and design [11]. The e-GP system suggested proposes developing a web based application. The front-end side implemented using HTML (Hypertext Markup

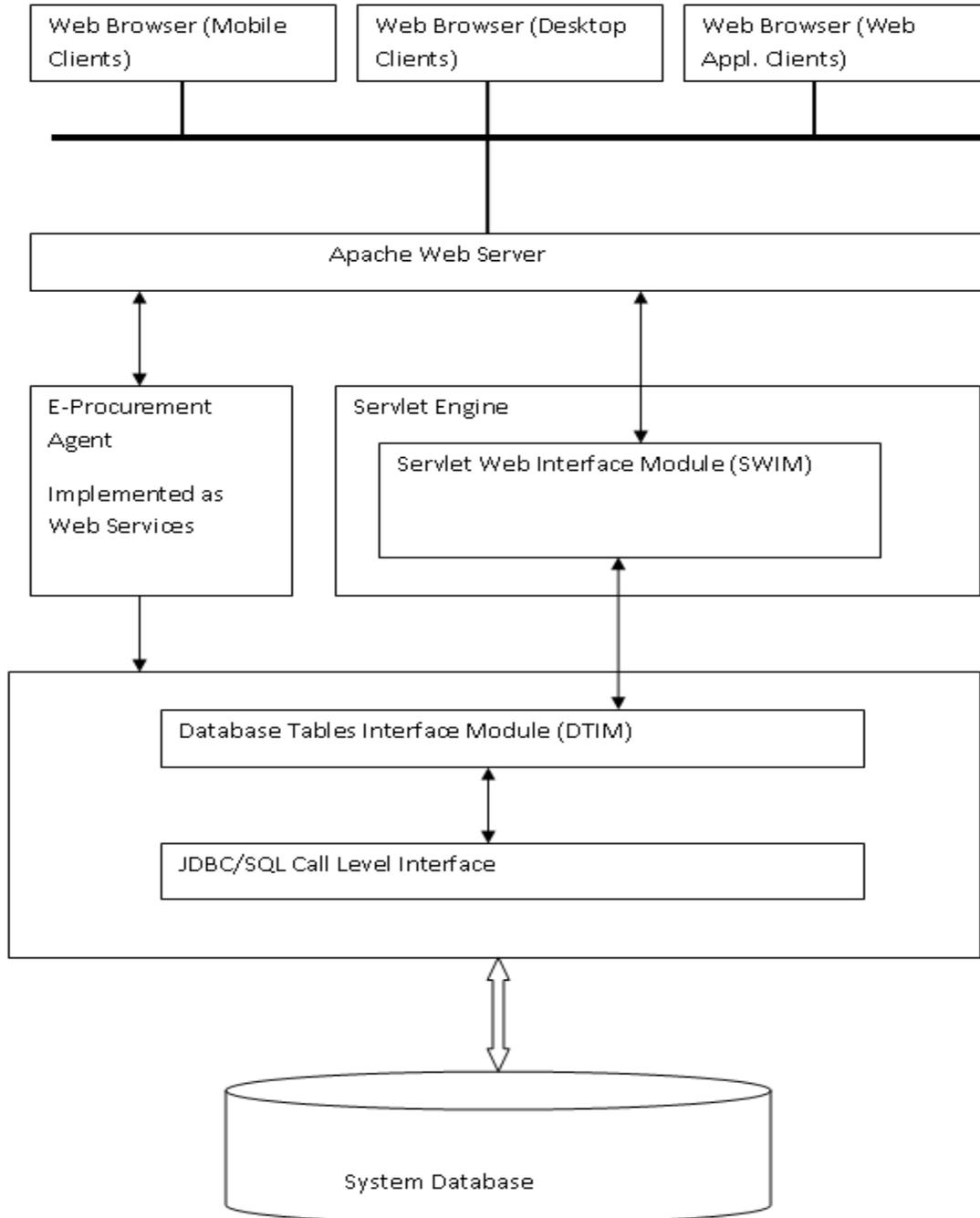
Language) and JavaScript while the back-end side implemented in Hypertext Preprocessor (PHP). The database management system is MySQL and the web server as the Apache.

## **System Design**

A Graphical User Interface sub-system can be implemented that uses different user interface components which will consume web services. These may include:

- a) A User Interface client module running on desktop computers. As GUI-based applications provide rich user interface elements and interactions and is often used by purchasing personnel working from their desktop inside a company as suggested by Chein and Meixell.
  - b) A browser-based application can provide an easy access to the e-Procurement system as long as a connection to the internet is established. Web presentation layer components are web programs running on the server-side.
  - c) Mobile clients. Mobile device such as cell phones, personal digital assistants (PDAs) can consume Web services. Special micro-browsers can be used to get access to a server-side Web program. The mobile web programs need to render Web pages in formats such as WML or HTML that are appropriate for the requesting mobile devices [Chein & Meixell, 2011].
- 2) E-Procurement Agent: The e-Procurement agent is a software sub-system component implemented in Web services. It serves as middle -tier component to handle the interactions with the Web Services Registry and with the Web browser clients. The e-Procurement Agent is implemented as Web services to be consumed by the front-end user interface applications
- 3) Servlet Web Interface Module (SWIM) implements the Web interface for the system. Users use the Web browser to communicate with the system while SWIM establishes the communication and interchange information between the system and the users through the Web browser [14]. It maintains and controls the flow of data between the user and the system. SWIM is based on Java Servlets Technology. Servlets are applications running on the Web server to manage client's requests [14]. The communication between the Web browser (clients) and the Apache Web server is over a Secure Socket Layer (SSL) i.e. HTTPS. Since the system is multi-users system, there is need to manage individual session achieved with the help of Servlet session tracking [14]. When a user makes a request, a session ID is created for the user, which identifies the user throughout user interactions with the e-procurement Agent.

4) The system database consists of data and facts about the clients (suppliers and procurement Entities) together with rules governing procurement procedures. We used relational database for the persistence layer as stated above but the programming language used is object-oriented. The Database Interface Module (DTIM) implements the object-oriented interface for the relational database. DTIM uses Java Database Connectivity (JDBC) [Dada, Kochs, Peterson, et al] for connection into the database.

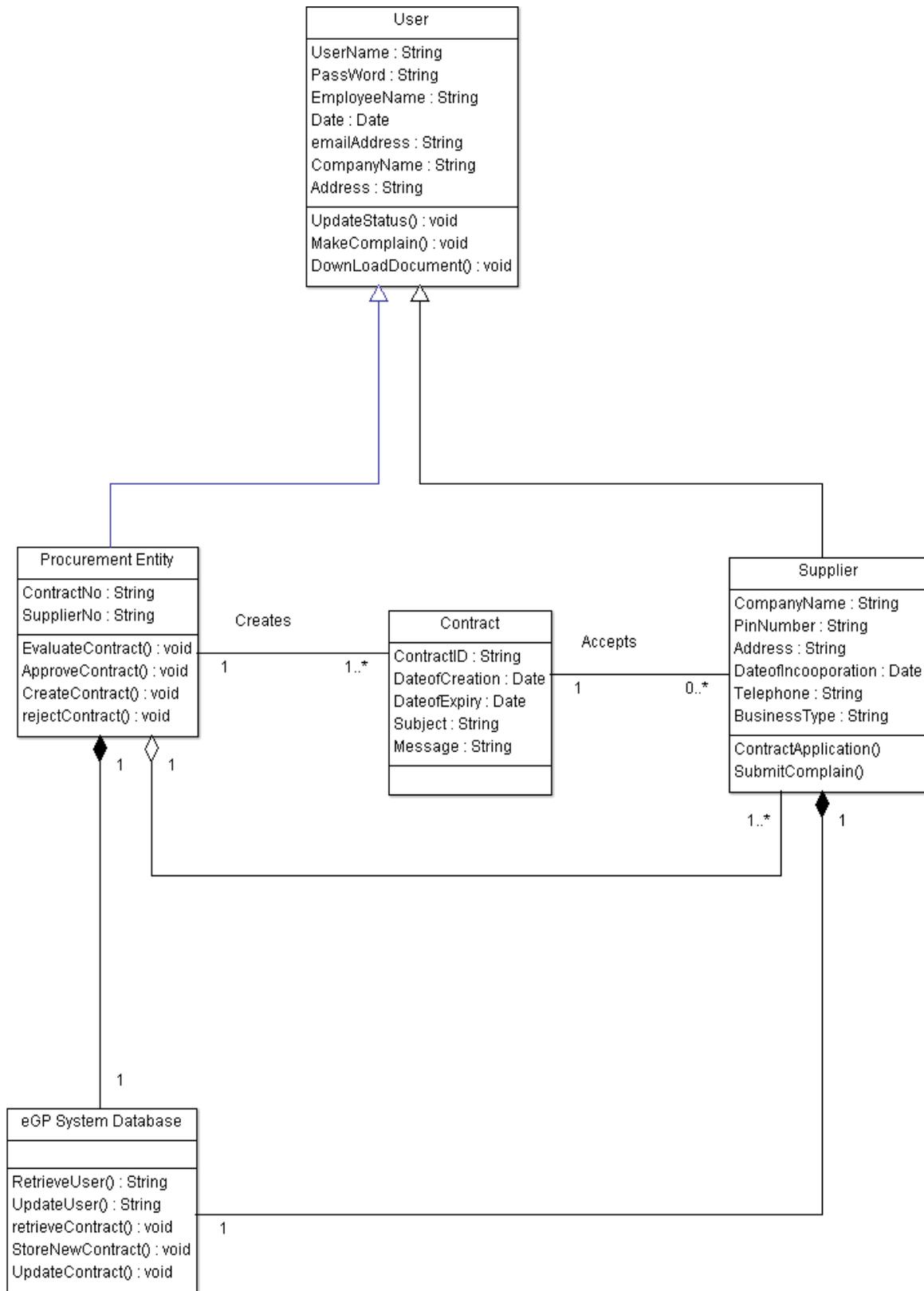


## **Figure 25: Architecture of e-GP System**

### **E-GP System Modeling**

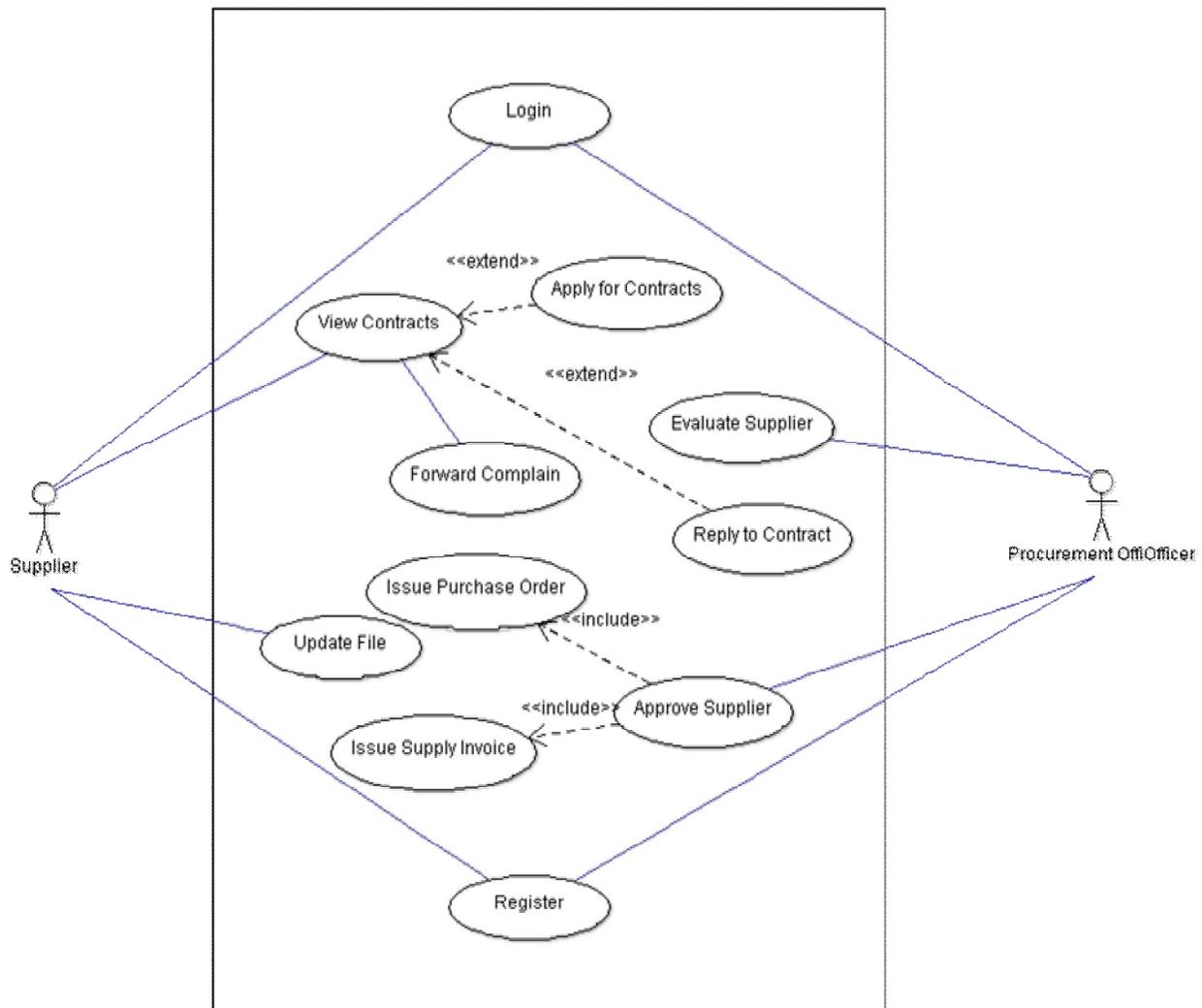
Modeling is a technique used to represent complex systems at different levels of abstraction, and helps in managing complexity of design in computer based systems. UML is an object-oriented language that can be used to model object-oriented systems. It is possible to use UML to model web applications by using extensions supported by UML [Emad Goshes et al]. Conallen proposed an extension of UML for web applications.

Class Diagrams are used in UML to model a collection of objects with similar attributes and behaviour. The e-GP System prototype has identified a user, Procurement entity, contract, supplier and e-GP system database as classes in the e-GP System. Each of these classes has a relationship with one or more of the other classes. Procurement Entity and Supplier have an inheritance relationship with a User class. A special kind of aggregation referred to as composition relationship exists between the procurement entity and e-GP system Database, e-GP System Database and Supplier and between supplier and procurement entity. Figure 2 below shows such a scenario.



**Figure 26: Class Diagram for the e-GP System**

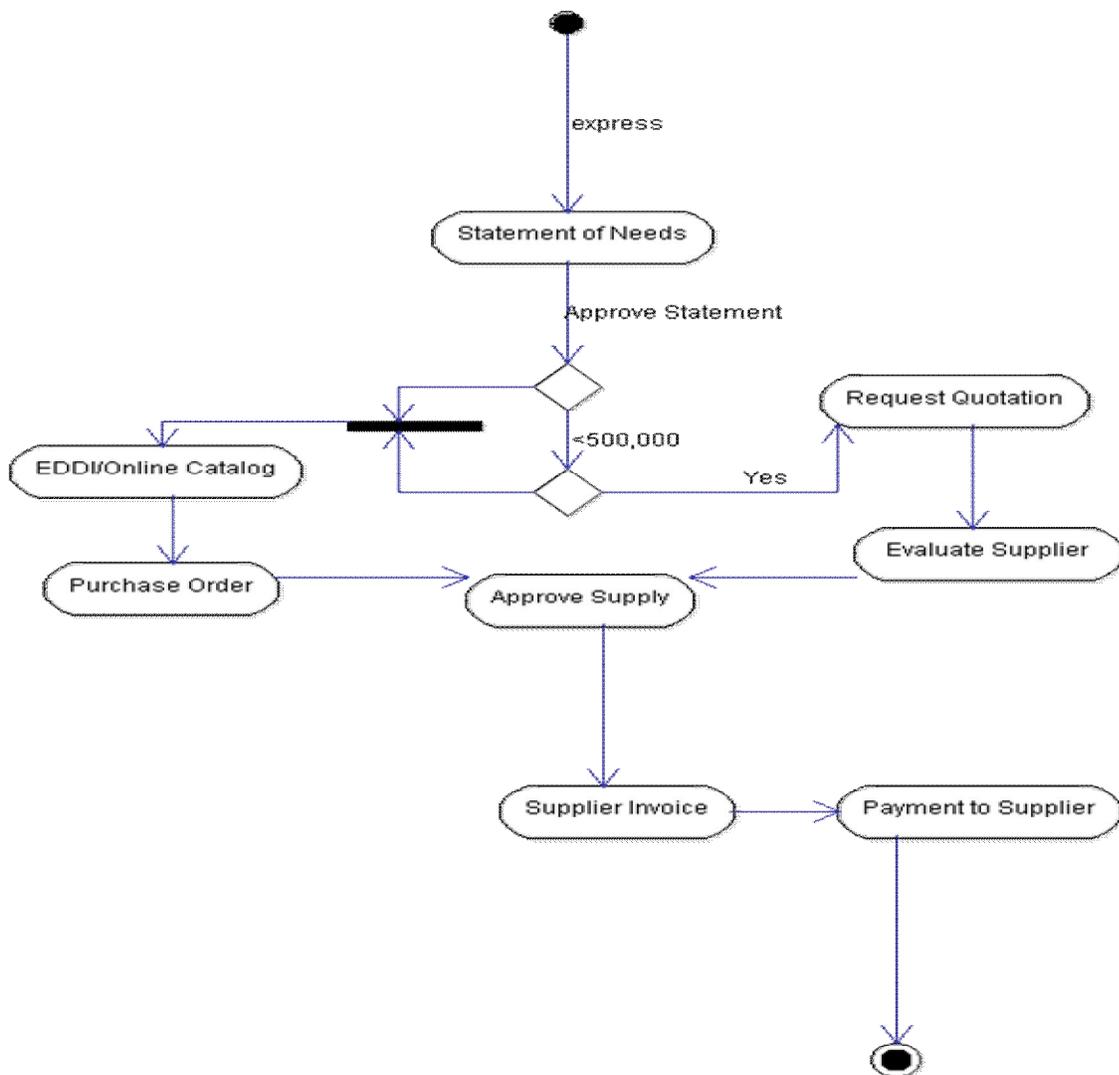
A use case is a methodology used in system analysis to identify, clarify, and organize system requirements. It shows the boundaries under which a system operates. The use case is made up of a set of possible sequences of interactions between systems and users in a particular environment and related to a particular goal. It consists of a group of elements (for example, classes and interfaces) that can be used together in a way that will have an effect larger than the sum of the separate elements combined. The use case should contain all system activities that have significance to the users. Figure 3 below shows a sequence of interactions between the systems and user in an e-GP web portal environment.



**Figure 27: Use Case Diagram for the e-GP System**

A state diagram is used in computer science and related fields to describe the behavior of systems. State diagrams require that the system described is composed of a finite number of states. State

diagrams are used to give an abstract description of the behaviour of a system. This behavior is analyzed and represented in series of events that could occur in one or more possible states. Figure 4 below describes the various events used to describe state and behaviour of an e-GP System.



**Figure 28: State chart for the e-GP System**

**Summary**

The desire for accountability and transparency in government operational activities is great amongst the Kenyan population. Freedom of information is a driving force to a free market society that encourages fair competition. With the advent of the internet, information has readily been available and people have been able to choose and make better decisions. Development of an electronic Government Procurement Systems (e-GP) can lead to improvement in management of government

procurement processes, thereby ensuring transparency, monitoring, control, fair selection of bidders, reduced cost of transactions and increased efficiency. A well functional e-GP system for the Kenyan can in future encourage fair competition amongst countries in the regional trading blocks of COMESA and the East African Community.

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## **S2012-07: Towards a Fraud Free Electoral Process in Kenya: A General Purpose Image-Based Electors Smart Card Using an Enhanced Least Significant Bit Steganographic Method**

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### **Abstract**

To legally participate in any political elections in Kenya, one must of necessity be in possession of at least two documents i.e. the elector's card and the national identity card. Both of these documents and indeed other general identification documents make use of the bearer's face photograph and some textual identification information. The unprecedented growth in digital imaging and processing technologies have meant that, with little or no knowledge of the technology involved one is conveniently able to tamper with photographs and identity information on such documents resulting in cases of fraud e.g double registration and voting which have consistently marred our electoral process. In this paper we propose the use of a general purpose smart card based identification document during elections. The textual identification information of the card bearer and his or her biometric data are embedded in his or her face photograph using an enhanced, randomized least significant steganographic method. The same identification details of the card holder are also stored in a centralized database to provide for double authentication during voting. The card bearer cannot tamper with the identification data as it is embedded in his photograph. An experimental design is setup to determine the effectiveness of the method by comparing the original

and the reconstructed images' statistical characteristics to ensure that no notable differences exist. The values of the most important image signal objective statistical characteristics are analyzed and discussed for both the cover images and the reconstructed images as produced by the least significant bit method and the enhanced, randomized least significant bit method. The experimental results show improved security of the biometric data and personal identification details.

**Key words:** *Biometrics, Steganography, , Smart Card, Carrier Image*

## 1. INTRODUCTION

The voting process in Kenya is becoming increasingly complex by the day. During the general elections scheduled for early next year for example, there will be more ballots cast at the same time than in any other voting time in the history of the country. Past experiences have shown that malpractices ranging from double registration, double voting and vote buying do occur. The duration taken during verification of a voter's documents creates unnecessary delays and in some instances illegitimate documents can be used in a voting process. Fast and reliable identification of a voter is therefore very important and necessary to make the elections smooth, effective and fraud free. Biometric authentication systems are a viable and reliable method to address the issue of use of multiple documents during voting. This is the automatic verification of a persons claimed identity through the use of physiological traits of the individual eg fingerprints, face, hand veins, iris, retina, palm print etc. A biometric system helps in authenticating one's identity by use of a smart card and a password or identity number. The biometric template is compared with the details of the individual stored elsewhere e.g. in a central database. Figure 1.0 shows a sample picture of a smart card.



Figure 1.0: A sample picture of a smart Card

## 2. SMART CARD

A smart card is a portable credit-card-sized document with a memory and a microprocessor. It can manipulate and store data. To retrieve its contents, it is normally swiped in a reader. A smart card contains a digital certificate and makes use of a knowledge factor such as a password.

There are various types of smart cards in literature Yahaya *et al.* (2010). The template - on - card (TOC) smart card is used in this paper. In a TOC, the original individual's verification biometric template is stored inside the smart card's memory. To authenticate the person's identity, the reader retrieves the identifying template from the smart card's memory and tries to match it with that stored for a registered individual in a database stored elsewhere.

A number of smart card biometric based ID systems exist and are used the world over. Examples include the UK's asylum seekers' card and the US defense department access card (Yahaya *et al.*, 2010). Biometric based smart cards can be used as a common identity document for a variety of requirements within business or government environments. This is because they can support multiple authentication and authorization methods e.g. use of biometric password keys, digital certificates etc. Smart cards can also be applied in controlling physical access to buildings and social places, authenticating computer logon, accessing remote networks and email etc.

In a voting and voters registration environment, smart cards can promote convenience to voters and the voting process administrators bringing about huge saving in terms of costs through consolidation of authentication process by use of a single identity document.

### **3. BIOMETRIC AUTHENTICATION USING FINGER PRINTS**

Biometric based authentication system makes use of personal attributes data or body data e.g. iris or finger prints (Change *et al.*, 2005). This is because this data is not only unique to the individual concerned but it also remains throughout the individual's life span. The growth in the Information Technology industry and the continued embracing of the same in every facet of life makes it very necessary to have reliable and secure identification.

Every individual possesses unique finger print properties which remain so throughout his life time. Accordingly, the finger prints matching is one of the most secure and reliable technique of proving identity. They consist of a unique pattern formed by ridges of raised skin and furrows of lowered skin. Making an inked imprint of a thumb leaves an impression of ridges while the un inked areas of the fingers represents the furrows between the ridges (Jain and Jianjiang, 2011). Terminations or bifurcation of finger print ridges known as minutiae are most unique and therefore important in the identity of an individual. Figure 3.0 shows the parts of a finger print.

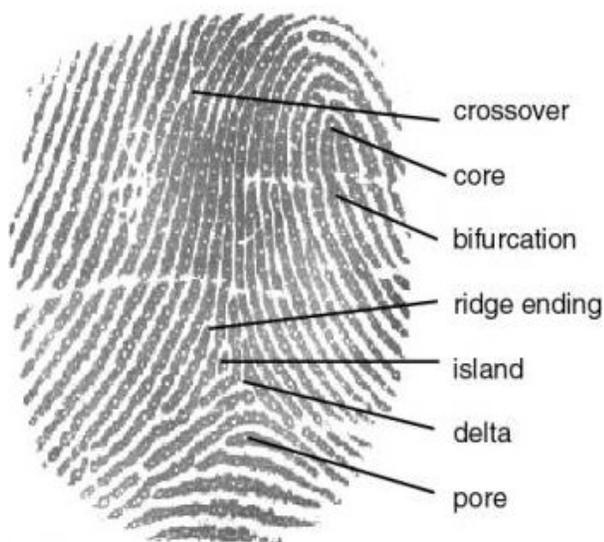


Figure 3.0: Parts of a Finger print

For this paper, use of finger print biometric is chosen due to the smart card's memory size and also time factor for verification. Commonly available smart cards have approximately between 8-16 KB of memory while the minimum size of a finger print template usable for matching and analysis is approximately a few hundreds of bytes. For the sake of time, the inbuilt processor in the smart card should complete the matching process as fast as possible (real time).

#### **4. ENHANCED LEAST SIGNIFICANT BIT STEGANOGRAPHIC METHOD**

Steganography is the science of hiding a confidential message in an innocent looking container file e.g. an image in a way that does not introduce perceptible distortions to the carrier file (Mohammad and Abdallah, 2008). It helps to conceal the existence of data. By use of steganography, confidential details can be embedded in a cover file and transmitted to the intended person without creating suspicion. A successful steganographic system embeds information imperceptibly in a cover file making sure that the exact information is extractable at the other end.

This paper proposes a biometric – based all purpose voters' card which stores the voter's details including identity card details and uses his finger prints template in the smart card to verify his identity. The finger print template and the voter's details are embedded in the voter's face image stored in the smart card while the same details are stored in a centralized database elsewhere. After extracting the voter's details from his image in the smart card, they are matched with the details in the database. This helps in arresting the issues of tampering with the voter's documents and also curbs double registration and voting. It also makes the process of voting faster and saves on costs.

In a steganographic system, there exists an embedding algorithm and an extraction algorithm. Using the embedding algorithm, the cover image's bits are slightly modified to accommodate the hidden information.

The most commonly used method in the spatial domain is the LSB method which replaces the least significant bits of the cover image with the bits of the secret message. The use of an enhanced LSB method which utilizes varied and random bits in a true color image to embed the confidential message is proposed in this paper. The Linear Congruential Generator (LCG) method proposed by D.H. Lehmer is used to generate the pseudo random numbers used to match the specific bits in the cover image where the secret data bits are hid. LCG method is one of the most successful random number generators. It is also fast and saves on computer memory.

The formula is explained below.

$$\mathbf{X_{n+1}=(aX_n + c) \bmod m}$$

Where:

$X_0$  is the starting value , the seed ;  $0 \leq X_0 < m$

$a$  is the multiplier;  $a \geq 0$

$c$  is the increment;  $c \geq 0$

$m$  is the modulus;  $m > X_0, m > a, m > c$

The desired sequence of random numbers  $\langle X_n \rangle$  is then obtained by setting

$$X_{n+1}=(aX_n + c) \bmod m, \quad n \geq 0$$

$X_n$  is chosen to be in  $[0, m-1], n \geq 0$

Given that the previous random number was  $X_i$ , the next random number  $X_{i+1}$  can be generated as follows.

$$X_{i+1}=f(X_i, X_{i-1}, \dots, X_{i-n+1})(\bmod m) = (a_i X_i + a_2 X_{i-1} + \dots + a_n X_{i-n+1} + c)(\bmod m)$$

A stego key ( $k$ ) is used during extraction which in this case is the message digest of the user supplied password.

According to Hull & Dobell (1972), a linear congruential sequence defined by  $m, a, c$  and  $X_0$  has full period if and only if the following three conditions hold:

- The only positive integer that exactly divides  $m$  and  $c$  is 1
- If  $q$  is a prime number that divides  $m$ , then  $q$  divides  $a - 1$
- If 4 divides  $m$ , then 4 divides  $a - 1$

Additionally, the value of  $m$  should be rather large since the period cannot have more than  $m$  elements. The value of  $m$  should also necessitate a fast computation of  $(aX_n + c)$  i.e speed the generation of random numbers. Observing all these requirements, the parameters for the LCG picked as follows:

#### **Modulus ( $m$ )**

The 48-bit computer word length was picked as the value of  $m$ . Any Pentium IV and above computer should have this word length or larger. This in essence provides the size of  $m$  to be  $2^{48}$  which is equivalent to **281,474,976,710,656**. For the sake of this experiment and bearing in mind that the digital images used are a few kilobytes in size, this period is sufficient enough to set up the experiment.

To ensure faster generation,  $m$  is recommended to be a power of 2 or close to a power of 2 and hence the choice of the word length. Using the AND operation also enhance speed instead of the normal division operation which is considered slower.

#### **The seed ( $X_0$ )**

The first value of the seed ( $X_0$ ) is supplied by the message digest of the user supplied password. This is done using a special form of encryption that uses a one-way algorithm which when provided with a variable length unique input (message) will always provide a unique fixed length output called hash, or message digest.

#### **Multiplier ( $a$ ) and Increment ( $c$ )**

To ensure full period and in following with requirements identified above, the values of the multiplier and the increment are picked as follows.

$$a \text{ (Multiplier)} = 25214903917$$

$$c \text{ (Increment)} = 11$$

The values are used to initialize the random number generator used for the experiment.

The numbers generated by this PRNG determines the specific bits in the pixel bytes of the cover image where data bits of the secret data file are to be embedded. For example considering storing the 200, which binary representation is 11001000 in a grid of 3 pixels of a 24-bit image, utilizing a single LSB of each color channel the enhanced LSB algorithm will store the significant bits of the message randomly into the cover image bits as shown in figures 4.0 and 4.1 below.

0	0	1	0	1	1	0	1	0	0	0	1	1	1	0	0	1	1	0	1	1	1	0	0
1	0	1	0	0	1	1	0	1	1	0	0	0	1	0	0	0	0	0	0	1	1	0	0
1	1	0	1	0	0	1	0	1	0	1	0	1	1	0	1	0	1	1	0	0	0	1	1

Figure 4.0 Original Bits

0	0	1	0	1	1	1	0	1	1	0	0	1	1	0	1	1	1	0	0				
0	0	1	0	0	1	1	0	1	1	0	0	1	1	0	0	0	0	0	1	0	0	0	
1	1	0	0	0	0	1	0	1	0	1	0	1	1	0	1	0	1	1	0	0	0	1	0

Figure 4.1 Modified Image Bits

### 5. RESEARCH METHOD

The experimental research method is used in measuring the effect of using selected varied and random pixels during the embedding process on imperceptibility. This method represents the standard practice applied in manipulating independent variables in order to analyze the generated data to test the research hypotheses. A notable advantage of experimental research is the fact that it enables other researchers to easily replicate the experiment and be able to validate the results. It is therefore considered an accurate method of research (Shuttleworth, 2008), as the researcher can effectively establish a causal relationship between variables by manipulating independent variable(s) to assess the effect upon dependent variable(s).

An experiment was carried out to test the relationship between the specific embedding process (i.e. proposed method) and the outcome (i.e. imperceptibility level). Essentially the output of traditional least significant bit steganography method was used to evaluate the performance and effectiveness of the proposed method's output by comparing the stego images generated by the proposed method with those generated by the traditional least significant bit steganography method. This is commonly referred to as comparative experiment (Hinkelmann and Kempthorne, 2008).

### 6. DESIGN

## 6.1 Design Framework

Figure 6.0 shows the design framework for the elector's card based on Pfitzmann model.

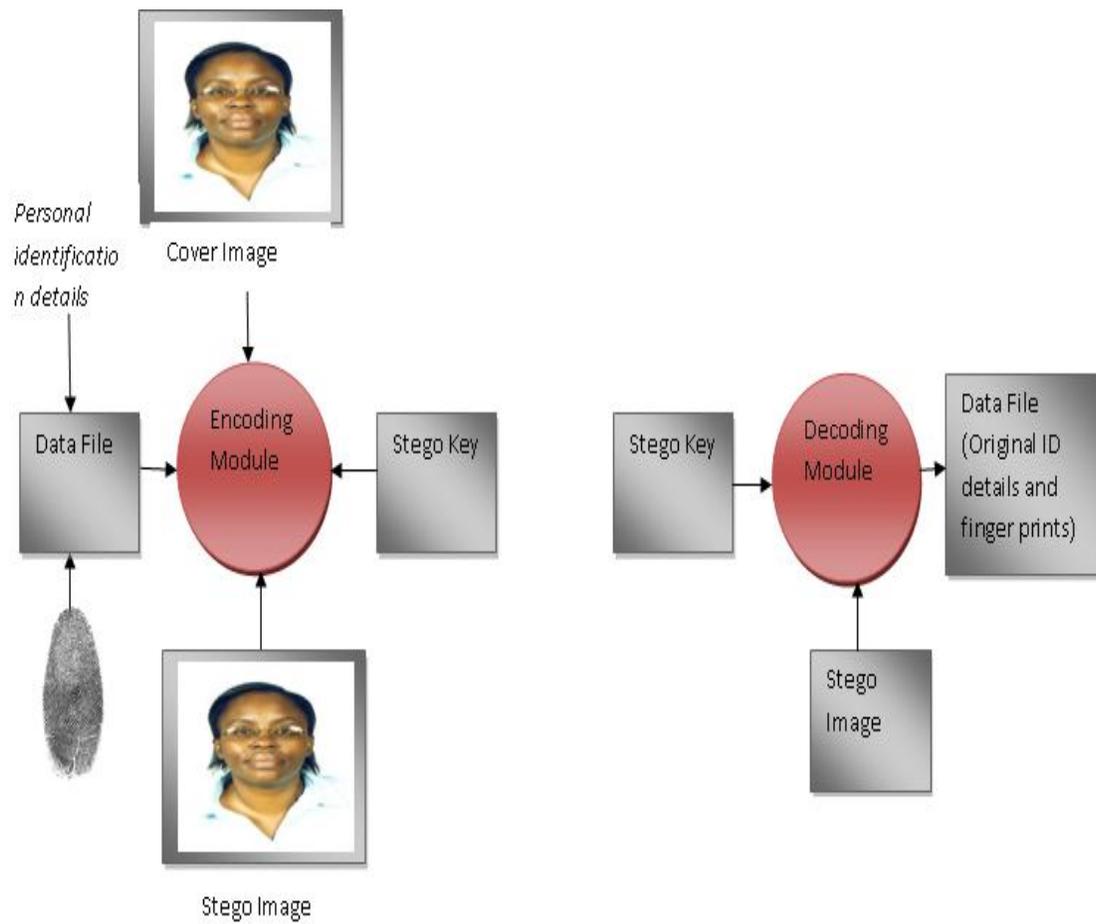


Figure 6.1: Framework of the proposed image-based electors' smart card (Pfitzmann, 1996)

The elaborate embedding algorithm is depicted in figure 6.2 below while the extraction algorithm is shown in figure 6.3.

**Input** : Cover Image, Biometric data file (Payload)  
**Output** : Stego image (image containing hidden file)

1. Convert Biometric data file to a byte stream
2. Get secret file length
3. Get image width
4. Get Image Height
5. Construct buffered Image
6. Convert buffered image to byte array
7. Number of pixels = Image Width \* Image Height
8. Initialize random number generator with the password message digest
9. Initialize bit to use per color channel
10. Get Biometric data file header size {File name + File length}
11. If file size > bits available for writing based on bits per color channel
12. Increment bits per color channel
13. If file size > maximum bits per color channel
14. Display error message {insufficient image size} else
15. Initialize image byte array
16. Write file header to image
17. Update channel bits used
18. Use LCG to
  - Select a random pixel
  - Select a random pixel color channel
  - Select a random color channel bit
19. Let bitToWrite [x][y][channel][bit] denote the selected bit in a specific color channel for writing
20. Let  $m_i$  denote the Biometric data file bit embedded in a color channel bit, bitToWrite[x][y][channel][bit]
21. For all image color channels do the following
22. If  $LSB(\text{bitToWrite}[x][y][\text{channel}][\text{bit}]) = m_i$ , then
23. do nothing
24. If  $LSB(\text{bitToWrite}[x][y][\text{channel}][\text{bit}]) \neq m_i$ , then
25.  $\text{bitToWrite}[x][y][\text{channel}][\text{bit}] = m_i$
26. while Biometric data file length; Repeat step 18 to 25 to embed the entire Biometric data file
27. Close stream.

**Input** : Stego Image, Password message digest  
**Output** : Biometric data file

1. Get image width
2. Get Image Height
3. Construct buffered Image
4. Convert buffered image to byte array
5. Initialize random number generator with the password message digest
8. Initialize image bits read to null
9. Read Biometric data file header
10. Update channel bits read
11. Use LCG to
  - Select a random pixel
  - Select a random pixel color channel
  - Select a random color channel bit
12. Let bitToRead([x][y][channel][bit]) denote the selected bit in a specific color channel for reading
13. Let  $m_i$  denote the message bit read in a color channel bit bitToRead([x][y][channel][bit])
14. For all image color channels do the following
15. If  $LSB(\text{bitToRead}([x][y][\text{channel}][\text{bit}])) \neq m_i$ , then
16. do nothing
17. If  $LSB(\text{bitToRead}([x][y][\text{channel}][\text{bit}])) = m_i$ , then
18.  $\text{bitToRead}([x][y][\text{channel}][\text{bit}]) = m_i$
19. Pack bit in bitSet
21. While Biometric data file length; Repeat step 11 to 20 to read the entire file
22. Close stream.
23. Obtain the entire message stream and convert it back into ASCII format

Figure 6.3: The Proposed enhanced LSB algorithm general extracting algorithm

## 7. EXPERIMENTAL DESIGN AND TESTING

An analysis to examine the statistical properties of the stego images produced by the proposed method and the traditional LSB method was carried out. Statistical attacks are more powerful than visual attacks as they are able to reveal the tiniest modifications in the statistical properties of an image (Artz, 2001).

The following image quality metrics were employed for this purpose:

### 7.1 Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE)

Both of these metrics are the most common and widely used full reference metrics for objective image quality evaluation. In particular, PSNR is used in many image processing applications and considered as a reference model to evaluate the efficiency of other objective image quality evaluation methods (Wang et al., 2002b). PSNR as a metric computes the peak signal-to-noise ratio, in decibels, between two images. It is used in steganography to measure the peak signal-to-noise ratio in the original image and the stego image after embedding the hidden data. In the literature, PSNR has shown the best advantage almost over all other objective image quality metrics under different image distortion environments and strict testing conditions (Wang *et al.*, 2002a).

On the other hand, MSE measures the statistical difference in the pixel values between the original and the reconstructed image (Stoica *et al.*, 2003; Wang *et al.*, 2003). The mean square error represents the cumulative squared error between the original image and the stego-image. PSNR and MSE are defined in equation 1 and equation 2 below (Stoica *et al.*, 2003; Wang *et al.*, 2003):

$$MSE = \left( \frac{1}{MN} \right) \sum_{i=1}^M \sum_{j=1}^N (X_{ij} - \overline{X_{ij}})^2 \quad \dots \text{Equation 1}$$

$$PSNR = 10 \cdot \log_{10} \frac{I^2}{MSE} \text{ db} \quad \dots \text{Equation 2}$$

Where:

$X_{ij}$  is the  $i^{\text{th}}$  row and the  $j^{\text{th}}$  column pixel in the original (cover) image,

$\overline{X_{ij}}$  is the  $i^{\text{th}}$  row and the  $j^{\text{th}}$  column pixel in the reconstructed (stego) image,

$M$  and  $N$  are the height and the width of the image ...in equation 1.

$I$  is the dynamic range of pixel values, or the maximum value that a pixel can take, for 8-bit images:

$I=255$  .....in equation 2.

A lower MSE value means a better image quality ie lesser distortion in the cover image while the higher the PSNR value the better the quality of the image. (Mei *et al* .2009).

In order to evaluate the performance of the proposed method an experimental design was set up. Stego images from both the traditional LSB method and the proposed method were compared using the testing metrics discussed above. All the experiments were implemented and run on a PC Pentium IV Duo core, 2.1 GHz with 2GB of RAM under the Windows 7 Home Edition operating system. The following constants were ensured.

- Same images were used on both the methods
- Same information was embedded in each image ie equal payload
- Same evaluation metrics were used for each image
- Five digital pass port size face images were used as test data files (cover images). Table 7.1 shows the list of these digital images.

FILE NAME	DIMENSIONS	FILE SIZE
Alice.jpg	259 x 370 Pixels	20.5 Kilo Bytes
John.jpg	259 x 350 Pixels	9.42 Kilo Bytes
Loise.jpg	259 x 326 Pixels	13.1 Kilo Bytes
Mercy.jpg	241 x 370 Pixels	11.7 Kilo Bytes
Morris.jpg	259 x 303 Pixels	7.68 Kilo Bytes
Peter.jpg	259 x 262 Pixels	12.4 Kilo Bytes

TABLE 7.1: Test data Images

The specific data hiding steganographic method used was taken to be the independent variable (in this case the traditional LSB method and the proposed enhanced LSB method). In order to evaluate the efficiency of the proposed steganography method, the evaluation dependent variables which measure the image distortion levels were considered. Accordingly, for each steganography method (the traditional LSB method and the proposed enhanced LSB method) and for each cover image the value of each dependent variable was measured. The values of the dependent variables for both embedding methods were then compared. This is illustrated in table 7.2.

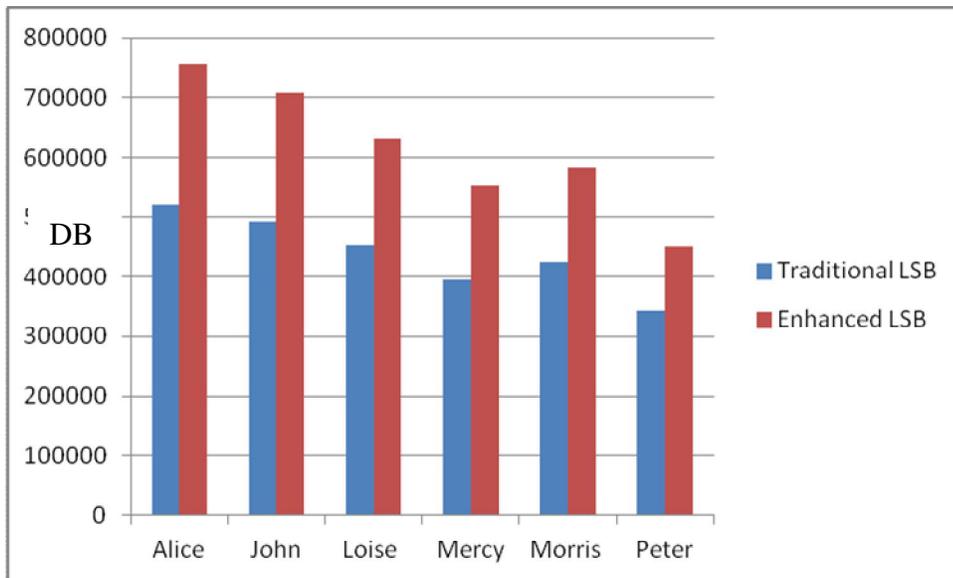
<b>IMAGE</b>	<b>METRIC</b>	<b>LEAST SIGNIFICANT BIT (DB)</b>	<b>ENHANCED LEAST SIGNIFICANT BIT (DB)</b>
Alice.jpg	PSNR	519798	755945
	MSE	1.12	0.77
John.jpg	PSNR	491218	707879
	MSE	1.19	0.82
Loise.jpg	PSNR	451571	631318
	MSE	1.28	0.91
Mercy.jpg	PSNR	395172	552643
	MSE	1.20	0.85
Morris.jpg	PSNR	423502	583336
	MSE	1.38	1.00
Peter.jpg	PSNR	344103	449760
	MSE	1.59	1.22

TABLE 7.2: Test data Images

## 8. EXPERIMENTAL RESULTS

### 8.1 Peak Signal to Noise Ratio (PSNR)

Figure 8.1 below shows the comparison of the PSNR of five stego images for both the traditional LSB method and the enhanced LSB method.



Images

Figure 8.1: The PSNR (DB) of stego images hiding in (Traditional LSB) vs hiding in (Enhanced LSB)

Every image tested registered a higher PSNR for enhanced LSB method as compared to the Traditional LSB method showing that the enhanced LSB embedding method distorts the image less improving on imperceptibility of the hidden data since a higher Peak Signal to Noise Ratio (PSNR) indicates less distortion (Mei Jiansheng *et al.* .2009).

## 8.2 Mean Square Error (MSE)

Figure 8.2 below shows a summary of the comparison of the MSE of five stego images for both the traditional LSB method and the enhanced LSB method.

For each stego image, a lower MSE was recorded with the enhanced LSB method as compared to the traditional LSB method. A lower MSE value means a better image quality ie lesser distortion in the cover image (Mei Jiansheng *et al.* .2009). This means that stego images generated by the enhanced LSB method have lesser distortions compared to those generated by the traditional LSB method and hence improved imperceptibility.

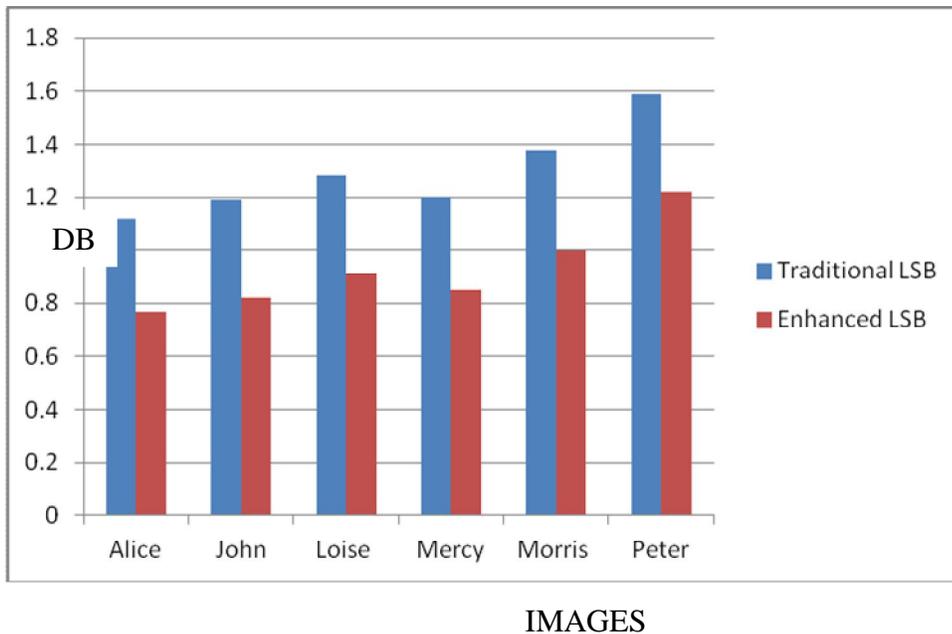


Figure 8.2: The MSE of stego images Hiding in (Traditional LSB) vs Hiding in (Enhanced LSB)

## 9. CONCLUSION AND FUTURE WORK

In this paper, a biometric electors' smart card based on an improved LSB steganographic method has been presented. The purpose is to embed the electors details and biometric data in his/her face image in order to provide a platform of authenticating a voter through a single document. These details are embedded in a more perceptible manner as compared to the way a conventional LSB method would do. There is a demonstration of increased imperceptibility to statistical steganalysis attacks on the cover image as proved through the perceptibility metrics used.

Future research can explore on more permanent embedding methods that are more stronger against steganalysis which cannot be destroyed through image manipulations.

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**S2012-08: Increasing Imperceptibility and the Hiding Capacity in the Least Significant Bit Steganographic Method for Information Hiding**

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The least significant bit (LSB) insertion method is a simple steganographic algorithm that takes the least significant bit in some bytes of the cover image and swaps them with a sequence of bytes containing the secret data in order to conceal the information in the cover medium. However its imperceptibility to statistical steganalysis is relatively low as revealed by the statistical characteristics of its resultant stego images compared to the original cover images. To increase the level of imperceptibility in the LSB insertion method, this paper proposes an enhanced LSB method that employs a selective and randomized approach in picking specific number of target image bits to swap with the secret data bits during the embedding process using a pseudo random number generator(PRNG). The password digital signature (message digest) value is used as a seed to determine the set of selected numbers used for targeting specific image bits for data hiding. An experimental design is setup to determine the effectiveness of the method by comparing and analyzing the stego images' statistical characteristics. This is to factually establish the levels of image distortion (noise) introduced in the original cover image when the two methods are used under the same payload and using the same image. The experimental results indicate improved levels of imperceptibility in the proposed method.

Key Words: *Steganography, Steganalysis, Stego image, payload, imperceptibility*

## **S2012-09: “Trackit”- A Wireless Tracking System**

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### ***ABSTRACT***

The GPS (Global Positioning System) is currently the most favored tool for location determination and navigation. Combined with mobile phones, it has gained rapid acceptance among the wider community. The integration of mobile phones and GPS receivers has provided a very powerful tool with great potential for devolvement into future mobile applications.

Trackit is a Mobile Tracking System that is capable of knowing the exact location of your employee, spouse, son or daughter real-time via GPS

The proposed system exploits the large potential that exists in the combination of GPS and J2ME to develop a navigation system. This new proposed application is developed based on the “GlobeTrotter” system.

To demonstrate the “TrackIT” system, tracking performance representative position data has been collected at different locations in Mombasa polytechnic university college. The tracked position can be displayed with just showing the current user location along with nearest tracking point such that zoom remains what user requests. The whole system uses the J2MEMAP API to locate the server of different map providers, then displays the current user location and tracks its users in real time.

In this paper the design and Implementation of a new proposed “Trackit” system has been presented. The entire system has been successfully tested and executed using the J2ME wireless toolkit and is ready for installation on mobile devices.

This tracking system allows the determination of tracks travelled and displaying them on small mobile devices with the use of Google! Maps, MSN Maps or Ask.com Maps in real time.

This paper lays a path for the future development of a position locator system in real time with the help of a server. The small mobile devices can be also used to locate children and elderly people in emergency situations.

## **KEYWORDS**

*J2ME, J2MEMAP API, GPS, TrackeIT, Tracking*

### **S2012-10: Comparative Assessment of Capacitor Coupling Sub-Station and Auxiliary Service Voltage Transformer for Rural Electrification**

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#### **Abstract**

The conventional distribution sub-station are points in a large electrical power transmission network where high-level voltage is transformed into medium-level voltage suitable for some industrial consumers supply, and for further transformation and distribution to low voltage end consumers. Most rural areas in Africa have low concentration of electrical energy users. As a result, most power utility will not be able to generate an adequate return on investment necessary to install a conventional distribution sub-station on the transmission line. Therefore, costs related to the deployment of a conventional distribution sub-station are prohibitive for most rural electrification projects. On the other hand, high voltage transmission lines on their path from the Generating stations to major urban centres typically transverse large spans of rural areas to which they do not supply electricity. The Capacitor-Coupling Sub-station (CCS) and Auxiliary Service Voltage Transformers (ASVTs) have been known for quite a while, but using this technology to transform high voltage (HV) to medium voltage (MV) for delivering power in rural areas within the vicinity of the HV line is still a new concept in developing countries especially in Africa. In order to address the drawback associated with prohibitive costs of a conventional sub-station; this paper compares the Penetration level of CCS with ASVT sub-stations on a power transmission network in Kenya. The comparison is based on a power flow analysis carried out for both systems. The objective or contribution is to establish the optimum penetration level of these technologies with regard to Cost, Safety, Capacity Constraints, reliability, and performance.

Key words: *Penetration level, Capacitor Coupling Sub-Station (CCS), Auxiliary Service, Voltage Transformers.*

### **S2012-14: Energy and Water Resources: Trading Off One Problem for Another: Review of the Evidence and Case Studies in Kenya's Energy Demands on Scarce Water Resources**

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#### **Abstract**

The nation's energy choices embody many tradeoffs. Water use is one of those tradeoffs. The energy sector is the fastest-growing water consumer in Kenya. Much of this growth is concentrated in regions that already have intense competition among water uses. However, as population increases, demand for energy and water continues to grow. Kenya's efforts to replace imported energy supplies with non-conventional domestic energy sources have the potential to further increase demand for water. At the same time, competing demands for water supply are affecting availability. Operation of some energy facilities has been curtailed, and siting of new facilities is

becoming more difficult. Whether the energy sector may exacerbate or alleviate future water tensions is influenced by near-term policy and investment decisions. These decisions also may determine whether water will limit country's capacity to reliably meet the nation's energy demand. Currently, the energy industry and states have the most responsibility for managing and meeting energy's water demand. The energy sector's water consumption is projected to rise 50% from 2005 to 2030. This rising water demand derives from both an increase in the amount of energy demanded and shifts to more water-intense energy sources and technologies. The more water used by the energy sector, the more vulnerable energy production and reliability is to competition with other water uses and water constraints. Climate change impacts that alter water patterns may exacerbate this vulnerability in some regions. Local or regional competition for water often is what makes energy's water demand significant. These local water resources are often consumed to support not only local energy demand but also national demand. For the past century, the Kenya has invested significant research, development, and construction funding to develop both fresh surface and groundwater resources. The result is a water infrastructure that allows us to harness the vast resources of the country's rivers and watersheds, controlling floods and storing water during droughts to provide reliable supplies of freshwater for agricultural, industrial, domestic, and energy uses. During this same period, the government develops extensive energy resources such as coal, oil, natural gas, and wind and created an infrastructure to transport process and distribute these resources efficiently and cost-effectively to consumers. These two achievements have helped stimulate unprecedented economic growth and development. This paper provides an overview of the interdependencies of energy and water, outlines the emerging energy demands on water resources and summarizes some of the major challenges. The methodology is largely normative. Secondary data is used with deep and comprehensive primary insights into the water energy nexus in Kenya to sufficiently address potential efficacy as the possible hope in achieving the Vision 2030 in Kenya and identical programs including the accomplishment of the Millennium Development Goals. The possibilities of sustainable alternatives are also explored.

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**Key Words:** *Demands, Energy, Economic, Linkages, Management, Water and Government Energy's Water Use*

The nation's energy choices embody many tradeoffs. Water use is one of those tradeoffs. The energy sector is the fastest-growing water consumer in the United States. Projections attribute 85% of the growth in domestic water consumption between 2005 and 2030 to the energy sector. This projected growth derives from anticipated demand for more energy and greater use of water intense energy alternatives. Much of energy's growing water demand is concentrated in water constrained regions. Affordable water supplies are limited, and competition for water is becoming more intense. Whether the energy sector helps exacerbate or alleviate future water tensions is influenced by current policy and investment choices. These choices also may determine whether water limits Kenya's capacity to reliably meet the nation's energy demand. Water limitations may hinder some water-dependent energy activities in specific locations.

The more water used by the energy sector, the more vulnerable energy production and reliability are to competition with other water uses and water constraints. Climate change impacts on water

supplies may exacerbate this vulnerability in some regions. This vulnerability would affect existing energy operations and new energy development, as well as all those activities that depend on the fuels and electricity produced.

The energy sector is changing. Paths chosen and capital investments made in the near term are likely to establish long-term trajectories for energy's water use. Trends indicate that energy's changing water use has national and regional significance for water consumption. A question for Ministries is: what is the appropriate government role in responding to energy's water demand? In the aggregate, current government energy policies contribute to energy's rising water demand, while energy interests and the state and local governments are responsible for managing and meeting water demands and resolving competition over water resources.

Questions for Ministries include *who* is the most appropriate entity to respond to energy's growing water demand and *how* to respond. At present, little direct government action is aimed at managing the energy sector's water demand; instead, the current division of responsibilities relies on the energy interests and state and local governments to meet and manage energy's water demand and resolve energy-water conflicts. The role of government policies in contributing to rising water demand is bringing into question the future government role in meeting and managing energy's water demand. Local or regional competition for water is often what makes energy's water demand significant; at the same time, the regional and local scales of water resources availability and management complicate many government water-related actions.

Options for managing and meeting energy's water demand range from maintaining the current approach, with little government action targeted at managing energy's water demand, to taking a variety of government actions. One option is to minimize growth in energy's freshwater use. This could be accomplished through changes to broad policies (e.g., energy demand management) or legislation specifically targeted at water use (e.g., promotion of water-efficient energy alternatives). Another option is to improve the energy sector's access to water. Access is generally a responsibility of the state, but some limited government actions are possible. An additional option is investing in data and research to inform decision-making and expand water-efficient energy technologies. These alternative policy approaches, which are not mutually exclusive, represent different potential roles and costs for the energy sector; energy consumers; and government, state, and local governments.

### **Energy Trends Shape Water Demand**

Trends in national energy investments, domestic energy use, population, and climate change impacts and responses can affect *how much* and *where* the energy sector uses water. Increased emphasis on domestic energy production and efforts to meet increasing energy demand are expected to increase freshwater use by the energy sector. A shift in the electricity sector away from traditional coal power plants may result in either more or less water consumption, depending on alternative fuels or electricity technologies. Carbon capture and sequestration (CCS) by electric utilities has the potential to consume significant quantities of water. Actions such as substituting wind for thermoelectric electricity generation could potentially reduce energy's water demand, but may raise other challenges for energy reliability, dispatch ability, and transmission. Other impacts, such as the movement of irrigated agriculture from food crops to energy crops, raise other concerns.

### **Energy Sector's Vulnerability to Water Constraints**

The more freshwater used by the energy sector, the more the sector is vulnerable to water constraints. However, as described above and in, major energy trends are pushing the sector to become more water-intensive. Water availability problems, especially regional drought and low stream flow, can pose a risk to energy production and reliability. Electricity generation is particularly sensitive to low-flow conditions. More than 80% of Kenya's electricity is generated at thermoelectric facilities that depend on access to cooling water. Low-flow conditions and water scarcity may constrain water-intense alternatives for thermoelectric cooling in counties across the country. Additional ways that water can constrain energy include a possible decrease in hydroelectric generation during drought. Bio energy yields may be reduced by low precipitation, droughts, heat waves, or floods. Energy extraction, like coal mining, may be scaled back to avoid water quality impairments exacerbated by low water conditions. While water constraints are often perceived as an issue for the western United States, an increasing number of water bodies in the East are experiencing diminished stream flows. While multiple examples exist of water availability affecting siting and operations of thermoelectric facilities from New York to Arizona, generally there are ways to reduce the use of water and the risk posed by water constraints. Water supplies often are most constrained during summer, when the energy sector's water use is at its height in many regions. Approximately 24 of the nation's 104 nuclear reactors are situated in drought-prone regions. A commonly cited example of how water availability can influence electricity generation occurred on August 16, 2007, when a nuclear reactor at the Browns Ferry Nuclear Power Plant in Alabama shut down for a day. Its cooling water discharge exceeded temperature regulations that protect the environment and wildlife of the receiving water body. The Nuclear Regulatory

Commission also sets minimum source water elevation levels for each plant, so that the plant is not operating if water levels fall below plant cooling water intakes. If cooling water sources fall below the established minimum water level, or if the maximum thermal thresholds cannot be met, the facilities are required to power down or go offline.

### **Emerging Challenges of Water and Energy Development**

The availability of adequate water supplies has a profound impact on the availability of energy, while energy production and power generation activities affect the availability and quality of water. In today's economies, energy and water are tightly linked. As illustrated in Figure 1, energy production and power generation require water, and water pumping, treatment, conveyance, and end-use conditioning require energy. As these two resources see increasing demand and growing limitations on supply, energy and water must be recognized as highly interdependent critical resources that need to be managed together in a more integrated way to provide reliable energy and water supplies and sustain future national growth and economic development while maintaining the health of ecosystems and the environment.

The emerging vulnerability of energy and water supplies and infrastructures is becoming clearer. Low water levels from drought and competing uses have limited the ability of power plants to generate power. Additionally, water levels in aquifers in many regions of Kenya have declined significantly, increasing energy requirements for pumping, and, in some cases, leading to ground subsidence issues. Lack of water for thermoelectric power plant cooling and for hydropower has the potential to contribute to power shortages like those of recent years that have illustrated the vulnerability of Power electrical grid to unplanned generation outages, especially in hot weather.

Of concern to many water managers is the effects climate variability and changes could have on snow fall and precipitation and the associated impacts on surface water reservoir storage and operations and ground water recharge. Climate variability has caused reductions in snow pack, earlier spring snow melt, and earlier but smaller peak stream flows in some regions. If the trends seen over the past 50 years continue, many regions could see significant reductions in reservoir storage levels, forcing reduced surface water withdrawal rates and decreasing future surface water availability.

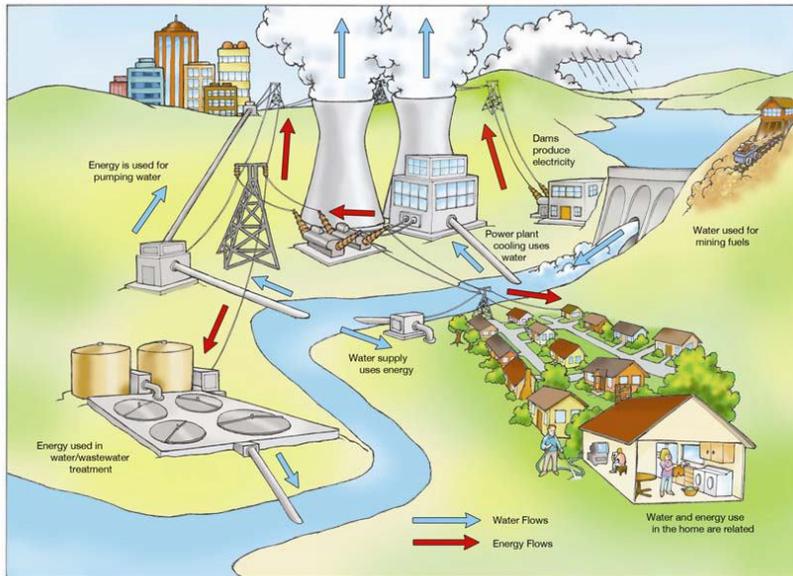


Figure 29: Water and Energy Interrelationships

### Projected Growth in Electric Power Generation

The current electricity demand is 1,191 MW while the effective installed capacity under normal hydrology is 1,429 MW. Generation capacities from Hydro, Geothermal, baggase (cogeneration) and wind are 52.1%, 13.2%, 1.8% and 0.4% respectively while fossil based thermal contributes at 32.5%. The peak load is projected to grow to about 2,500MW by 2015 and 15,000 MW by 2030. To meet this demand, the projected installed capacity should increase gradually to 19,200 MW by 2030.

The impact of new electric power generation on future water demands will depend on the number and type of power plants built the rate at which existing plants are retired, the type of cooling installed, and the type of air emissions controls required. Alternative approaches to evaporative closed-loop cooling systems are being developed in an effort to significantly reduce future demand for cooling water, but many technical and economic issues have limited their introduction. Emerging alternatives include dry cooling, which currently has significant cost penalties and performance issues in hot, dry weather, and hybrid cooling, which mitigates the performance penalty of dry cooling, but is currently more expensive and more complex to operate. Wet surface air cooling to enhance use of impaired waters to reduce fresh water use and consumption is also being considered. Different electric power generation approaches require different amounts of water and have different operational issues and benefits. The major electric power generation approaches include thermoelectric plants (coal, natural gas, biomass, and nuclear), and renewable energy plants (hydropower, geothermal, wind, and solar).

Hydroelectric power also uses water, but since the water remains in the river, Kenya Geological Survey MOEs not include hydropower use in water withdrawal statistics. Hydroelectric power is an important, but drought-sensitive, component of Kenya electricity generation, supplying 5 to 10



Figure 30: Wind Power

percent of generated power from 1990 to 2003, but also stabilizing the electrical transmission grid by meeting peak loads, reserve requirements, and other ancillary electrical energy needs. Beyond conventional hydroelectric power, other renewable energy sources, including wind, solar, and geothermal energy systems, currently contribute a very small additional percentage of the nation's electricity

generation. Solar photovoltaic, solar dish-engine, wind, and air-cooled geothermal hot water (binary) power systems offer a single significant advantage over other electricity generation technologies — they consume almost no water while producing electricity.

Some renewable energy applications, such as some geothermal and concentrating solar systems that use evaporative cooling for steam condensing, do have high water consumption. Interestingly, solar, wind, and geothermal energy resources are most abundant in regions most strongly associated with increasing water demand or water scarcity. Non-hydroelectric renewable power systems have limitations that have limited their wider use in many cases. Although the costs of these technologies are declining, the electricity they generate remains more expensive than from conventional generating sources in many cases. While geothermal, solar thermal power with integrated storage, and biomass systems can provide dispatchable power, other renewable energy technologies, such as wind, solar photovoltaics, and kinetic hydropower (run-of-river, wave) currently produce electricity only when the resource is present.

**Climate Change Could Increase Energy's Freshwater Vulnerability**

Snowpack, precipitation, and runoff are strongly related to climate. Climate change researchers predict both water quantity and timing changes. That is, the research indicates more precipitation in the form of rain and less in the form of snow, and changes to seasonal water availability in some areas (e.g., low-flows during dry seasons). Additionally, climate models predict more frequent

floods and droughts. These changes present challenges for hydroelectric dam operation. Changes in the availability and temperature of water resources also may affect operations of power plants that require water for cooling and that have thermal discharge limitations for cooling water. Climate change also may increase the demand for air conditioning, the electricity it consumes, and the water used to produce the electricity. The decreased runoff anticipated in the West, North Eastern and Coast would decrease the amount of water available for all uses, including the energy sector. That is, the water resource impacts of a changing climate would likely exacerbate already projected thermoelectric cooling constraints. The energy sector also is vulnerable to potential increased flood and storm hazards associated with climate change. An example is the disrupting effects of floods on fuel transport.

### **How Much Water MOEs Energy Demand?**

How much water will the energy sector use in the future? In large part, interest in answering this question is rooted in other questions of national significance, such as: Will water limit Kenya's capacity to meet the nation's energy demand? Will water constrain the nation's transition away from foreign sources of energy? Will water hamper the adoption of some renewable energy alternatives?

Quantification of energy's water demand and its significance is limited by significant gaps in available data and analyses. Water has no government data agency comparable to the Energy Information Administration that projects alternative demand scenarios. There is no authoritative government source to cite for the level of water use by the energy sector or for projections of how that use may change in future decades. For example, there are no forecasts that use multiple scenarios to identify sensitivity of water demand to multiple factors and policies, or that analyze energy's water use and water vulnerability in the context of factors significant to energy choices and policies, such as energy and transmission costs, emissions, and reliability.

### **Regional Significance of Energy's Water Demand**

Much of the anticipated growth in energy's water demand is in water-constrained areas, potentially exacerbating low availability during summer and droughts, and increasing competition with existing uses. That is, while energy's water demand is anticipated to rise across the United States, the West is likely to experience some of the more significant constraints and conflicts in meeting this demand. While local or regional competition for water is often what makes energy's water

demand significant, the regional and local scales of water resources and how they are managed often complicate government water-related actions.

### **Electricity Generation: Solar in North Eastern and Coast**

Another example of energy's regional water demand is concentrating solar power (CSP) in North Eastern and Coast. The region has abundant solar resources, but the region's water constraints can influence the attractiveness and feasibility of different solar technologies and the suitability of specific sites. Most concentrating solar power (CSP) consists of ground-based arrays of mirrors that concentrate the sun's heat, which is used in a thermoelectric process to generate electricity.

The two primary technologies are solar troughs and solar towers. Although CSP MOEs not emit greenhouse gases, its use of a thermoelectric process can raise water concerns, particularly if evaporative cooling is employed (that is, if water is evaporated to dissipate waste heat). Similar water concerns would be raised if new fossil-fuel thermoelectric power plants were to be similarly located in the North Eastern and Coast. For some North Eastern and Coast counties with relatively low water use, large-scale deployment of CSP or another thermoelectric facility (even with water-efficient cooling technologies) could significantly increase the current demand for water in the county. Some solar developers are using cooling alternatives that require less water (or have been encouraged or required to do so as part of state permitting or government approval of facilities on government lands). These alternatives include dry or hybrid cooling or use of impaired waters for cooling. These options generally come at a cost premium and with energy and cooling efficacy tradeoffs. Other solar developers have purchased water rights from willing sellers in states with active water markets. Still other solar developers are using solar technologies that require little or no water; these include photovoltaic solar, which uses panels of solar cells to convert sunlight directly into electricity, and dish engine CSP, which uses engines rather than a thermoelectric process to produce electricity. While these technologies are water-efficient, they have other constraints (e.g., cost, land use, dispatch ability). In summary, freshwater constraints like those in the North Eastern and Coast do not preclude solar development, but access to water shapes the technologies and costs of solar development.

### **Energy Crops: Biofuels in the High Plains**

An additional example of energy's regional water demand is biofuels in the High Plains. The water quantity (and quality) used for biofuels is particularly sensitive to biofuel feedstock, use of irrigation, and local climate and soil conditions at the growing site. Average water consumption by

the dominant Kenya's biofuel, corn-based ethanol, significantly exceeds the water intensity of other transportation fuels if the corn feedstock is irrigated. Irrigation of only a small amount of biofuel feedstock in areas without sufficient rainfall to support feedstock growth without irrigation has the potential to substantially increase national water consumption for transportation fuels. Of particular concern to the High Plains is expanded biofuels production on new or marginal lands, which could lead to additional irrigation demand and increased nutrient application, causing both water quantity and quality concerns. Even expansion of existing biofuel crops in current production, such as corn, raises water quality concerns with the possible increased application of fertilizers and pesticides necessary to increase yields (this is also of concern in regions such as the Midwest, where irrigation water concerns have been less significant). Recognition of water, land, and other issues related to biofuels, particularly irrigated corn- and soybean-based biofuels, has led to a search for feedstocks and other organisms that use fewer resources to produce. Recent government biofuels policies have attempted to assist this search by focusing on the development of a cellulosic biofuels industry. Dedicated biomass crops, such as switchgrass, hybrid poplars, and hybrid willows are considered by many to be more desirable crops because they have a short rotation (regrow quickly after each harvest) and use fewer resources, such as water and fertilizers, than traditional field crop production. Despite potential environmental benefits, concerns persist about the additional use of fertilizers and water resources that could be required to increase the per-acre yields to economically feasible levels; for example, that cellulosic feedstocks may be irrigated to increase yields, even though irrigation may not be required. Also, land use pressure for expanded production also applies to cellulosic biomass feedstock, possibly creating direct competition with current land conservation programs and replicating the concerns of traditional biofuel feedstock stated above. Despite government incentives, technological and economic hurdles continue to prevent the cellulosic biofuels industry from developing to commercial scale production.

### **Meeting and Managing Energy's Water Demand: Policy Options**

The previous sections described how energy's demand for water is increasing and provided some regional examples; this section discusses options for meeting and managing that demand. Historically the energy sector and the states have determined how water is used in the energy sector, but the significant role that current government policies are playing in driving up energy's water demand is raising questions about the government role in meeting and managing that demand. Consequently, Ministries is faced with deciding not only whether, and if so how, to alter current

policies to respond to energy's water demand, but also who is the most appropriate entity to respond to energy's growing water demand. Currently little direct government action is aimed at managing the energy sector's water demand, although government policies at times have significant indirect influence on this demand. Instead, present roles rely on the energy industry and the states and local governments to manage water constraints and to resolve energy-water conflicts.

Support or opposition for legislation affecting energy's water demand may be influenced by opinions about the proper government role in water allocation and planning, as well as concerns about the cost of actions and who is responsible for those costs. Positions on the larger energy and climate debate and other factors may also be important. Government responses to energy's water use are complicated by the wide-ranging and place-based nature of the issue, the variety of actors involved, the costs and other tradeoffs involved, and the existing institutions and divisions of responsibilities for water and energy.

If increased government action to meet and manage energy's water demand is deemed appropriate, possible actions fall under a few broad options. Attempts can be made to minimize the growth in energy's freshwater use by adopting general energy policies that are less water intense and more sensitive to water constraints, or by specifically promoting activities that reduce energy's water use, such as incentives for adopting less water intense energy generation technologies. Another option is to make freshwater available for the energy sector (e.g., through allocations, permits, or facilitating water trading); however, the majority of water quantity allocation and permitting decisions are up to the states. An additional option is improving data and analysis on energy's water use to better inform decision-making (e.g., resource planning efforts and decision-support tools) and enhancing the availability and dissemination of water-efficient technological alternatives.

### **Thermoelectric Cooling: Emerging Alternatives**

The withdrawal and water quality impacts of once-through cooling have resulted in newer power plants generally using evaporative cooling. Emerging cooling technologies have the potential to use much less freshwater than once-through or evaporative cooling. These include dry cooling (previously discussed), hybrid dry-wet cooling, cooling with fluids other than freshwater, and more innovative technologies (e.g., wet-surface air coolers, advanced wet cooling). However, these alternatives have their own costs and disadvantages.

A MOE report found that dry cooling could reduce water consumption to roughly 80 gal/MWh for solar troughs and 90 gal/MWh for solar towers. While they consume less water, dry and hybrid

cooling systems have financial as well as efficiency costs. Total annualized costs for dry cooling tower systems can be four times those of evaporative cooling tower systems.<sup>63</sup> Due to the higher cooling and lower generation efficiency costs, the cost of electricity from a dry cooled plant may be 10% higher than a similar wet cooled plant. Dry cooling uses fans to blow air for steam condensation. While power plants with dry cooling use considerably less water, dry cooling is less effective at cooling the power plant than evaporative cooling, thus reducing electric generation at the facility. The MOE report also found that electricity generation at a dry-cooled facility dropped off at ambient temperatures above 100°F. For a solar parabolic trough facility in the North Eastern and Coast, the benefit in the reduction in water consumption from dry cooling resulted in cost increases of 2% to 9% and a reduction in energy generation of 4.5% to 5%.<sup>65</sup> The cost and energy generation penalties for dry cooling depend largely on how much time a facility has ambient temperature above 100°F. Dry cooling would reduce generation on the same hot days when summer peak electricity demand is greatest. Chemicals added to the water at a thermoelectric facility to extend equipment life and improve operational efficiency

Hybrid wet-dry cooling attempts to balance water consumption with power generation efficiency; it remains under development for commercial scale applications. To weigh the tradeoffs in energy generation, cost, and water use, MOE researched hybrid cooling processes that combine dry and evaporative cooling. The hybrid system consists of parallel evaporative and dry cooling facilities, with the evaporative cooling operating only on hot days. By using dry cooling generally and evaporative cooling above certain ambient temperatures, losses of thermal efficiency from dry cooling can be reduced. How often the evaporative cooling is used determines how much water is consumed and the effect of hot days on thermal efficiency

## **Tradeoffs of Select Electricity Generation Technologies**

### **Hydroelectric Generation**

Hydroelectric power is produced when water passes through a turbine. Turbines for large-scale hydroelectric generation are located at dams. Electricity at Kenya hydropower facilities is produced with relatively low greenhouse gas emissions. However, hydropower's environmental effects can be significant. Conventional hydropower development through dam building often significantly alters river ecosystems, harming many indigenous species. Drought and changes to hydrology, such as possible reduction in snowpack under a changing climate, can reduce electricity generation at hydropower facilities because of the effects on reservoir operations and levels. Constructing new large dams is contentious; therefore, efforts to identify opportunities for

increasing hydropower generation have focused on smaller-scale opportunities or improved efficiency and expansion of hydropower at existing facilities.

### **Photovoltaic Solar and Wind**

Renewable electricity technologies that do not use thermoelectric processes may have minimal water requirements for electricity generation. Wind turbines and solar photovoltaic (PV) panels, for example, require small volumes of water for cleaning, but otherwise use no water. However, the minimal water intensity of wind and PV comes with tradeoffs. Transmission constraints; cost; and regulatory, technical, and operational factors currently restrict the extent to which solar and wind resources can be exploited to meet electricity demand. As previously noted, wind and PV are intermittent electricity sources. Some storage options for these intermittent technologies exist (e.g., wind used in conjunction with a pumped storage hydropower facility); however, their applications are limited and intermittency continues to limit generation from wind and PV. Electricity from PV is also currently more expensive than electricity from CSP, although electricity from wind is less expensive than electricity from CSP. For a discussion of wind technologies and policy issues, see CRS Report RL34546, *Wind Power in the United States: Technology, Economic, and Policy Issues*, by Stan Mark Kaplan.

### **Geothermal**

There are several ways to use geothermal energy: electricity generation (discussed herein) as well as direct-use (recovering water heated by the earth) and heat pumps (using the earth's heat to cool/heat buildings). Traditional geothermal power production uses naturally occurring convective hydrothermal sources in hot rock formations to produce steam to run a thermoelectric power plant's turbines (i.e., a geothermal flash system). Alternatively, for lower temperature geothermal resources, a second working fluid is heated by the geothermal water using a heat exchanger; it is the working fluid that drives the turbines (i.e., a geothermal binary system).

Finally, because the majority of hot rock is dry, electricity can also be generated by injecting water into fractured rock to be heated (i.e., an enhanced geothermal system). The water is then injected back into the rock formation to create a relatively closed-loop system. Because the geothermal or injected water is an essential component of geothermal electricity generation and the size of the plants are generally smaller than 50 MW, dry cooling is becoming the standard for new geothermal facilities. Smaller power plants are generally easier to dry-cool than larger plants.

Enhanced geothermal power plants require relatively little land and can be used in coproduction with enhanced oil recovery to lengthen the lifespan of oil fields. These enhanced systems are an emerging technology, so more research and development are needed for large-scale commercial deployment. Current research is investigating the possibility of replacing water with carbon dioxide as the working fluid, which would significantly reduce water usage and would be a means of carbon sequestration.

### **Concluding Remarks**

The energy sector has long been a major water user, so why the current concern? Major energy trends are pushing the energy sector to become more dependent on, and therefore vulnerable to, freshwater availability. This is occurring at a time of increasing concerns about the adequacy and reliability of freshwater supplies due to population growth and climate change. Energy resource and technology paths chosen and capital investments made in the near term are likely to establish long-term trajectories for energy's water use.

Many of the current trends are in part driven by government policy. The government partially shapes the energy sector and at times defines a vision for the nation's energy future (e.g., biofuel production targets). Some stakeholders have raised concerns about the feasibility and consequences of meeting various energy targets and policy proposals, including concerns about physical inputs like water, land, materials, and rare minerals. Because affordable freshwater is a finite resource, commitments of water supplies for the energy sector reduce availability for other sectors and for ecosystems. Local or regional competition for water is often what makes energy's water demand significant; at the same time, it is the regional and local scale of water resources and how they are managed that often complicates many government water-related actions. The government role in energy supply and demand raises questions about the policy direction for meeting and managing energy's water needs, among them: If energy security is a national security issue, is energy's water use by association a national security issue? Would this be a justification for government spending on energy and water efficiency measures? Water supply concerns are not only being raised in the context of energy. There also is growing concern about water availability and aquatic conditions for meeting the demands of the agricultural and municipal sectors and the needs of ecosystems and threatened and endangered species; these concerns are raised particularly in the context of droughts and impacts of climate change on water resources. Given available freshwater resources, a challenge for the nation will be to cost-effectively, sustainably, and reliably meet energy demands while satisfying agricultural, municipal, and industrial water demand, as well as ecosystem needs.

This challenge raises fundamental and controversial questions about how freshwater resources are allocated and used for various purposes, and about the availability and value of water in different sectors of the economy and in the environment. At issue for Ministries is the role that the government funding plays in shaping, meeting, and managing energy's water demand, while accounting for the significant role of the states and private sector in water use decisions.

#### **ABBREVIATIONS**

<b>CBK</b>	Central Bank of Kenya
<b>CCS</b>	Carbon Capture and Sequestration
<b>CRF</b>	Cost Recovery Factor
<b>CSR</b>	Concentrated Solar Power
<b>ERC</b>	Energy Regulatory Commission
<b>GDC</b>	Geothermal Development Company
<b>GDP</b>	Gross Domestic Product
<b>GoK</b>	Government of Kenya
<b>GT</b>	Gas Turbine
<b>GWh</b>	Giga Watt hours
<b>HPP</b>	Hydro power project
<b>IPP</b>	Independent Power Producer
<b>ISO</b>	Independent System Operator
<b>KWh</b>	Kilo Watt Hour
<b>MOE</b>	Ministry of Energy
<b>MSD</b>	Medium Speed Diesel
<b>MW</b>	Mega Watts
<b>MWh</b>	Megawatt Hours
<b>PV</b>	Photo Voltaic

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**S2012-15: Assessment of Anthropogenic Activities And Climate Change Effects on Sustainability of Tudor Creek Ecosystem**

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**Abstract**

Climate change and anthropogenic activities along Tudor Creek ecosystem were evaluated in three hotspots selected for faunal and floral biodiversity survey. Microbial community and pollution level were analyzed during the 2010 / 2011 wet and dry seasons. Findings demonstrated the presence of heavy metals in water, soil as well as faunal muscles. Ti, V, Cr and Mn were below 0.15 mg/L in the water samples while Mn, Fe, Cu, Zn, Pb and Ti were found in soil and faunal muscles at concentration ranges of 0.46 – 914.00 and 1.94 – 1863.00 µg/g, respectively. Floral biodiversity survey recorded four mangrove species, *Rhizophora mucronata*, *Sonnerata alba*, *Ceriops tagal* and *Avicennia marina*. The mangrove species inhabited Mikindani and Moroto while Old Town had none. *R. mucronata* was the most diverse and desirable for silvi-cultural as well as re-forestation. The species expressed diversity index of 0.75 and 0.57 in Mikindani and Moroto, respectively. The corresponding dominance indices were 3.7 and 1.9, respectively. *C. tagal* was unique to Mikindani site and expressed diversity and dominance indices of 0.33 and 0.0048, respectively. Crabs, oysters and gastropods accounted for 80% of the faunal population. Fishes, crustaceans, mollusks, insects and birds were also significant faunal clusters in the ecosystem. Microbial investigations revealed the presence of *Citrobacter* and *Enterococci* in Old Town. *Pseudomonas* was most predominant in Moroto soil while water was predominated by *Escherichia coli* and *Enterococci*. Non- and biodegradable solid pollutants were also recorded. Biodegradable materials were more abundant in Mikindani site as opposed to Old Town that was highly dominated by non-biodegradable materials. It is apparent from the generated information that both human activities as well as climate change influenced environmental and health sustainability of the Tudor Creek ecosystem.

**Key words**

*Biodegradable, Biodiversity, Climate Change, Ecosystem, Fauna and flora, Heavy metal and Pollution*

**1.0 Introduction**

Effects of increased pollution in the environment are rapidly growing. Heavy metal contaminants are common pollutants in both urban and peri-urban ecosystems. Mostly, the pollutants arise from industrial effluents, urban run-off and domestic wastes. Metallic contaminants are harmful to human, animals and plants (Yahaya *et al.*, 2009). Their effects are aggregated

through bioaccumulation in the food chain (Szefer *et al.*, 1997). For this reason, investigation of soil and chemical pollutants in terrestrial and aquatic environments are essential. Evaluation of pollution levels in soil and water samples due to heavy metal accumulation is important as it has the potential of explaining environmental and human health risks. Changes in heavy metal concentration above acceptable levels whether due to natural or anthropogenic factors can result in serious environmental and health challenges (Yahaya *et al.*, 2009). The emergence of unplanned housing structures in Tudor Creek has led to depletion of mangrove forests with a view of clearing building sites besides providing construction materials and firewood. Climate change has exacerbated anthropogenic activities with adverse effects on sustainability of marine resources at Tudor creek.

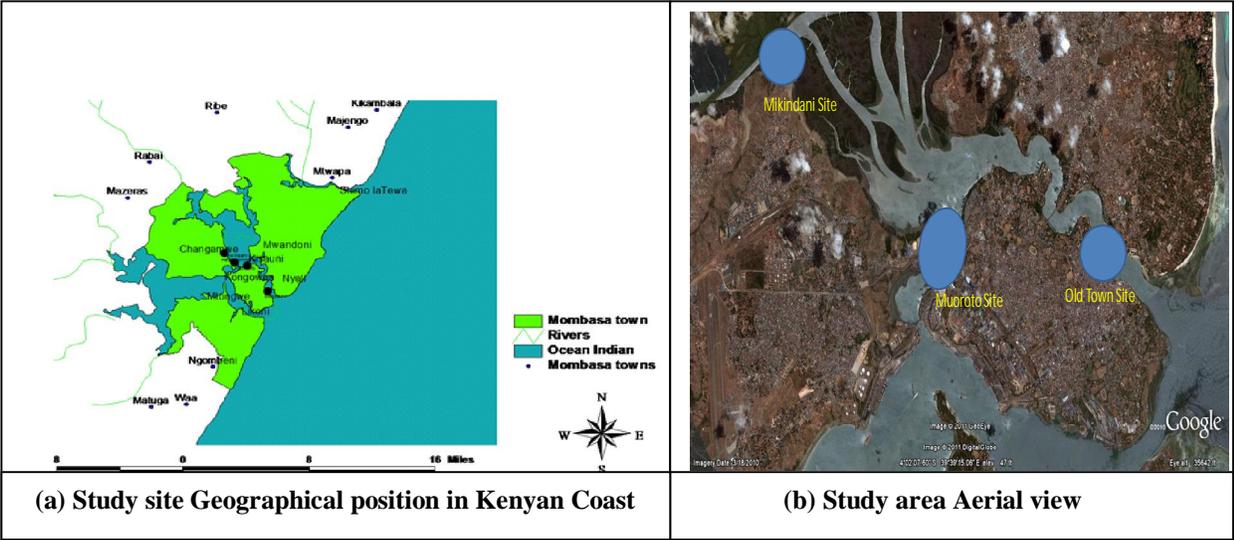
Anthropogenic activities particularly, agricultural production alongside the discharge of raw effluents coupled up with agrochemical wastes from industrial plants have negatively impacted on the floral and faunal biodiversity in the ecosystem. The worst hit is the fishing industry that supports a large population of the Creek's inhabitants. Heavy metals such as Cu, Ni, Zn, Fe and Mn are usually taken up by plants and microorganisms in trace amounts to meet their nutritional requirements. However, mangrove ecosystems act as sinks or buffers for removing or immobilizing metals near aquatic ecosystems (Pahalawattarachachi *et al.*, 2009). When taken up in slightly large amounts, heavy metals cause adverse effects on organisms through bioaccumulation (Szefer *et al.*, 1997). Chemicals such as Pb, Cd, Hg and Ti do not have any known physiological value. However, they are detrimental when taken up even in trace amounts (Farombi *et al.*, 2007). Heavy metals such as Cd have been documented as serious causes of human health complications (Duruibe *et al.*, 2007). Arsenic is reported as an important cause of cancerous deaths and skin lesions. Additionally, it is responsible for high rates of miscarriages and premature delivery besides triggering neurological complications reported elsewhere (Duruibe *et al.*, 2007; Mgya, 1998). It is against this background that the study sought to investigate the types and levels of pollutants along Tudor Creek, besides the elucidation of floral and faunal biodiversity as well as assessment microbial community and functions associated with the ecosystem.

## **2.0 Materials and Methods**

### **2.1 Site Description**

The study was performed along Tudor Creek in western Indian Ocean that extends between longitude 39°30' E and 39°45' E and latitude 3°4.5' S and 4°15' S (Fig. 1a). The Creek is situated between Mombasa Island and North Coast mainland along the western Indian Ocean. Old Town,

Moroto and Mikindani were selected as study sites (Fig. 1b). Temperature range of the study area was 35°C and 21°C, maximum and minimum, respectively. The average annual relative humidity was 77.6% while the average annual rainfall was 1162 mm (Mombasa Island Weather Website, 2011). It offers an ideal environment for studying processes underling anthropogenic and climatic change effects that influence human livelihood. The influx of rural – urban immigrants and subsequent settlement in the congested Mombasa city has resulted into rapid establishment and expansion of unplanned informal housing systems characterized by poor drainage systems that culminate into deplorable sanitation situation along the Creek. The Creek supports livelihoods of a large human population occupying Old Town, Kongowea, Buxton, Kisauni, Mishomoroni, Tudor, Moroto, Burukenge, Kibarani, Kenya Meat Commission, Bangladesh, Changamwe and Mikindani. Most inhabitants of the cited areas live in deplorable slum and survive on less than US\$ 1 per day.



**Fig. 1: Maps showing (a) geographical position and (b) aerial view of Tudor Creek**

Anthropogenic activities carried out along the Creek included, swimming, fishing, agriculture, construction, industrial processing among other socio-economic activities. The cited activities discharge huge waste into both terrestrial and aquatic environments within the ecosystem. Direct disposal of solid wastes and discharge of raw effluents into the aquatic environment influences creek water quality, dissolved oxygen concentration, turbidity and conductance that have a direct influence on marine and terrestrial life. The enumerated parameters alongside others contribute towards deterioration of the aquatic environment. The deforestation of mangrove plantations has equally negatively influenced Tudor Creek ecosystem. The study reports on negative impacts of both climate change and anthropogenic activities for enhanced sustainable

livelihood with focus on floral and faunal biodiversity indices as indicators of the environmental sustainability, microbial community functions as drivers of biogeochemical processes besides acting as biodegradation agents and types and levels of pollutants especially heavy metals with special focus on human health risks alongside environmental sustainability within the ecosystem.

## 2.2 Faunal and Floral Biodiversity Estimates

Four 50 m by 50 m transects adjacent to each off shore were identified for floral estimates while faunal diversity was estimated in four 2 m x 2 m transects located within each transect. Shannon Weiner Index of general diversity (H) and indices of dominance (C) were estimated using

the following respective formulae: 
$$H = \sum_{i=1}^s \left(\frac{n_i}{N}\right) \log_2 \left(\frac{n_i}{N}\right) \quad \text{and} \quad C = \sum_{i=1}^s \left(\frac{n_i}{N}\right)^2$$
, where  $n_i$  is the importance value of each species represented by the number of individuals while  $N$  is the sum of the importance values and  $s$  is the summed taxa number (Kumar *et al.*, 2010).

## 2.3 Soil /Water Sampling and Chemical Analysis

Soil samples were collected from a depth of 0-15 cm using a clean plastic trowel in 2 m by 2 m pre-selected faunal estimate transects. The soil samples were kept in a polythene bag (500 ml) while water samples were collected in 250 ml plastic containers in four replicates from each site during the 2010-2011 wet and dry seasons. Soil samples were analyzed using Energy Dispersive X-ray Fluorescence (EDXRF) while water samples were analyzed using Total Reflection X-ray Fluorescence (TXRF). One gram of well mixed air dried soil samples from each site was weighed into a 120 ml flask after grinding using pestle and mortar. Further grinding using Frisch Pulveriser type 02102 No. 3186 was performed and sieved through a 100  $\mu$ M mesh. Each of the 1 g soil samples was mixed and homogenized with 0.5 g cellulose binder in the ratio of 2:1. Three replicate pellets per sample measuring 2.5 cm diameter weighing between 400-500 mg were prepared using manual hydraulic press. The pellets were kept at room temperature in readiness for irradiation before being subjected to standard analysis protocol. Water samples were filtered using Whatman No. 42 filter paper into clean 100 ml conical flasks. 10 ml of each sample was pipetted into a clean vial after which, 20  $\mu$ L of 1000 ppm Gallium stock solution was added. Each sample was shaken for one minute to homogenize. Aliquots measuring 10  $\mu$ L of each sample was pipetted into clean oven dried quartz carrier. Each sample carrier was irradiated for 300 seconds using a S2PICOFOX TXRF molybdenum anode connected Spectrophotometer operated at 50 kV at a current of 1000

$\mu\text{A}$ . The measured spectra were used to estimate the concentrations of heavy metals using S2PICOFOX software for specific elements based on the following formula;  $C_{is} = N_x/S_x/N_{is}/S_{is} \times X_{C_{is}}$  and  $C_i = I_i/S_i \cdot A_i$ , for water and soil samples, respectively. Averages of the generated values were calculated. Soil and water pH as well as conductance were measured using pH and conductance meters (Yahaya, 2009).

## 2.4 Microbial Community Investigations

Microbial community investigations were performed based on culture dependent methods that adopted standard nutrient agar and broth growth media. The inoculated plates were incubated and observed for microbial growth. Colony forming units (cfu) were scored for presence or absence in each growth culture medium upon which the observed colonies were estimated using direct counts and most probable numbers (MPN). The microbial colonies were sub-cultured for further analysis through inoculation onto fresh media such as xylose lysine deoxycholate then subjected to gram staining for characterization and identification.

## 3.0 Results and Discussion

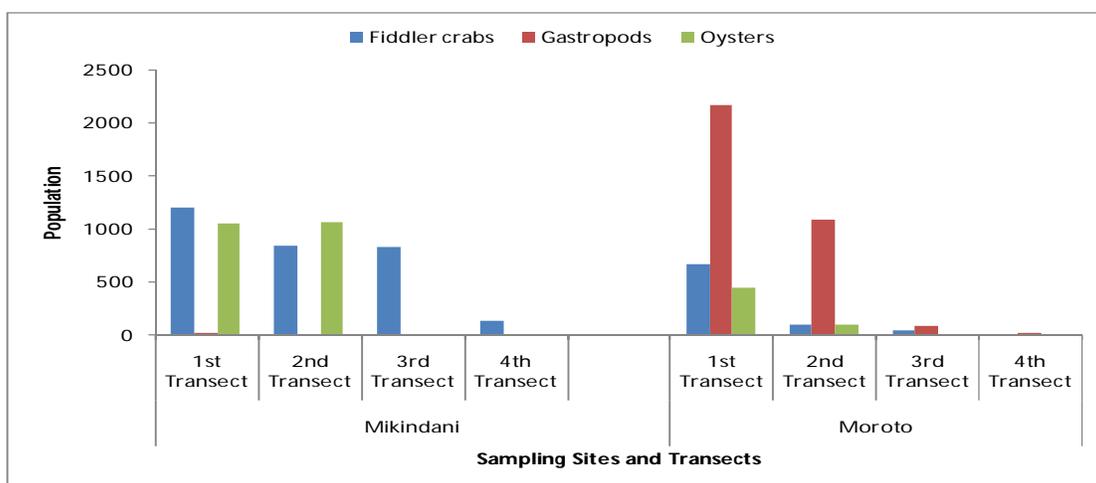
Climate change and anthropogenic activities impacted adversely upon conservation efforts and sustainable management of Tudor Creek ecosystem (Fig. 2a & b).



Fig.2) Mangrove deforestation at Mikindani

Both Mikindani and Moroto sites were rich in faunal biodiversity. It is quite apparent from the generated information that Tudor Creek ecosystem is facing an ecological threat. Both climatic change effects and anthropogenic activities are fast reducing the area covered by mangrove forests and will thus increase the threat to human safety. Construction of informal settlements along the shoreline has the potential of causing natural hazards such as erosion, flooding, storm waves and surges (Fig. 2a and 2b). These findings are in agreement with those of Gilman *et al.* (2008). In

addition, the loss of mangrove species such as *Avecennia marina* through logging for sale and clearing of sites for human settlement, agricultural activities and provision of firewood have the potential of reducing coastal water quality, endangering biodiversity and elimination of both fish and crustacean nursery habitats. Fishes, crustaceans, mollusks, nematodes, insects and birds were also significant members of the faunal group. Crabs were the most abundant ground inhabiting organisms accounting for 40% followed by oysters that comprised 25% while gastropods made up 15% (Fig. 6 a & b).



ig. 6a. Faunal distribution at Mikindani and Moroto

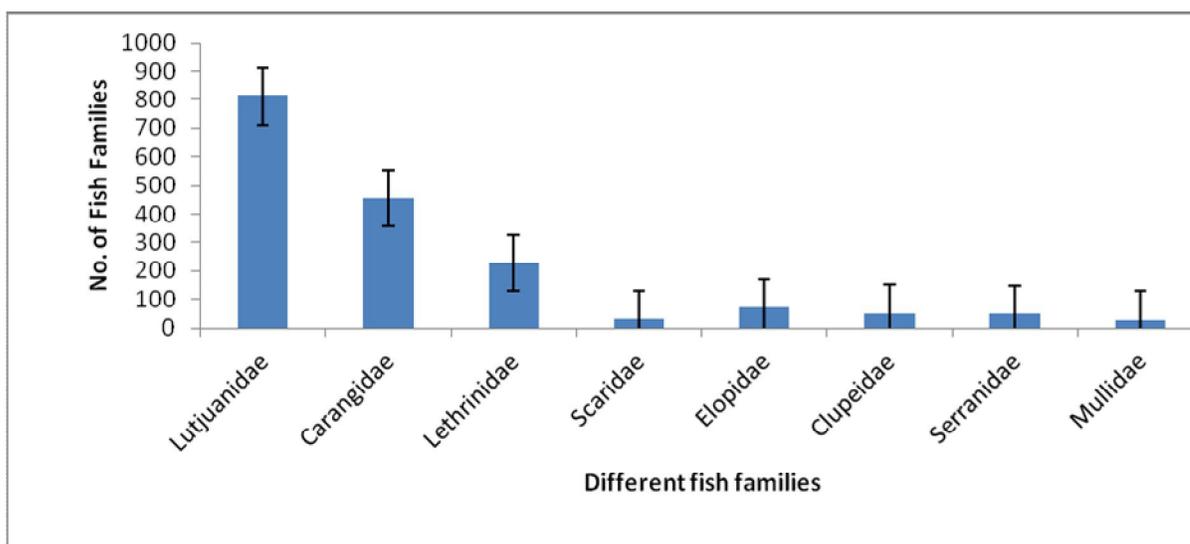


Fig.6b. Fish population harvested at Tudor Creek

Negative impacts on the coastal ecosystem may adversely affect the socio-economic activities of human population relying on the creek's marine resources. Alongside the restoration of marine life, mangroves are a major resource for the local inhabitants for income generation activities such as building poles, wood for boat construction as well as firewood among other uses. These activities were evidenced through the rampant mangrove logging along the Creek (Fig.2). Mikindani had the highest floral species diversity that accounted for 60%. *R. mucronata* was the most diverse with an index of 0.75 and 0.57 for Mikindani and Moroto, respectively (Table 1).

Table: 1 Mangrove species distribution among transect, where (-) denotes non-existence

	Mikindani				Moroto			
	<i>R. mucronata</i>	<i>C. tagal</i>	<i>A. marina</i>	<i>S. alba</i>	<i>R. mucronata</i>	<i>C. tagal</i>	<i>A. marina</i>	<i>S. alba</i>
<b>1<sup>st</sup> Transect</b>	<b>0.76</b>	<b>0.36</b>	-	<b>0.28</b>	<b>0.76</b>	-	<b>0.05</b>	-
<b>2<sup>nd</sup> Transect</b>	<b>0.76</b>	<b>0.29</b>	<b>0.09</b>	<b>0.18</b>	<b>0.69</b>	-	<b>0.11</b>	-
<b>3<sup>rd</sup> Transect</b>	<b>0.75</b>	-	-	<b>0.34</b>	<b>0.43</b>	-	<b>0.62</b>	<b>0.2</b>
<b>4<sup>th</sup> Transect</b>	<b>0.74</b>	-	-	<b>0.1</b>	<b>0.39</b>	-	<b>0.64</b>	-

The corresponding dominance indices were 3.674 and 1.853, respectively. *C. tagal* was present only in Mikindani with diversity and dominance indices of 0.33 and 0.0048, respectively. *C. tagal* was uniquely found inhabiting transects furthest from shoreline while *R. mucronata* and *S. alba* predominated the shoreline. The biodiversity index of *C. tagal* in the transect next to shoreline was 0.36 with adjacent transects recording 0.29. *S. alba* accounted for 0.02% and 0.4% of Mikindani and Moroto mangrove populations, respectively (Fig. 4).

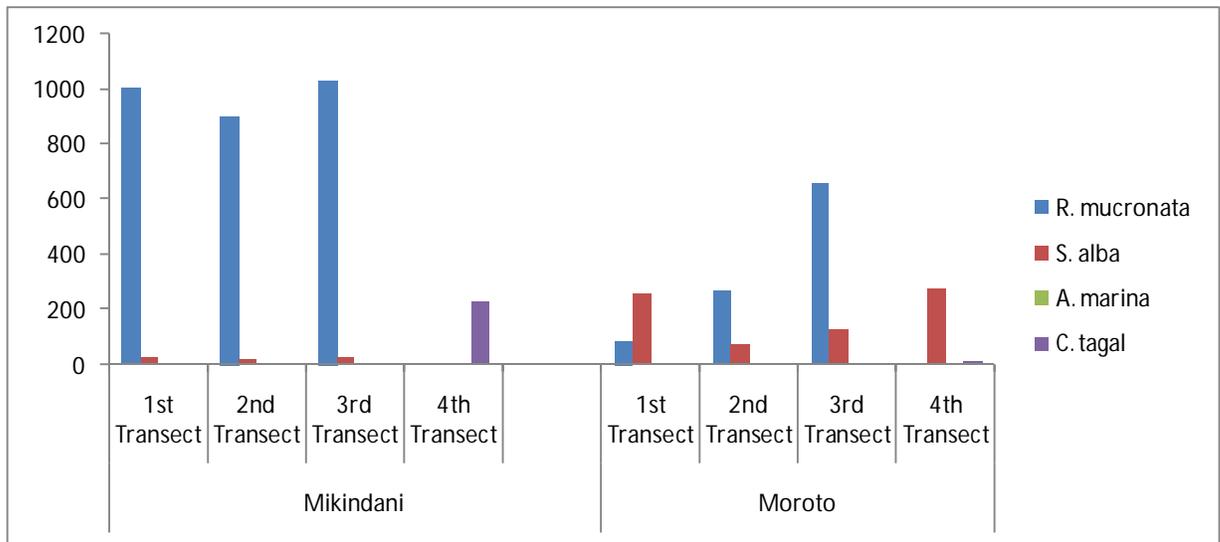


Fig. 4. Mangrove distribution in transects at Moroto and Mikindani sampling sites

- A. *marina* suffered losses due to logging and its exploitation resulted into large areas of mangrove forest depletion (Fig. 2a). Similar observations were made by Ewel *et al.* (1998) who observed that different kinds of mangrove forests provide different goods and services that prompted their exploitation. It was also more dominant in Moroto with an index of  $8.55 \times 10^{-1}$  while Mikindani had  $4.00 \times 10^{-6}$ . Comparison of diversity indices revealed that *A. marina* was more diverse in Moroto (0.36) than Mikindani (0.09). However, *R. mucronata* was the most desirable mangrove species for silvicultural practices and reforestation activities because of its fast growth and viviparous seeds (Fig. 5a).

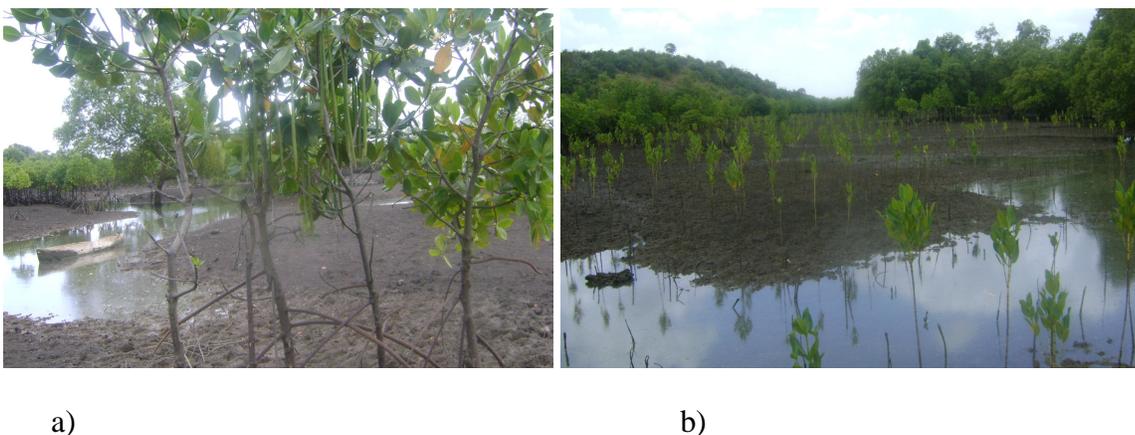


Fig. 5a,b: Photograph of viviparous *R. mucronata* seeds and re-forested pilot site

Estimates of the annual economic value of mangroves have been made based on the cost of products and services they provide (Gilman *et al.*, 2008). By 2006, the cost of mangrove products and services were estimated to be within the range of US\$ 200,000 – 900,000 ha<sup>-1</sup> (Wells *et al.*, 2006). Elsewhere, the cost of mangrove restoration has been estimated to be about USD 225 – 216,000 ha<sup>-1</sup>. This cost was exclusive of the cost of land for mangrove restoration (Lewis, 2005). The value of mangroves based on storm protection and flood control in Malaysia was estimated to cost US\$ 300,000 km<sup>-1</sup> of coastline. This cost was based on the replacement of mangroves with rock built walls to guard against stormy waves and flooding. The value of mangroves on Moreton bay in Australia was valued at US\$ 4,850 ha<sup>-1</sup> based on the catch of marketable fish (Ramsar Secretariat, 2001). Equally, the value of mangroves can be estimated based on the cost of restoring or enhancing coverage of the deforested shoreline. A pilot reforestation programme has been initiated through this study at Mikindani to conserve *R. mucronata* mangrove trees. Due to the demonstrated high value of mangroves, an attempt to initiate a planting program at the Mikindani site was undertaken during the research project implementation period (Fig.5b). Poachers log mangrove trees within the ecosystem for various uses thus creating the need to institute conservation measures to secure the rare *R. mucronata* mangrove species along Tudor Creek. Similar attempts have been made in Thailand where it is reported that the cost of mangrove restoration was estimated to be US\$ 946 ha<sup>-1</sup> while the cost of protecting existing mangroves was US\$ 189 ha<sup>-1</sup> (Ramsar Secretariat, 2001). The provided body of information demonstrates that it is cheaper to protect existing than restore depleted mangrove forest.

Natural aquatic systems may extensively be contaminated with heavy metals released from domestic, industrial and agricultural activities (Conacher *et al.*, 1993). Analysis of chemical pollutants demonstrated the presence of heavy metals in water, soil as well as faunal  
cles as demonstrated by X-ray fluorescence spectrum (Fig. 8).

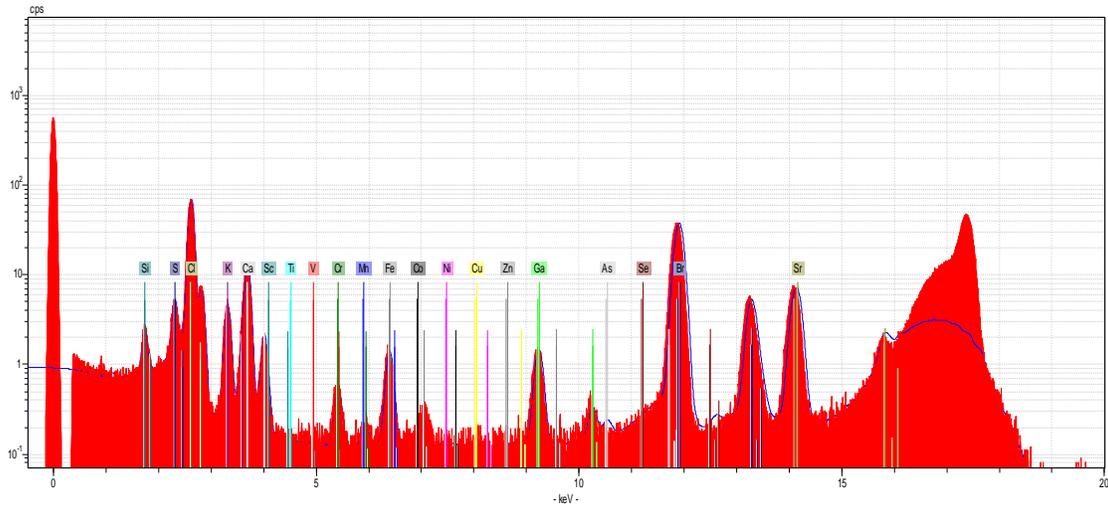


Fig.8. Typical TXRF spectrum (log scale) for heavy metals detection in water samples  
 The three hotspots reported significant concentrations of Ti, V and Cr at 0.15 mg/L while Ni, Cu, Zn, Pb and As in water were below detection levels set at 0.05 mg/L. (Figs. 9 and 10)

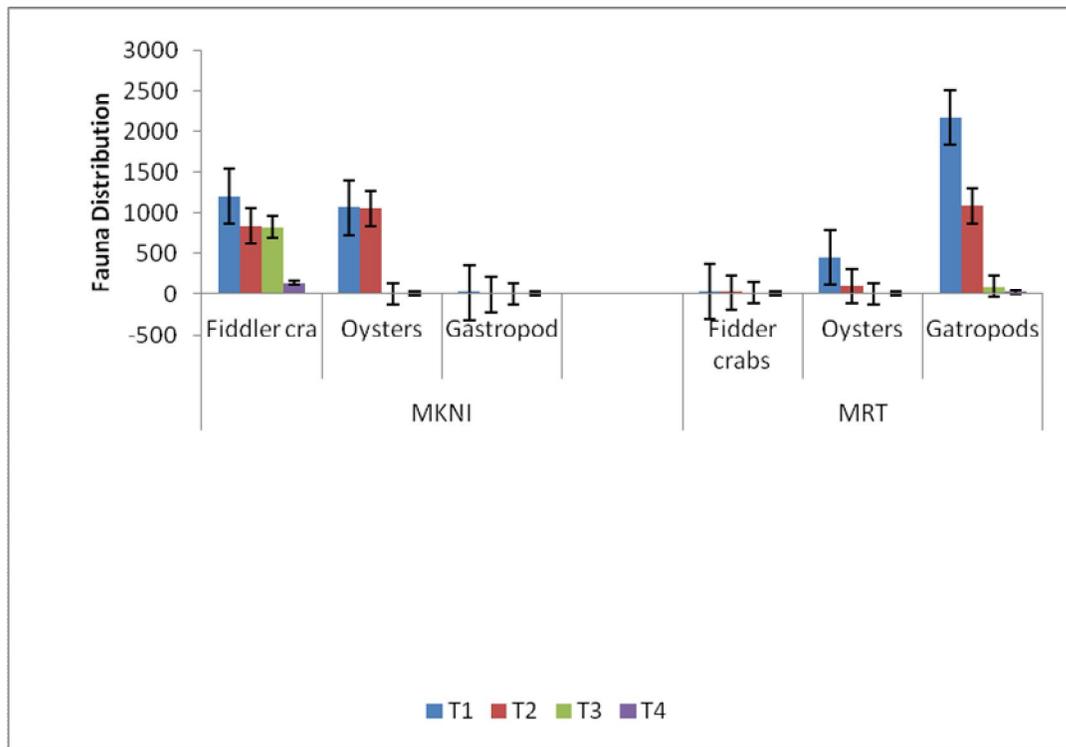


Fig. 9: Fish families landing in Moroto and other faunal groups along Tudor Creek

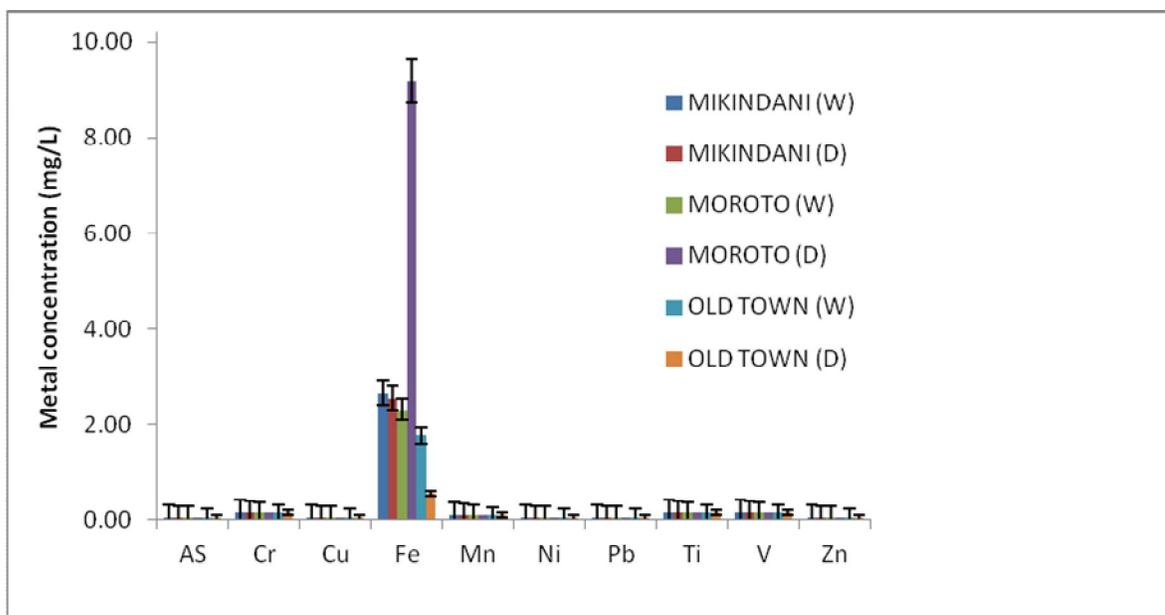


Fig.10: Heavy metal concentrations in water during wet (w) and dry (d) seasons.

On one hand, Fe concentrations were quite significant in water samples during the wet and dry seasons (Fig. 9). On the other hand, large Mn, Zn, Pb and Cu concentrations were observed in soil samples too during the dry and wet seasons (Fig. 10). Significant concentrations of Ti, V and Cr at 0.15 mg/L were recorded in Tudor Creek water samples (Fig. 9). Ni, Cu, Zn, Pb and As were below detection levels set at 0.05 mg/L of water samples. Similarly, Pb and Cr were below detection levels of 0.05 mg/L in fish and oyster muscles. The detection of significant heavy metal concentrations in both water and faunal muscles demonstrate the effect of background heavy metal contamination on the health of the aquatic organisms with the potential of bioaccumulation in the food chain (Szefer *et al.*, 1997). Faunal muscles, had Fe as the most abundant heavy metal, especially among gastropods, crabs and oysters (Table 3).

**Table 3. Heavy metals concentration ( $\mu\text{g/g}$ ) in faunal muscles. Means with same letters are not significantly different from each other ( $p < 0.05$ )**

Fauna		Cu	Cr	Fe	Mn	Pb	Ti	Zn
Crustacean	Fiddler crab	53.30 $\pm$ 1.20 <sup>m</sup>	<0.10	1863.00 $\pm$ 26.0 <sup>v</sup>	31.40 $\pm$ 1.20 <sup>j</sup>	<0.05	71.00 $\pm$ 2.60 <sup>o</sup>	38.40 $\pm$ 0.90 <sup>l</sup>
	Prawn	33.80 $\pm$ 0.80 <sup>k</sup>	7.94 $\pm$ 1.03 <sup>c</sup>	257.00 $\pm$ 130 <sup>f</sup>	4.13 $\pm$ 0.86 <sup>b</sup>	<0.05	9.70 $\pm$ 1.66 <sup>cd</sup>	24.70 $\pm$ 0.69 <sup>i</sup>

<b>Fish family</b>	Carangidae	<0.05	<0.10	96.70± 1.80 <sup>p</sup>	1.94± 0.71 <sup>a</sup>	<0.05	3.31± 1.40 <sup>b</sup>	14.00± 0.52 <sup>e</sup>
	Lethrinidae	<0.05	<0.10	386.00± 9.00 <sup>s</sup>	22.80± 3.10 <sup>hi</sup>	<0.05	34.00± 5.40 <sup>kl</sup>	19.60± 1.50 <sup>gh</sup>
	Lutjanidae	<0.05	<0.10	157.00± 3.50 <sup>q</sup>	3.81± 0.93 <sup>b</sup>	<0.05	7.66± 1.87 <sup>c</sup>	11.80± 0.63 <sup>d</sup>
<b>Mollusks</b>	Gastropod	21.50 ± 1.00 <sup>h</sup>	65.30 ± 2.90 <sup>n</sup>	721.00± 13.00 <sup>u</sup>	8.33± 1.34 <sup>c</sup>	<0.05	37.90± 3.20 <sup>l</sup>	10.60± 0.70 <sup>d</sup>
	Oyster	15.00 ± 1.10 <sup>ef</sup>	<0.10	461.00± 8.00 <sup>t</sup>	17.10± 1.90 <sup>fg</sup>	<0.05	31.50± 3.70 <sup>k</sup>	406.00± 15.00 <sup>s</sup>

Cu was also detected in gastropod and oyster muscles at concentration ranges between 15.0-53.3µg/g though not high as those of Fe. Mn, Zn and Cu were detected within a concentration range of 1.94-99.5 µg/g in fish muscles. However, Hg, Cd and As were not detected (Table 3).

Heavy metal contamination may have devastating effects on the ecological balance of the recipient environment and diversity of aquatic organisms including fish (Farombi *et al.*, 2007). High concentrations of Fe recorded in gastropod muscles has the potential of being used as a nutritional supplement, especially among expectant mothers and children. Clearing of mangroves hamper the flourishing of marine life that includes fish. The fishing industry is critical since it provides fish, a known source of proteins besides being a source of income and thus plays an important role in economic empowerment for livelihoods among Creek inhabitants. Findings on biomass accumulation from mangrove inhabited sites are supported by those of Mumby *et al.* (2004) who reported that marine flora have the potential of enhancing biomass of coral reef aquatic life and fish communities in the Caribbean.

Marine faunal resources such as fishes represented by *Lutjanus argentimaculatus* and *Gymnocranius elongates* alongside oyster species such as *Crassostrea gigas* and crabs like *Goetice depressa* and *Leptodius exaratus* are among the dominant faunal groups harvested and marketed along Tudor Creek (Fig. 7a&b).

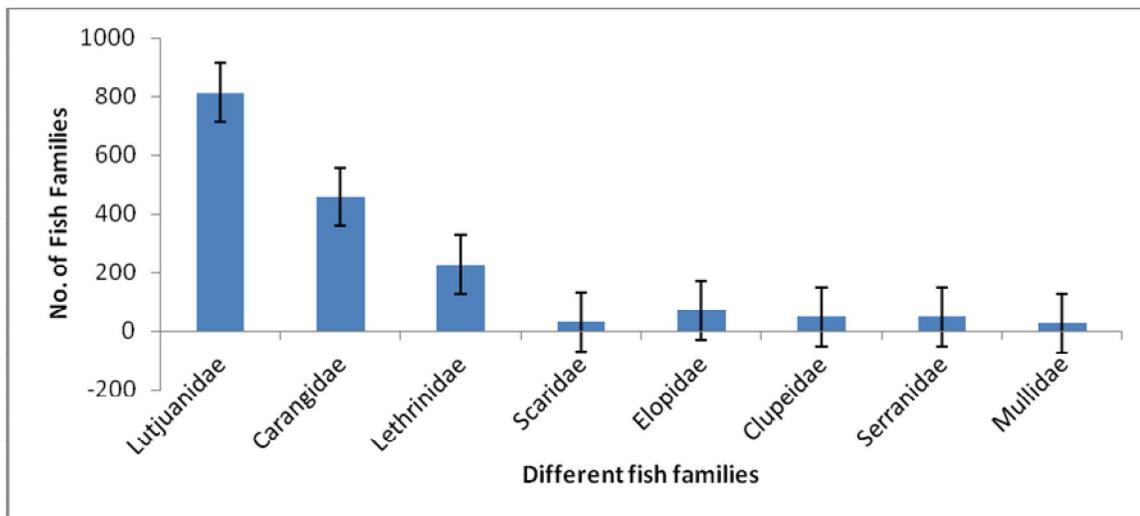


Fig.7a. Marketable fish landing in Moroto

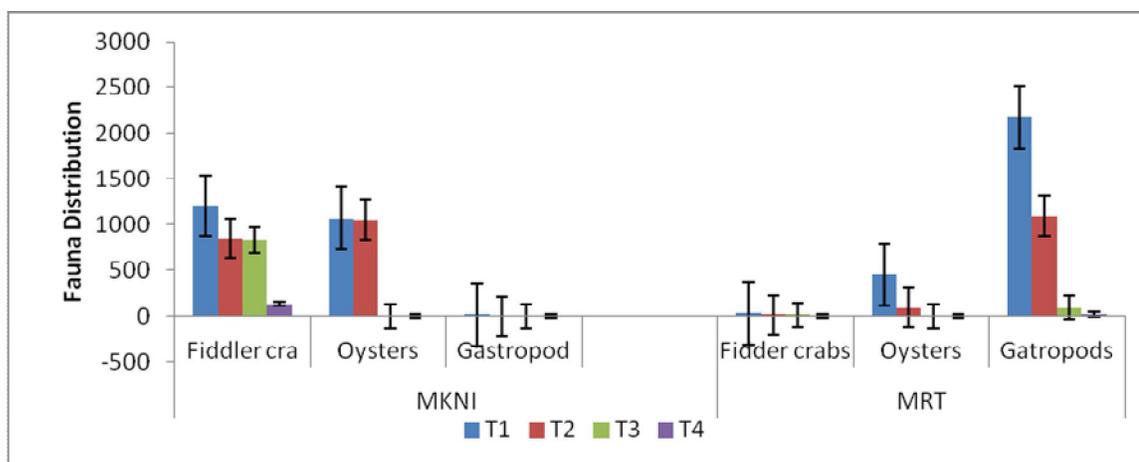


Fig.7b. Crustaceans and Mollusks in Mikindani and Moroto (T=Transect)

The study revealed that crabs were the most abundant faunal group accounting for 40% followed by oysters that comprised 25% while gastropods made up 15%. The detection of high concentrations of some heavy metals in muscles of these delicacies present potential health risk among the populations dependent on them for nutritional provision. Concerns regarding nutritional provision while guarding against bioaccumulation of heavy metals in aquatic organisms inhabiting polluted environments have similarly been expressed by Narayanan (2008). Elsewhere, attempts have been made to use aquatic organisms like fishes and sea dwelling birds such as *Calomectris diomedia* as biomarkers through tracking of specific indicators to monitor heavy metal pollution (Narayanan, 2008; Renzoni *et al.*, 1986).

Mangrove ecosystems are considered highly productive by functioning remarkably well in various ecological processes and climate change mitigation. This consideration has been underscored through the identification of desirable species with silvicultural practices for reforestation as has been demonstrated at the Mikindani site (Fig. 5a&b). It is also worth noting that mangrove eco-systems have the capacity to act as a sink or buffer to remove or immobilize metals. Mangrove species like *R. mucronata* could have played a critical role in phytoremediation of the Mikindani site, thus resulting into low heavy metal concentrations in both soil and water samples. Notwithstanding the above, mangroves have the potential of mitigating climatic changes by acting as carbon sinks through carbon sequestration. Different categories of non- and biodegradable solid wastes were enumerated. The highest proportion of solid wastes reported in Mikindani comprised of dry twigs and leaves with a negligible number of polythene bags as well as plastic bottles. Solid wastes in Moroto were predominated by plastic bags and bottles whereas Old Town recorded the highest number of solid wastes comprising of plastic bottles, old tyres, old clothes and sandals (Fig. 11).

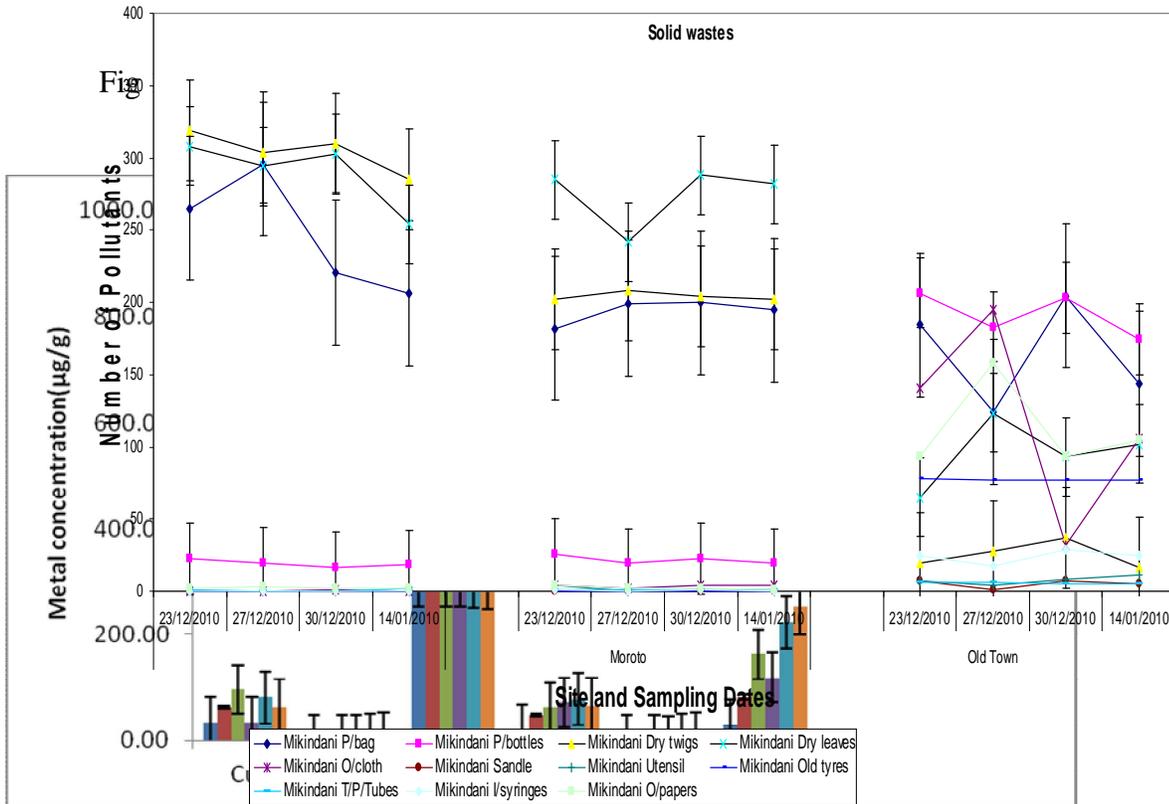


Fig. 11: Heavy metals concentrations in soil during wet (w) and dry (d) season  
 Establishment of informal settlements resulted into open sewage systems with negative effects on ecological balance and human health (Fig. 3a & b).



Fig. 3a. Informal Settlement at Moroto



Fig.3 b). Open sewage system at Moroto

Some of the open sewage systems were exploited for agricultural crop production because of the high plant nutritional resources emanating from the decomposing organic matter (Fig. 3b). Besides the raw effluents being sources of environmental pollution, they provided possible suitable breeding sites for disease causing vectors like mosquitoes that transmit malaria. Microbial investigation employing nutrient agar and Mackonkey broth supported growth of microbial cultures. Sub-cultures in xylose lysine deoxycholate subjected to Gram staining revealed the presence of *Citrobacter* and *Enterococci* in Old Town water and soil samples. *Pseudomonas* was most predominant in Moroto soil sample while water was predominated by *Escherichia coli* and *Enterococci* (Table 2). Inoculation of known quantities of soil and water samples revealed diverse growths of microbial communities that were quantified using direct counting methods and most probable numbers (MPN) of the microbial cells based on colony forming units.

**Table.2. Microbial communities in soil and water samples from the study areas**

Site	Sample	Replicate	Growth (NA)	Growth in Mac broth	Growth inXLD	Gram reactions	Probable organisms
Old Town	Water	1 <sup>st</sup>	+	+	+	-ve rods	<i>Citobacter</i>
		2 <sup>nd</sup>	+	+	+	-ve rods	<i>Citobacter</i>
	Soil	1 <sup>st</sup>	+	+	-	+ve cocci	<i>Enterococci</i>
		2 <sup>nd</sup>	-	-	-	NA	NA
Moroto	Water	1 <sup>st</sup>	+	+	+	-ve rods	<i>E. coli</i>
		2 <sup>nd</sup>	+	+	-	+ve cocci	<i>Enterococci</i>
	Soil	1 <sup>st</sup>	+	-	+	-ve rods	<i>Pseudomonas</i>
		2 <sup>nd</sup>	+	-	+	-ve rods	<i>Pseudomonas</i>
Mikindani	Water	1 <sup>st</sup>	-	-	-	NA	NA
		2 <sup>nd</sup>	-	-	-	NA	NA
	Soil	1 <sup>st</sup>	-	-	-	NA	NA
		2 <sup>nd</sup>	-	-	-	NA	NA

The role of microbes in biodegradation of solid wastes cannot be underestimated. It is known that microbes have a critical role to play in remediation of environments infested with high concentrations of heavy metals (Bruins *et al.*, 2000 and Chouari *et al.*, 2003). Deployment of both plants and organisms especially bacteria in an attempt to break down pollutants to usable nutrients while converting them to less harmful forms for plant uptake is a bioremediative scientific pathway that is quite noble and offers a great promise for future phytobioremediation programmes (Challis, 2008). The detection of *Pseudomonas* in soil sampled from Moroto that also exhibited high concentrations of heavy metals demonstrated some level of correlation which led to the speculation that the organisms could have played a major role in the detoxification of chemical pollutants. Elsewhere, radiation resistant bacteria such as *Deinococcus radiodurans* are reported to be used in cleaning of soil and water bodies contaminated by toxic radioactive wastes (Wolfe-Simon *et al.*, 2010). The development of biotechnologically modified *Pseudomonas putida* by incorporating both mercury detoxifying and toluene-degrading genes as bioremediative agents has been reported (Duruibe *et al.*, 2007). Old Town recorded gram negative rods, *Citrobacter*, *Enterobacteriaceae* family with heavy metal accumulation potential by building phosphate complexes. It is worth

noting that two gastrointestinal bacterial species, *Escherichia coli* and *Enterococci* were also recorded in Moroto water samples. It was noted that raw domestic sewage loaded with human fecal material was discharged directly into the ocean water. The water quality signified by high turbidity values, low dissolved oxygen are indicators of stressful aquatic environment. It is worth noting that water quality determined by pH, turbidity, dissolved oxygen, conductivity and other physico-chemical parameters had a role to play in influencing microbial, faunal and floral biodiversity. It is apparent from the generated information that both human activities as well as climate change effects impacted adversely on Tudor Creek ecosystem.

#### **4.0 Project Outputs**

After identifying and elucidating the environmental conditions along Tudor Creek:-

- Engagement in research relating to environmental protection along the Tudor Creek provided information on the level and type of pollutants in the area.
- The generated information has highlighted the potential health risks associated with the heavy metal contamination that could build along the food chain especially through fish consumption.
- Direct engagement of the community in re-afforestation programmes as well as creation of awareness on the economic potential of mangrove species alongside proper management of wastes and the disposal systems can contribute towards the improvement of Tudor Creek environmental condition for sustainable livelihood enhancement.
- The characterized microbial communities associated with the ecosystem gave indication that they could be playing a role in the biodegradation of the pollutants and thus acted as bioremediation agents.
- The recording of a large diversity of both flora and fauna is an indication that the environment even though polluted is an important ecological niche which needs to be sustainably exploited for the benefit of the inhabitants.

#### **5.0 Conclusions**

The survey revealed that Tudor Creek is rich in faunal and floral biodiversity that is adversely impacted upon by both anthropogenic activities and climatic changes. The effects of these factors threaten socio-economic aspects and environmental sustainability of the ecosystem. It is therefore necessary to establish a well coordinated and concerted effort to sustain livelihoods of the local inhabitants while conserving the Tudor environment.

## 6.0 Recommendation

Given the natural and induced negative impacts on Tudor Creek ecosystem, it is recommended that:-

- Awareness of pollution detrimental effects should be made so as to enhance advocacy.
- Sorting, treating and disposing and recycling of biodegradable wastes should be encouraged.
- Establishment of settlements close to the shoreline and waste disposal along the Creek should be discouraged and suitable alternative sites identified.
- The Mombasa municipality, industries, factories and domestic should adequately treat wastes before discharging into the creek waters.
- Mangrove logging should be discouraged and conservation programmes such as mangrove reforestation initiated along the Creek.

## 7.0 Acknowledgement

The Tudor Creek Rehabilitation for Sustainable Livelihood Enhancement Research Project was undertaken by Mombasa Polytechnic University College scientists and technicians. The researchers appreciate the financial support offered by National Council for Science and Technology through Research Grant- NCST/5/003/0396. The authors acknowledge the technical assistance of Mr. Ali Kanga, Ms. Monica Mwangi and Ms. Stellamaris Mutuku.

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### **S2012-16: Analysis of Air Pollution in Naivasha**

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## **S2012-18: Assessment of the Environmental Impacts of Irrigation Water Use by Smallholder Farmers in Gem Rae Irrigation Scheme, Kenya**

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### **Abstract**

Kenya places a lot of emphasis on the reduction of poverty in order to improve livelihoods of her people. In order to accelerate this, the government of Kenya has adopted a strategy to revitalize Agricultural sector through irrigation development among other strategies. Irrigation provides the best option for intensification of agricultural production since options of achieving the same through rain fed agriculture are almost exhausted. The study reviewed experience with irrigation projects in Kenya with particular attention to smallholder irrigation in Gem Rae. It examined the environmental impacts such as siltation, soil erosion and public health impacts associated with irrigation development. The study used cross-sectional survey technique in which a sample of 119 smallholder farmers practising irrigation interviewed using a structured questionnaire. All chairmen of scheme management committees were involved in a group discussion. Data was analysed using frequencies and percentages as well as chi-square at 5% level of significance ( $\alpha=0.05$ ). The research revealed that impacts such as siltation, water borne diseases, soil erosion, water supply and loss of biodiversity were statistically significant. There was increased water borne diseases as result of irrigation development. This resulted in public health hazards, reduced labour supply and low scheme production levels. The research further showed that these impacts had adverse negative effects on the level of household rice production and household incomes to smallholder farmers in the study area. The research concluded that future development of smallholder irrigation need to factor in the social economic and environmental trade-off of irrigation in the suitability criteria for its development. The research recommended measures such as construction of earth dams, use of protective clothing, fish farming, issue of title deeds, construction of water intake and infrastructure development among others to mitigate the negative impacts for better management of irrigation schemes in Kenya for sustainable food production and poverty alleviation.

**Key words:** *Environmental impacts, smallholder farmers, poverty alleviation, sustainable food production, household incomes*

### **1. INTRODUCTION**

Kenya has a total land area of 582,646 square kilometres of which, about 99,050 square kilometres (17%) is classified as medium to high agricultural potential experiencing at least 700mm of rainfall per annum. The remaining 83% is classified as Arid and Semi-Arid Lands (ASAL) and needs some irrigation for meaningful farming to take place. Irrigation is necessary in order to increase food production to provide food security to support the rapidly growing population, and ensure economic growth in the dwindling land holdings of high to medium potential areas. To ensure household food security and improved living standards of the rural population, the government and donor agencies continue to support the development of smallholder irrigation schemes (Gichuki *et al.*, 1992). This is due to their ease of management and because they have direct impact on the livelihood of rural households.

Gem Rae irrigation scheme is one of the smallholder irrigation schemes in Kenya in which farmers' groups manage irrigation water on their own and share development costs among themselves. The farms are of variable sizes and are operated by farmer's organisation within the scheme. The area is within Lake Victoria basin. It receives a mean annual rainfall of 1250mm with peaks in April and November. The area is characterized by unreliable rainfall with constant floods, which displaces residents almost yearly. Other characteristics include resource degradation through soil fertility loss, destruction of natural vegetation and loss of biodiversity. Irrigation therefore became necessary, not only to increase agricultural production but also to control flood occurrence. The produce from the scheme is used to meet subsistence demands as well as for domestic market. However, most residents of this place and particularly those who practice farming as a full time occupation are still food insecure and live below poverty line. Increasing agricultural productivity will be necessary for increased food production and poverty alleviation in the area. Irrigation development can achieve this but only if it is done sustainably. The sustainability of irrigation projects depends on the taking into consideration of environmental effects as well as on the availability of funds for the maintenance of the implemented schemes (FAO, 1997).

The need for expansion of irrigation in areas with irrigation potential while encouraging introduction of supplemental irrigation in medium to high rainfall areas to guard against crop failure and ensure high quality produce is paramount. The Economic Recovery Strategy for Wealth and Employment Creation (2003-2007), targets the development and rehabilitation of irrigation schemes in the country to increase production of strategic crops such as horticulture, cotton and rice. The National Development Plan (2002-2008) also emphasizes creation of an enabling environment to accelerate irrigation development in the country. The Kenya vision 2030 document envisages a transformation of agriculture from the current practices to a more commercially oriented agriculture (GOK, 2007). The agriculture sector remains a key pillar of the Kenyan economy contributing about 25 percent of GDP. However, productivity in the sector is significantly lower (2-3 times) than international benchmark countries. The sector possesses additional opportunities to unlock potential of Kenyan land with a strong need for legal and institutional reforms. Among other areas, the document proposes a strategy to prepare new lands for cultivation by strategically developing irrigable areas of Arid and Semi-Arid Lands (ASALs) for both crops and intensified livestock production. It also proposes an increased access to markets particularly to small holders through establishment of aggregators. The aggregators are expected to greatly

improve the supply chain, eliminate middlemen and hence benefit the farmer through higher producer prices.

However, it is important to observe that irrigation activities, whichever type practiced is likely to affect the natural ecological systems in the irrigation areas. This could adversely affect human beings, plant and animal life (Odhiambo *et al.*, 1991). These effects on natural ecological systems are referred to as environmental impacts. These impacts may be positive or negative and can be socio-cultural, physical, biological or chemical (Yabann, 1996). The benefits of irrigation are many and include food security, increased incomes, and employment creation among others. The negative impacts may affect food production, the very commodity irrigation was designed to achieve. Despite the growing evidence on the environmental impacts of irrigation, many governments look to irrigation schemes for improving food security of the country; improving incomes of the peasant farmers, and contributing to the development of the national economy (Haile, 1988), without paying adequate attention to the social, cultural and environmental sustainability of the scheme.

This paper reviews the environmental impacts associated with irrigation water use in Gem Rae irrigation scheme and how they can be mitigated for sustainable development of irrigation activities to enhance household food security.

### **1.1 Statement of the Problem**

Gem Rae experiences unreliable rainfall, resulting in many farming households languishing in poverty. One possible way of improving food security /household income levels given that agriculture is the major economic activity in Kenya is to explore the possibility of practising irrigated agriculture extensively. The Kenya Government has expressed concern on this and has consequently developed a strategy to revitalize agriculture through revamping collapsed irrigation systems and encouraging development of smallholder irrigation. But many farming households in the irrigated areas such as Gem Rae are still food insecure and continue to live below poverty line. The use and ultimate expansion of irrigation is however associated with some environmental impacts which are believed to affect the yields. The environmental impacts include siltation, soil erosion, water logging, socio-economic and public health impacts. This study investigated the extent to which these environmental impacts affect food production and consequently household incomes in the study area.

### **1.3 Significance of the Study**

The government of Kenya has embarked on a strategy to revitalize agriculture in order to increase food supply and create employment at household levels. But this strategy has been crippled by unreliable and inadequate rainfall in most parts of the country, necessitating the need to increase water use through artificial supply in order to supplement the inadequate rainfall in order to improve agricultural yields. The intensification of agriculture is necessary through use of appropriate technologies of which irrigation is one of them. This means that new irrigation projects will have to be established, whereas the existing ones will have to be expanded to meet this demand. However, massive expansion of irrigation projects has both positive and negative impacts, which are thought to have a direct bearing on food production levels. Although some of these impacts have been documented in literature, it is worth noting that some environmental impacts are site specific and differ in magnitude. The study reviewed the environmental impacts of irrigation water use in Gem Rae irrigation scheme. The study examined the extent of environmental impacts on sustainable food production and by extension food security in the study area.

## **2.0 STUDY AREA AND METHODOLOGY**

### **2.1 Study Area**

The study was carried out in Gem Rae irrigation scheme. The site was chosen for the study because it is a smallholder irrigation scheme: irrigation management system that has shown tremendous expansion in Kenya and is managed by individual farmers. The scheme also practices flood/basin irrigation, a system that is believed to be associated with a lot of environmental consequences.

Gem Rae is a rice-growing scheme close to Lake Victoria, about 30 kilometres from Kisumu. It is in North Nyakach Location, Nyakach district, Kisumu County, Kenya. The water source for the scheme is the River Awach. Topography across the scheme is flat with an average gradient of about 0.5% and prior to irrigation the area was mainly wetland with periodic flooding. The prevailing soils across the scheme are medium to heavy, dark grey or black clay soils suitable for rice cultivation. The scheme is in the lower midlands agro-ecological zone classified as humid/arid. Mean annual precipitation is 1250mm with peaks in April and November. The rainfall pattern is highly variable, however, with monthly maximum typically two or three times the mean.

Temperatures are fairly constant throughout the year with monthly maximum ranging from 25°C and 35°C.

The current irrigated area is approximately 90 ha with a total of 270 plots averaging 0.3 ha. There are 250 landowners. A further 28 ha is occupied by out growers on the fringe of the scheme making use of excess water from Gem Rae and flow in the river downstream of the intake.

## **2.2 Research Methodology**

The study employed a cross-sectional survey research design to collect data from the sample size of 120 smallholder farmers. This type of design involves data collection in only one survey round (Casley & Kumar, 1988). Surveys are important in research and have been found to be effective in describing characteristics of population under study (Kathuri & Pals, 1993; Fraenkel & Wallen, 2000). They are cost effective and also exploratory enabling the researcher to make inferences though not to the level of cause and effect (O'Connor, 2002).

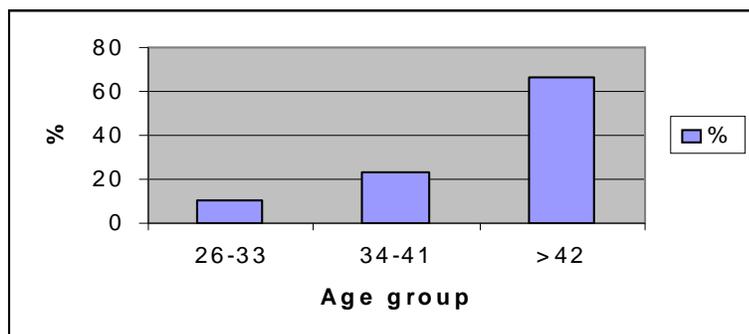
The collection of primary data relied on a rapid assessment procedure using structured questionnaire addressed to farmers within the study area and interview schedule to guide a focus group discussion with leaders of scheme management committees. Data was collected at one point in time from a purposive sample of 119 households. Simple random sampling was done on the sample frame to select the required sample. The data was then summarized, coded and entered into the computer where analysis of quantitative data was done using the Statistical Package for Social Sciences (SPSS). Frequency and percentages were used for descriptive statistics while Chi-square at 5% level of significance was used for inferential statistics. Qualitative data from focus group discussion was analysed using checklist.

## **3.0 GENERAL CHARACTERISTICS OF SMALLHOLDER FARMERS IN THE STUDY AREA**

### **3.1 Age Distribution of the Farmers.**

About 23.5% of the farmers interviewed indicated that they were between the ages 34 – 41 years. This is a prime age when the farmers are active and can work for long hours and for many years.

This is an important aspect for sustainable food production. Such people are also ready to adopt technologies delivered to them. Figure 1 present the frequencies and percentages of age group of the farmers interviewed. Farmers who are within the age group 18 – 43 years tend to be more active in practical, as compared to older farmers. It can however be seen from Figure 1 that majority of the farmers interviewed (66.4%) had the age of forty-two years and above. This is an aging group and may be detrimental to sustainability of production. However, groups with majority of members within similar age group are expected to be more effective. This is because members of the same or similar age group tend to have similar interests.



**Figure 31: Age of the farmers**

### 3.2 Length of Time Stayed on the Farm

About 33.6% of the farmers interviewed had stayed in the scheme for over forty-one years whereas about 51.1% of women farmers interviewed said that they had stayed in the scheme since marriage. Farmers were asked to indicate the number of years they had stayed in the scheme. This one was done to determine the originality of the respondents. This would then be used to gauge the sustainability of rice production in the scheme. This is because the original inhabitants of the scheme are likely to spend their entire lifetime there and would like to reap the benefits of the scheme for long. This may be as opposed to the emigrants who may not have incentive to improve land for production. Most of the respondents were found to be original residents of the scheme. Table 1 presents the length of time the farmers had stayed in the scheme.

**Table 4 : Length of time the farmers had stayed in the scheme**

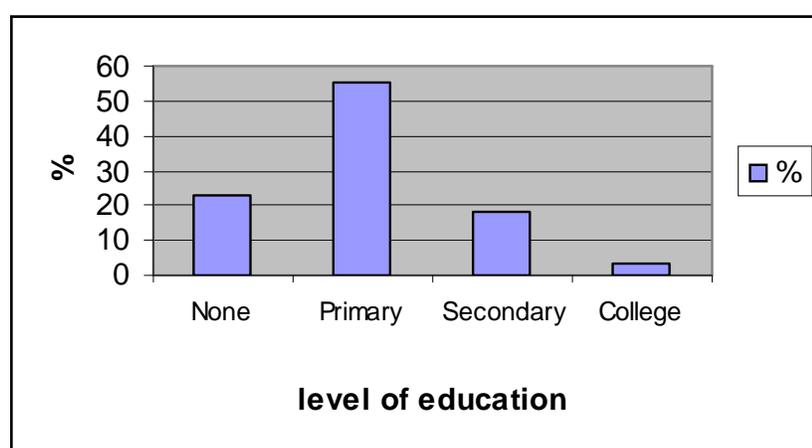
Time (years)	Percentage
21-30	2.5
31-40	11.8
>41	33.6

**Total**

**100**

**3.3 Level of Education of the Respondents**

About 55.0% of the farmers interviewed had at least primary level of education and another twenty-two farmers (18.5%) had secondary school level of education. Those with secondary level of education and above were 21.9%. Figure 2 presents the frequency and percentages of these levels of education of farmers. The farmers with high level of education are expected to have high intellectual capacity. This high level of education enhances the understanding of information given and should also improve the farmer’s level of participation in agricultural activities.



**Figure 32: Level of education of the farmers**

**3.3 Gender Distribution**

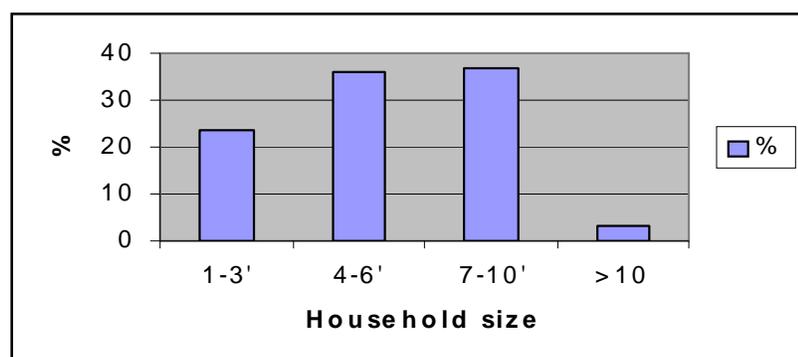
More than half of the farmers interviewed (53.8%) were female compared to 46.2% being male. The gender distribution of the farmers interviewed is shown in Table 2. This is an indication that women play a significant role in scheme management and operations, especially in situations where men are on off-farm employment or are looking after livestock. The intensification of agricultural production, which goes hand in hand with irrigation, results in considerably more work for smallholder households. Women were observed to be having bigger workloads, as they were also responsible for all domestic duties such as fetching water and firewood. Women were also represented in scheme management committee. This was observed since the treasurer of scheme management committee was a woman. However there is need for an increased representation of women in the scheme management committee since they are the majority. The traditional attitude of the scheme communities towards women’s roles needs to be investigated, so that appropriate approaches to encourage their participation are identified.

**Table 5: Gender Distribution of Farmers**

<b>Gender</b>	<b>Frequency</b>	<b>Percentage</b>
Male	55	46.2%
Female	64	53.8
<b>Total</b>	<b>119</b>	<b>100.0</b>

### **3.4 Household Size**

About 37.0% of the farmers interviewed had household size of between seven and ten people. 36.1% of the farmers interviewed had between four and six people in their households. Household size refers to the number of dependants in the household including children and relatives staying within a household. In many cases, the household size provides a measure of the availability of family labour for farming activities. However, with the large household sizes coupled with occasional poor crop harvests, most farmers indicated having problems in meeting food demand for the household members. Some farmers talked of caring for the children orphaned as a result of HIV/AIDS related infections. Figure 3 presents the household sizes of the farmers interviewed.



**Figure 33: Household sizes of the farmers**

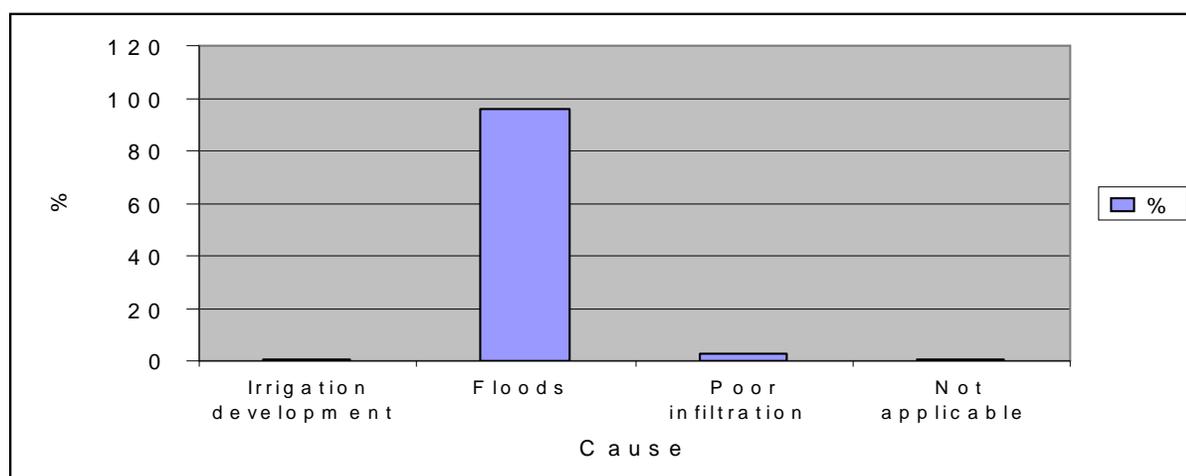
## **4.0 ENVIRONMENTAL IMPACTS IN GEM RAE IRRIGATION SCHEME**

### **4.1 Water Logging**

Flooding and drainage problems are normally experienced by irrigation schemes located in flat topography such as Gem Rae. About 97.5% of the scheme farmers interviewed mentioned that the problem results in increased number of mosquitoes and labour inputs. This leads to low crop production. The problem of water logging however does not entirely arise from scheme implementation but was already common to the area due to constant flooding as reported by about 95.8% of all the scheme farmers interviewed. The incidence of water logging was common during rainy season as a result of floods but since irrigation is carried out during dry season the few cases of water logging could not be linked to irrigation development, in any case irrigation development

play a role in flood control other than just to increase production of rice in the study area. The problem however interferes with scheme operation and performance through structural and crop damage. Some farmers especially those whose plots are adjacent to the river had since abandoned their plots due to floods.

About 78.1% of all the farmers interviewed said that they use dykes and bands around homes and rice fields to control floods. They however claimed that these measures were expensive in terms of labour input. About 20.2% of all the framers interviewed would leave the water to drain naturally due to lack of finance to engage labour. Figure 4 presents the causes of water logging in the scheme.



**Figure 34: Causes of water logging**

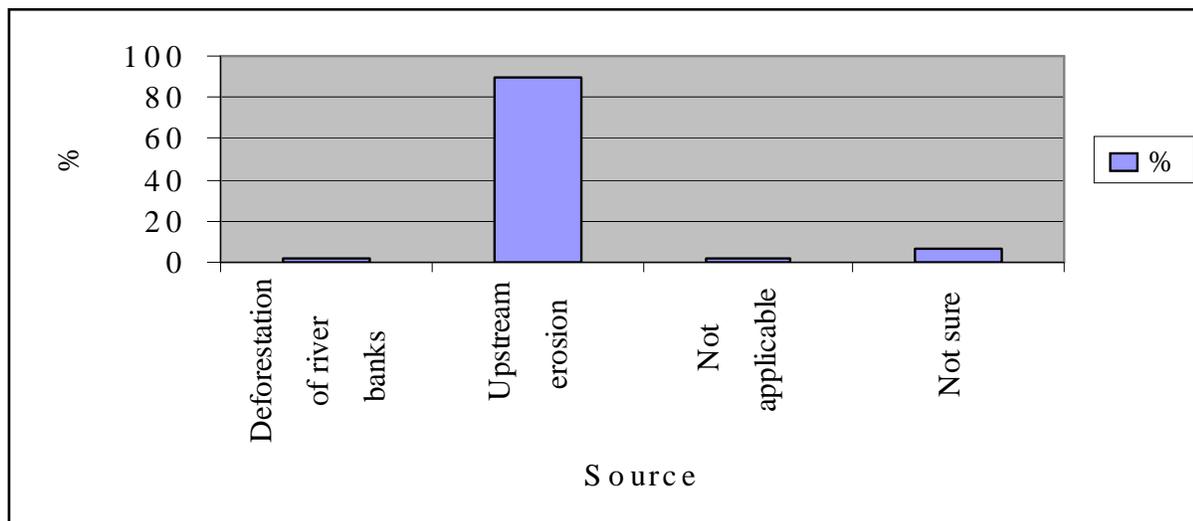
**4.2 Siltation**

Siltation of canals was found to be a very big problem in Gem Rae irrigation scheme. This was particularly evidenced by an intake at River Awach that has since been abandoned due to high load of silt. Farmers found it labour intensive to keep on de-silting every planting season leading to abandonment of the intake. Siltation is mainly dependent on the origin of the irrigation water, which determines the sediment load but can also be influenced by other factors such as poor maintenance of canals and destruction of canal by livestock

About 89.9% of all the farmers interviewed blamed the problem on poor farming methods upstream, leading to collapse of riverbanks hence high sediment loads. When asked to respond on the extent of the effect of siltation on farm activities, 91.6% of all the farmers interviewed reported that the effect was negative with increased seriousness of flooding and water shortage in the scheme.

Field observations show a build up of sediments in slower moving areas of the water channels and a shrinking of the river in sections close to irrigation main canals. These results corroborate the findings by Urama (2005) that indicated that the water flow rates in the headrace canal are higher than in the secondary canals, thus sediments settle out in areas where the flow velocity decreases, changing the river flow regime. These changes are partly responsible for water supply problems especially to the downstream users. Frequent clogging of irrigation abstraction structures by soil sediments during the life of the projects was reported by farmers.

However, a positive effect is the deposit of nutrient carrying silt in the scheme plots that replenishes the soil nutrient content, improving crop performance. On the estimated cost of maintaining these canals during plating season, 70.6% of all the farmers interviewed said that the cost was high since de-silting 20 metres of canal would cost about Kenya shillings 100 . This increases the cost of production. Figure 5 highlights the sources of silt in the scheme.



**Figure 35: Sources of silt**

**4.3 Water use conflicts.**

Irrigation water shortage was found to be a problem to many farmers in the scheme. This problem was mentioned by about 96.6% of the farmers interviewed. The problem is mostly encountered towards the end of the growing season, which coincides with low water supply by the river. During this period, conflicts within the scheme and with surrounding non-scheme farmers are common. Most of the conflicts reported were resolved through negotiations between the parties involved at the local level and by agreeing to adopt and enforce rules. Farmers interviewed mentioned water

use conflicts with upstream water users, whom they held responsible for creating serious shortages during the dry season due to poor abstraction methods.

Reports by some farmers indicated that these conflicts sometimes degenerated into physical confrontation. These results support findings by Chambers and Garwood (2000) that irrigation return flow pollutes river and streams, which are the only source of water for drinking, fishing, and swimming for the rural population. This leads to conflicts between irrigators and other users of irrigation facility, including fishermen and other farm households. Table 3 presents causes of water supply problems on the Scheme.

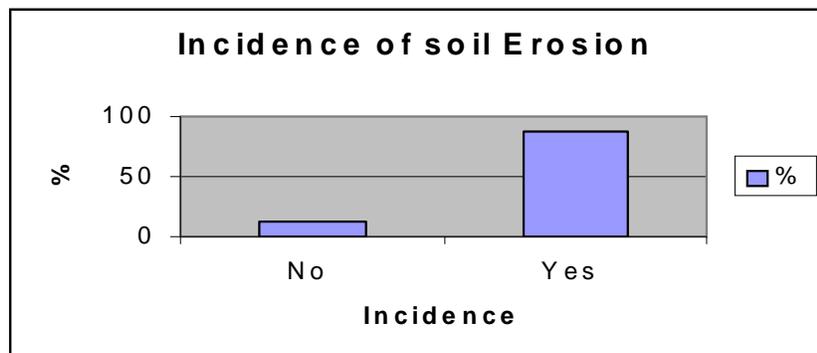
**Table 6: Causes of water supply problems**

<b>Cause of water problem.</b>	<b>Frequency</b>	<b>Percentage</b>
Conflicts (high demand) & dry season	68	57.2
Canal siltation	41	34.4
Dry season & canal siltation	3	2.5
Insufficiency & conflicts	2	1.7
Lack of uniformity in planting	1	0.8
None	4	3.4
<b>Total</b>	<b>119</b>	<b>100.0</b>

#### **4.4 Soil Erosion**

Soil erosion occurs in many parts of the country, due to improper agricultural land use, overgrazing, and bush clearing. The development of smallholder irrigation schemes may in many cases; influence the reduction of accelerated soil erosion, since irrigation plots are intensively cultivated and some form of bench terracing for erosion control has been introduced. However, erosion caused by scheme development may occur due to overgrazing around the scheme, destruction of irrigation structures by farm animals and poor maintenance of bench terraces. About 88.2% of all the farmers interviewed mentioned that soil erosion occur especially during floods which sometimes sweep away seedlings. When erosion occurs, the topsoil, which are mostly the deposits due to siltation is swept away. This lowers the soil nutrient content leading to reduced crop performance.

When asked about the measures they put in place to check the problem, about 88.2% of the farmers admitted that since flood irrigation involves use of terraces and bands to retain water, these bands were also effective in controlling erosion. They however said that grazing livestock during off-season usually destroys these structures. Figure 6 presents incidence of soil erosion in the scheme.

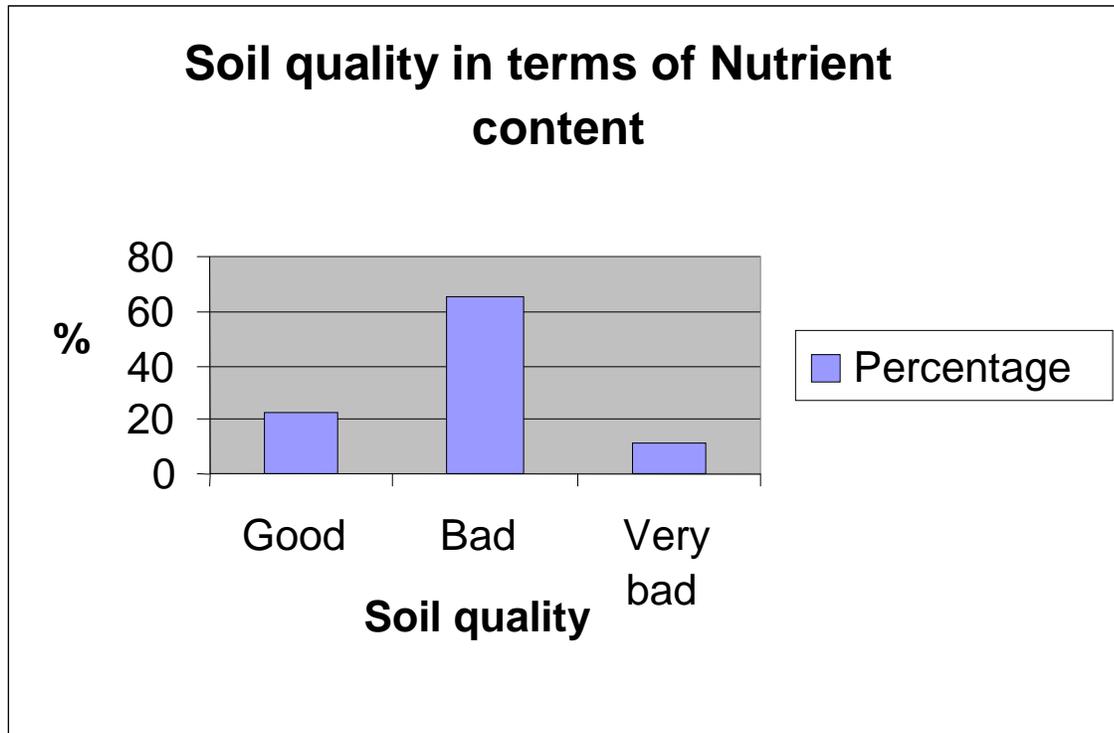


**Figure 36: Incidence of soil erosion**

### 5.5 Changing Soil Nutrient Content

About 65.5% of all the farmers interviewed indicated that the nutrient content based on crop performance had reduced that there was need for fertilizer to replenish the lost nutrients. The plots were continuously cultivated with one crop resulting in exhaustion of nutrients. This has resulted in declining crop productivity. Comparing the quality of soil now based on the yields and the time farmers started carrying out irrigation, it was observed that the yield had tremendously gone down. The declining soil fertility is partly due to soil erosion, which ensues as a result of flooding which sweeps the topsoil. Since farmers also deal with one crop (rice), there are chances of depletion of some nutrients at certain soil levels due to nutrient uptake by these plants. Similar findings were reported by Shortle and Griffin (2001) that showed that irrigation development depletes organic matter in the soil. This is crucial because of the role of organic matter in maintaining soil fertility, soil structure and soil stability as well as its role in carbon sequestration (Wilson & Maliszewska, 1997).

It is however important to note that irrigation water is heavily loaded with sediment (silt) which recharges the soil nutrient content in the plots and this could be responsible for good crop performance as reported by about 22.7% of the farmers who feel that the quality of soil is still good. Figure 7 presents the quality soil as gauged by farmers interviewed.



**Figure 37: Soil quality in terms of nutrients**

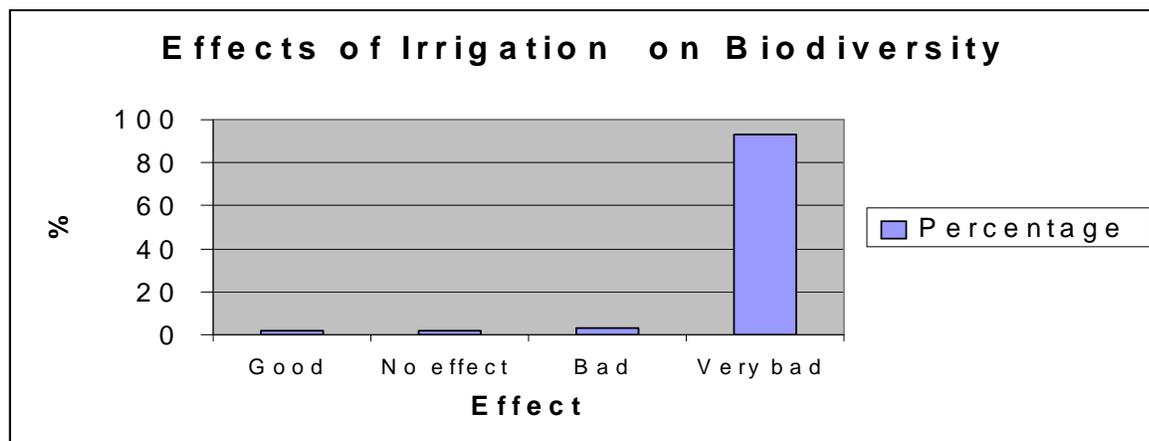
#### **4.6 Scheme Encroachment**

Scheme encroachment is attributed to irrigation scheme development in Gem Rae. This problem has been aggravated by the increased demand for scheme expansion, due to influx of people attracted by the scheme production. This has led to changes in biodiversity and loss of dry season grazing land. It should be noted that Gem Rae irrigation scheme was established by farmers themselves in farmlands that were previously under grazing and habitat for wild animals. The reduction in grazing land has resulted in higher concentration of livestock on the remaining grazing land. Consequently, the resulting overgrazing causes increased land degradation due to erosion and subsequent siltation of irrigation canals during the rainy seasons. In addition, this has caused land use conflicts due to crop damage by livestock and wildlife. Bush clearing for wood fuel harvest is a common problem in Gem Rae irrigation scheme due to sparse vegetation. This problem is enhanced by the increase in population associated with scheme development.

The findings indicate that irrigation development greatly affected plants and animals. More intensive land use, expansion of area under irrigation, drainage of wetlands, and introduction of new crops inevitably entail a decline in biodiversity or a shift in the interrelationships between species as well as loss of many species. The creation of irrigation canal network, river diversion, and flooding has destroyed the established habitats to create new ones.

Irrigation development has also led to monocropping and this has not only reduced the diversity of food crops in the local markets, but also increased the vulnerability of crops to pests and diseases. There were also observed incidences of algae growth in the irrigation drainage canals. Urama (2005) also observed that the monoculture practiced in the irrigation farms also displaces mixed cropping and agro-silvopastoral systems practiced in the river basin. Other changes reported were in the form of decline in number of fish caught in the river per year, and increase in number of waterfowl and other wild birds visiting the irrigated farms during harvesting of rice.

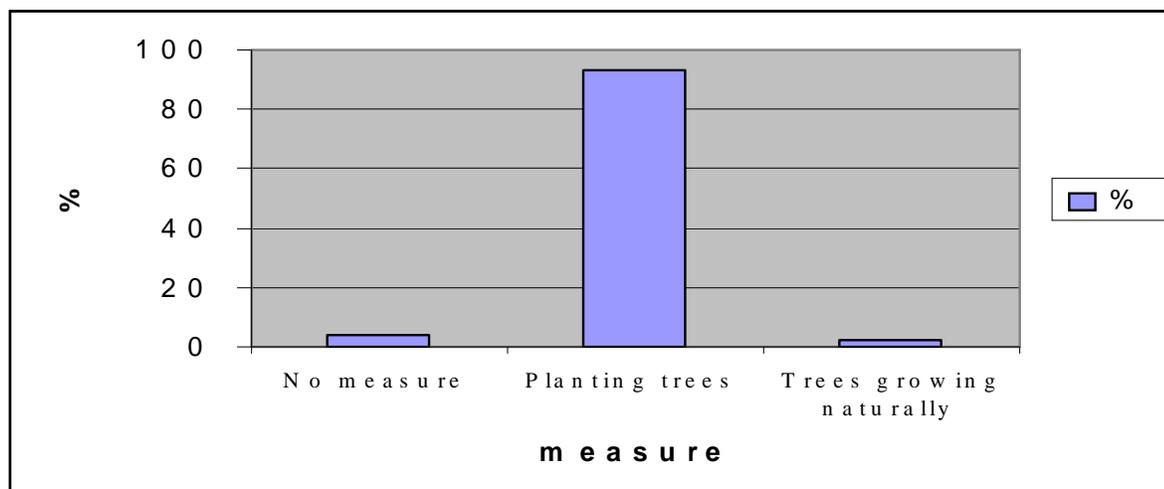
As in many other countries, the most important reasons for loss of biodiversity in Kenya must be sought in the expansion and intensification of agriculture (including irrigated agriculture) as well as in deforestation and overexploitation of water resources. Wildlife is seen in terms of competition for crops, and at least in part, for water, and farmers seem uninterested in observing any other plant or insect species. Figure 8 presents the magnitude of effect of irrigation on biodiversity.



**Figure 38: Effects of Irrigation on Biodiversity**

#### 4.7 Environmental Conservation Measures in the Scheme

The environmental conservation measures in the scheme is key in trying to reverse the problems that constraints the scheme. 93.3% of all the farmers interviewed indicated that they plant few trees within and around homes citing lack of land to plant trees in large scale. It is therefore important that appropriate land use systems such as agro-forestry be encouraged. This should involve planting of fast growing tree species for wood fuel. This will save on time and labour especially for women who have to walk several kilometres fetching firewood. The farmers also mentioned that the bands they construct in the paddy fields reduce the rate of soil erosion. However, this is important in providing wood fuel sources among other needs. Figure 9 presents the environmental conservation measures practiced by farmers in the scheme.



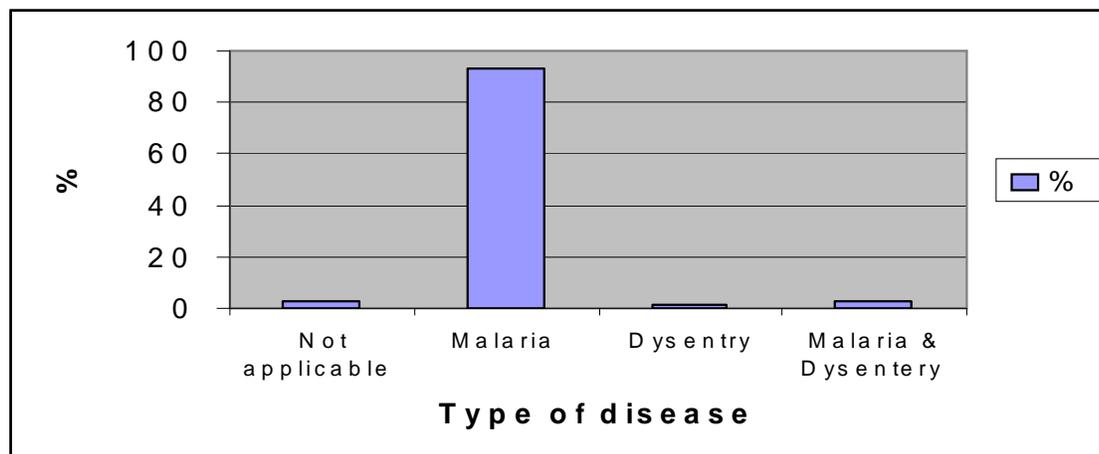
**Figure 39: Environmental measures in the scheme**

#### **4.8 Water-borne/Water Related Disease.**

About 97.5% of all the farmers interviewed indicated that their family members had suffered from diseases such as malaria, dysentery and bilharzias. This shows that the occurrence of water-borne disease is very severe. This is closely related with high aquatic weed growth in the scheme. The study considered the indicators, which are associated with the occurrence of the diseases. These included excessive growth of aquatic and other weeds in open earthen canals (more breeding opportunities for vectors) and adherence to recommended safety precautions during farming operations (e.g. no rubber boots worn indicating high risk of infection). The scheme had high growth of weeds such as water hyacinth in and along the canals. When asked whether they use any protective measure on their feet while in the farm about 62.2% of the farmers interviewed said they do not use any protection. About 93% of the farmers indicated that most of their family members had suffered from malaria as shown in Figure 10.

It was reported that these diseases had an effect on the farm labour supply and this impacted negatively on the yield, with about 90.8% of the farmers mentioning that the magnitude of the effect was very big. This is as opposed to the idea that irrigated agriculture is designed to contribute substantially to conditions that favour good health in terms of food security, an improved infrastructure allowing better access to health services and economic progress which permits rural households a greater purchasing power for drugs and health services (WADSCO, 1981; Haile, 1988).

On mosquitoes that spread malaria, about 96.6% of the farmers interviewed felt that the number had increased due to irrigation. About 79.0% of the farmers said that they were using mosquito nets. However, most farmers indicated that mosquitoes even bite early before people go to sleep and this could be the time when many people were getting infected.



**Figure 40: Type of Disease Suffered by Respondents and Family Members**

#### **4.9 HIV/AIDS Effect.**

The impact of HIV/AIDS was reported in the study area where about 49.6% of all the farmers interviewed said that the disease had significant effect on the yields. This is depicted in Table 4. HIV/AIDS has also become a problem because of the high number of orphans who are taken care of by their old grand parents. This pose a burden to these people resulting in increased poverty levels. HIV/AIDS is neither water-borne nor water related but because of the rate at which it spreads and kills people, it becomes a public health issue and therefore analysis of its impact in the scheme is necessary. It is a menace to many households and it is more severe in areas where the level of poverty is high particularly in the developing world. It impacts heavily on labour productivity and since the active population is at high risk of contracting the disease, sustainability of most development projects may dwindle. The grand effect of this disease is reduced yields.

**Table 7: Magnitude of the Effect of HIV/AIDS on the Yield**

<b>Magnitude of effect</b>	<b>Frequency</b>	<b>Percentage</b>
Very small	3	2.5
Not at all	56	47.1
Big	1	0.8
Very big	59	49.6

<b>Total</b>	<b>119</b>	<b>100.0</b>
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#### 4.10: Checklist of Environmental Impacts

**Table 8: Checklist of Environmental Impacts**

<b>Environmental impacts</b>	<b>Effects</b>
Flooding and drainage hazards	<ul style="list-style-type: none"> <li>▪ Project failure</li> <li>▪ Crop damage</li> <li>▪ Water logging</li> <li>▪ Sedimentation and siltation</li> </ul>
Water borne disease occurrence <ul style="list-style-type: none"> <li>▪ Malaria</li> <li>▪ Dysentery</li> <li>▪ Bilharzias</li> </ul>	<ul style="list-style-type: none"> <li>▪ Public health hazards</li> <li>▪ Reduced labour supply for scheme operations and management,</li> <li>▪ Increased cost of treatment</li> <li>▪ Low scheme production level</li> </ul>
HIV/AIDS	<ul style="list-style-type: none"> <li>▪ Reduced labour supply</li> <li>▪ Increased cost of treatment</li> <li>▪ Increased number of orphans</li> <li>▪ Time wasting in caring for the sick</li> <li>▪ Low scheme production levels</li> </ul>
Pollution due to disposal of domestic waste	<ul style="list-style-type: none"> <li>▪ Public health hazards – disease and flies</li> <li>▪ Pollution of irrigation water for drinking</li> <li>▪ Pollution of underground water sources due to irrigation</li> </ul>
Soil erosion due to bush clearing and land preparation	<ul style="list-style-type: none"> <li>▪ Loss of fertile top soil</li> <li>▪ Sedimentation /siltation of surface water</li> <li>▪ Increased cost of production – purchase of fertilizers and control of erosion</li> <li>▪ Decreased in crop production</li> </ul>
Destruction of crop by livestock and wildlife	<ul style="list-style-type: none"> <li>▪ Decrease in crop production</li> <li>▪ Human –wildlife conflict</li> <li>▪ Land use conflict between farmers</li> </ul>

Siltation	<ul style="list-style-type: none"> <li>▪ Water supply problems</li> <li>▪ Increased cost of production</li> <li>▪ Decrease in crop production</li> <li>▪ Flooding and drainage problems</li> <li>▪ Nutrient carrying silt replenish soil nutrient content</li> </ul>
Encroachment into forests, swamps and desiccation of wetland	<ul style="list-style-type: none"> <li>▪ Decrease in bio-diversity</li> <li>▪ Loss of firewood /timber</li> <li>▪ Destruction of habitats for wildlife and sanctuaries for breeding birds</li> <li>▪ Reduction of dry season grazing land</li> </ul>
Insufficient supply of wood fuel	<ul style="list-style-type: none"> <li>▪ Indiscriminate clearing of forests</li> <li>▪ Land degradation</li> </ul>
Loss of dry season grazing land and overgrazing around the scheme	<ul style="list-style-type: none"> <li>▪ Disruption of pastoralist economies</li> <li>▪ Soil erosion</li> <li>▪ Sedimentation and siltation of surface waters</li> </ul>
Land use conflicts due to obstruction to movements of wildlife and pastoralist cattle	<ul style="list-style-type: none"> <li>▪ Wildlife disturbance</li> <li>▪ Crop damage by wildlife</li> <li>▪ Crop damage by livestock</li> <li>▪ Overgrazing by livestock in scheme area</li> </ul>
Water supply problems	<ul style="list-style-type: none"> <li>▪ Water use conflicts</li> <li>▪ Decreased crop production</li> </ul>

## 5.0 CONCLUSION

The cross sectional analysis of environmental and household characteristic in the study area and results of interview with farmers corroborate empirical evidence found in the literature. The irrigation development had significant deleterious environmental impacts to extent that might preclude sustainable agriculture in irrigated areas. The environmental impacts included loss of biodiversity, increased incidence of water borne diseases, siltation, soil erosion, and water use conflicts.

The analysis found a significant decline in the fertility and structural quality of soils of the irrigated farm to the extent that can lower crop production on irrigated farms in the study area. This is perhaps the conclusive evidence on the unsustainability of irrigated agriculture in the study area.

Sustainable management of agricultural land is itself a pre-requisite for sustainable agriculture and has strong links to environmental security (Asadu, 1996; Wilson, 1997). These differences in soil fertility in the irrigated farms and irreversible degradation of part of the soils in irrigated farms explain the observed decline in rice yields in the study area. The ensuing soil erosion of irrigated farms coupled with catchment degradation caused build up of silt loads in irrigation canals. This led to increased cost of production and water supply problems especially to the downstream water users. Apart from these biophysical impacts on soils, other social, economic, health, and ecological impacts observed in the study area deepens concerns for sustainable agriculture under smallholder irrigation schemes in Kenya.

Irrigation development in the study area has led to increased natural resource scarcity leading to different types of social conflicts as different stake holders (farmers, pastoralists, fishermen and households) struggled to maintain access to land and water resources. The change from communal property rights and land tenure system to individual ownership of land within the study area violated local farmers' perception of land and water resources and multifunctional assets. Land and water resources were traditionally managed not only as source of food but also for providing feed for livestock during dry season. Also these areas provided habitat for wildlife. This has since changed with encroachment taking the centre stage. As a result of this, livestock grazing around the scheme occasionally cause damage to crops leading to conflicts between pastoralists and farmers. The damage also lowers the rice yields. Wild animals such as hippopotamus were also reported to be causing great crop damages. These animals not only eat or trample crops, but also pose danger to humans when confrontations occur. This leads to human wildlife conflicts.

The health impacts of irrigation on farm household have also been negative. There were increased incidences of water borne diseases and HIV/AIDS. These significantly affected farm labour supply and efficiency. The disease also leads to change of priority setting as funds are diverted to care and treatment of the sick.

The impacts of irrigation on biodiversity have also been negative. While irrigation increased the number and diversity of bird species that visit the farms during the dry season, most terrestrial mammals migrated. Also most plant species that were present in these areas have been replaced by monocropping. However, aquatic weeds have flourished in irrigation canals, as a result of eutrophication.

On balance, the study finds that in addition to its biophysical impacts, irrigation development had other social, health, economic and ecological impacts that were found to be significantly affecting the yield of rice thereby putting the sustainable practice of arable agriculture on the irrigated soils of the study area at risk. This problem is exacerbated by the decline in farm size due to increase in population leading to intensive cultivation.

Future developments of smallholder irrigation should therefore factor the social economic and ecosystem trade offs of irrigation in the suitability criteria for its development. These considerations are critical to the success and sustainability of irrigation.

## **6.0 RECOMMENDATION**

Based on the findings and conclusion, the study makes the following recommendations;

### **1. Water use and protection**

There is need for the establishment of water users association in the study area to enhance user - based coordination of water abstraction. This will promote conflict prevention and resolution mechanisms. To regulate the water use, there is need for continuous monitoring of water abstraction. Instilling water meters at individual users' levels can do this. To ensure water availability even during the dry season, there is need for the development of water infrastructure (water storage facilities and rainwater harvesting facilities). It is noted with concern that a lot of water goes to waste in floods during rainy season. This water can be stored for later use by constructing dams. Earth dams can be constructed for storage of water for watering animals. The construction of a more efficient water obstruction structure (water intake) is necessary to ensure efficient water movement into the farms. Installing a water pump can possibly reduce irrigation water crisis especially if this pumping can be done from the nearby River Nyando to supplement water from River Awach which is small in volume. This will help the farmers to get enough water to expand their irrigation activities. This will however call for the farmers to pay for maintenance of the pump and the scheme management committee should coordinate this. Along with this, protection of the river catchment and riparian area is necessary. This can be done by practising sound agricultural practices along the river channel such as planting it with suitable trees especially the indigenous species. This will reduce bank erosion that decreases river volume through sedimentation.

### **2. Public health impacts**

There is need for awareness creation to the farming households to embrace use of safety wears such as gumboots, gloves, and water treatment methods to control some of the diseases. The more vulnerable groups such as children below 5 years, expectant mothers, and the old people should be provided with insecticide treated mosquito nets to control malaria. Farmers should also be encouraged to construct fishponds, which will control malaria by feeding on mosquito larvae. It is noted with concern that the whole of Gem Rae scheme has no operational dispensary and the sick have to travel to Katito, which is 10km away or Pap-Onditi, which is 20km away to get medication. It is therefore recommended that a dispensary be constructed well furnished with medical staff to deal with these problems. A mobile clinic may also be necessary. Constant inspection by public health officers is necessary to ensure that every home has a functional pit latrine. This is important for control of diseases like bilharzias, dysentery, and cholera.

On HIV/AIDS, a lot is done by the government and NGOs to create awareness but a lot more is still needed. People should be encouraged to know their status through Voluntary Counseling and Testing (VCT). It is only unfortunate that the nearest VCT centre is 10 kilometres away. The village communities should be empowered to take the centre stage in fighting the disease. However, to obtain more detailed information about the effects of irrigation on the spread of water-borne and water related diseases, medical surveys would have to be carried out over a length of time. Such surveys should not only include the scheme participants, but also people living in the surrounding areas of the scheme as reference for comparison. This was not possible during the present scope of the study.

### **3. The legislation on riparian lands needs to be reinforced in the study area**

These lands should be planted with suitable trees to avoid degradation of riverbanks. The erosion of these banks is partly responsible for the high amounts of silts in irrigation canals. In addition to this, a buffer zone along Lake Victoria should be left intact. This region should be regenerated with indigenous grasses and trees. This vegetation will provide a buffer zone for the nourishment of the wild animals such as hippopotamus. This will also help in conservation of biodiversity.

### **4. Improving small holder irrigation activities**

Since smallholder irrigation has direct impacts on food security, incomes and poverty alleviation of the households, it is recommended that smallholder agriculture be transformed from subsistence to a commercial and profitable business enterprise. This can be done by the government allocating more resources to these irrigation schemes to make them more productive. Modernization of

irrigation is necessary to reduce water losses. On smallholder schemes, modernization of irrigation schemes usually means lining and cementing the irrigation canals and installing mechanical or electrical water abstraction facilities from intake points to the fields.

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#### **S2012-19: Bacteriological Quality of Water From Selected Water Sources in Samburu South – Kenya**

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#### **S2012-20: Effects of Seed Maturity Level, Desiccation, Packaging and Storage Temperature on Seed Quality of Spiderplant (Cleome gynandra L.)**

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#### **Abstract**

Two experiments were conducted to determine the critical moisture content and the best storage conditions for spiderplant seeds with a view to addressing the poor seed quality and promote conservation of this plant genetic resource. In experiment one, seeds harvested at three pod maturity stages; yellow, yellow-green and green were dried above silica gel to percentage moisture contents of 20, 10, 5 and 2. For each maturity stage, viability and vigour tests were conducted. Percent germination and vigour increased with seed maturity. Prior to storage, initial germination for green, yellow-green and yellow pod maturity stages was 0.75%, 12% and 14.5% respectively. Green pod maturity stage had the least vigour as indicated by the mean germination time and electrical conductivity values of 4.18days and 420.77 $\mu\text{Scm}^{-1}\text{g}^{-1}$  respectively. Yellow pod maturity stage had the highest vigour of 2.00 days mean germination time and electrical conductivity of 20.51 $\mu\text{Scm}^{-1}\text{g}^{-1}$ . Yellow-green pod maturity stage was intermediate with 2.02days mean germination time and 22.61 $\mu\text{Scm}^{-1}\text{g}^{-1}$  of electrical conductivity. Germination of seeds from yellow and yellow-green pods increased with reduction in moisture content while that of green pods decreased. Based on this study, the critical moisture content for spiderplant seeds could be between 5% and 3%. Mature seeds that had been dried to the four moisture levels in experiment one were sealed in aluminum foil and polythene packets and stored at ambient temperatures (10°C - 26°C),

5°C and -20°C for six months. After six months storage period, viability and vigour tests were conducted. Seed stored for six months at 5% moisture content and minus 20°C recorded the highest seed quality. There were no significant differences ( $P>0.05$ ) between seeds packaged in aluminium foil and polythene packets. In conclusion, spiderplant seed should be harvested at yellow pod maturity stage, dried to 5% moisture content, and stored at minus 20°C.

**Key words:** *Cleome gynandra* L., desiccation, storage conditions, viability, vigour

## **INTRODUCTION**

Indigenous crop genetic diversity is of vital importance to future efforts of providing sustainable increases in agricultural production, especially through genetic manipulations. Great efforts should, therefore, be geared towards conservation of these germplasm, for present and future utilization. Many crops of regional or local importance have been relatively ignored by most scientific studies. Ironically, though, this goes on against a rich background of information on the vital role that these indigenous crops have played in feeding the majority of rural populations throughout Africa.

Among the wild edible plants, indigenous leafy vegetables feature prominently in the diet of African communities. The indigenous vegetables commonly grown in Kenya include cowpea (kunde), slenderleaf (mitoo, miroo), spiderplant (dek, tsaka, saget), Jews mallow (murere, apoth), African nightshades (managu, sugi, osuga) and leaf amaranths (dodo, terere). These species were considered as weeds and were not cultivated (Ivens, 1967), although harvested as vegetables from the world (Chweya, 1997; Bukenya-Zaraba, 1997). Slowly these species are being recognized as vegetables that need to be cultivated in small sections of the farm, kitchen and home gardens and along rows of staple crops (Chweya, 1997). However, these African indigenous vegetables have received little attention from scientists and policymakers in terms of plant breeding and seed production (Chweya, 1997; Schippers, 1997). There is need therefore of carrying out studies on how seed quality attributes of these vegetables are affected by seed production, handling and storage practices.

This study focuses on spiderplant (*Cleome gynandra* L.). Synonyms of *Cleome gynandra* (L.) are *Gynandropsis gynandra* (L.) Briq.; *Cleome pentaphylla* (L.); *Pedicellaria pentphylla* (L.); *Gynandropsis pentphylla* (L.); *Gynandropsis denticulate*; *Cleome acuta* (Hammer, 1986). *C. gynandra* belongs to the botanical family Capparaceae (Capparidaceae) and sub family cleomoideae. The family contains about 700 to 800 species divided into 45 genera (Kuhn, 1998; Kokwaro, 1994). The genus *Cleome* is a near relative of the cruciferae (Brassicaceae) family (Bremer and Wannorp, 1978). It has over 200 species (Iltis, 1967; Bruinsma, 1985) consisting of herbaceous plants.

Though not actually threatened with extinction, the spiderplant is facing the danger of genetic erosion. Little domestication has been done. With increasing pressure on agricultural land, its ecological niches are fast disappearing. Genetic erosion, hence, is bound to be rapid. In general, little is known about the cultivation techniques, the extent and structure of genetic variation, and the seed physiology of spiderplant. Very few systematic studies on characterisation and evaluation have been conducted on this species and little, if any, systematic germplasm collecting has been done (Martin, 1984). This is primarily because of the low priority and status accorded to this crop nationally and internationally. This is regrettable considering the significant contribution this local vegetable has played in the nutritional well being of many rural populations, especially in Africa. Furthermore, beyond Africa this vegetable has a significant role to play in widening the world's currently narrow food base. Grubben and Almekinders (1997) recommended that plant breeding and seed production by farmers and private sector should be stimulated. This they noted could reduce the risk of genetic erosion of this species. Chweya (1997) observed that there should be formal research to support domestication of spiderplant through activities like evaluation, characterization and seed production.

It is important, therefore, that germplasm of spiderplant be systematically collected, conserved, characterised and documented for present and future use. It is however, unfortunate, that little is known of spiderplant seed production, handling and seed storage physiology. Such studies are, therefore, important for effective management of spiderplant seeds under short and long-term storage. This would minimise genetic erosion of germplasm arising as a result of long-term storage ageing processes.

In Kenya, spiderplant has gained popularity among farmers due to its nutritional and medicinal values. In the local markets, bundles of leafy shoots as well as uprooted young plants are offered at exorbitant prices in many parts of Kenya (Western, Nyanza, Coast, Nairobi, Central and Rift Valley), (National Research Council, 1984; Maundu, *et al.*, 1993). The vegetable can therefore provide a source of income for rural areas, especially for the poor rural women and the unemployed youth.

It is popular in cultural diets and existing evidence suggest that spiderplant is endowed with higher level of nutrients than its exotic counterparts (Chweya and Mnzava, 1997). The leaves contain over and above the normal recommended adult daily allowance of vitamins A and C, calcium and iron (Arnold *et al.*, 1985). The amino-acid composition of spiderplant leaf-protein has a high chemical score, comparable to that of exotic vegetables such as spinach. High levels of

nutritionally critical amino acids, like lysine, arginine, aspartic acid, glutamic acid, tyrosine and histidine have been reported (Mnzava, 1990).

The leaves and seeds of spiderplant are used in indigenous medicine in many countries (Baruah and Sarma, 1984; Kumar and Sadique, 1987; Opole *et al.*, 1995). Indigenous knowledge possessed by rural women in Kenya indicates that spiderplant has several medicinal uses (Opole *et al.*, 1995). Its leaves are crushed to make a concoction that treats scurvy and marasmus. Sap from young leaves treats epilepsy and recurrent malaria. Seeds and roots are ingested for the expulsion of roundworms and bruised leaves are applied on boils to prevent formation of pus. Spiderplant has insecticidal, anti-feedant and repellent characteristics (Verma and Pandey, 1987; Chandel *et al.*, 1987; Akhtar, 1990; Pipithsangchan, 1993). Leaves have anti-tick properties (Chandel *et al.*, 1987). The ethanol extract is toxic to insect pests, such as painted bug (*Bagrada cruciferarum* Krik) and the Diamond Back Moth of cabbage (*Plutella xylostella* L.), (Pipithsangchan, 1993). The extract from the mature seeds is toxic to brinjal aphid (*Aphis gossypii* Glov.) and the larvae of *Heliothis armigera* (bollworm), (Verma and Pandey, 1987). The seeds contain phenolic compounds, which are natural products (Jain and Gupta, 1985). Lipids from seeds could be used in soap manufacture (Gupta and Chakravarty, 1987).

It has been reported that one of the major problems in the cultivation of spiderplant is the availability of high quality seeds (Chweya and Ezyaguirre, 1999). Farmers harvest leaves as vegetables for a number of times before allowing plants to go into seed production or nip off the first flower heads to encourage branching for more seed production. A survey carried by Maundu *et al.* (1993) found that the majority of growers use tins and polythene paper because they are readily available. Traditionally seeds are kept in guards and pots. Major problem faced by farmers is the production of seed that possesses low viability and vigour. The production practices, harvesting, processing, packaging and storage of spider plant could be contributing to poor quality of seed planted by farmers. The purpose of this research was to study how the seed quality of spider plant is affected by different maturity stages, packaging and storage conditions, with a view to finding out the optimal method of production, handling and storing of these seeds.



Fig.1: Photograph of spiderplant (*Cleome gynandra* L.) taken from one of the experimental plots.

## MATERIALS AND METHODS

### Maturity stage experiment

To ensure that seeds were harvested at different maturity stages even on a single plant, individual flowers with anthers exposed at a time when pollination is expected were tagged using strings of different colours for each date of tagging, which corresponded to the date of fertilization. The first tagging of flowers was done on 19/6/2002 on five plants from each of the six experimental plots, the second on 29/6/2002 while a final tagging was done on 29/7/2002. Thereafter, seeds were harvested at once on 14/8/2002 in three-pod maturity classes characterized by distinct visual colours. Yellow pods were at 55 days after fertilization (DAF); intermediate yellow-green pods were at 45 DAF and a final stage of green pods was harvested after seeds had been maturing on plant for 15 DAF.

Seeds enclosed in fruits at different maturity classes described above were manually removed from the plants on 14/8/2002 and placed in khaki envelopes (A 3), packed loosely in a carton (48 cmx36 cmx30cm) and transported to the laboratory at National Museums of Kenya (NMK), Nairobi, where they were kept under room temperatures. In the following morning six pods were shelled manually to obtain seeds for initial moisture content determination so that further

investigations on initial viability, vigour and desiccation could be started at known seed moisture content.

### **Desiccation experiment**

Dry seeds of *Cleome gynandra* L. (accession number, GBK-032229-Uasin-Gishu), sealed in an aluminium foil packet (6cmx6cm) were obtained from the Gene bank of Kenya, Muguga. The seeds were transported to Chepkoilel campus of Moi University. Prior to sowing and in order to avoid imbibition injury, the sealed packets were opened and allowed to stand at room temperature overnight. The seeds were planted in the field using Randomized Complete Block Design (RCBD) at Chepkoilel farm, Moi University Eldoret which is situated at latitude 0<sup>0</sup>30<sup>0</sup> N, longitude 35<sup>0</sup>15<sup>0</sup> E and altitude 2180 meters above sea level. The area is within the Uasin Gishu plateau, which is in the Lower Highlands (LH3) agro ecological zone (Jaetzold and Schmidt, 1982). The site has a temperature range of 10<sup>0</sup>C- 26<sup>0</sup>C and relative humidity of 45%- 55%. Spiderplant seeds were harvested at three developmental stages: yellow pods - 55 days after flower opening (DAFO); yellow-green pods - 45 DAFO and green pods -15 DAFO. Prior to desiccation, initial seed moisture on fresh weight basis was determined gravimetrically in five replicates each of 50 seeds in a well ventilated oven at 103<sup>0</sup>C±1<sup>0</sup>C for 17 hours. Seeds were removed in the oven and allowed to cool for about 30- 45 minutes inside a desiccator. Seed moisture content was expressed on a fresh weight basis as:

$$\% \text{ seed moisture content} = \frac{\text{Initial seed weight (g)} - \text{seed weight after drying (g)} \times 100}{\text{Initial seed weight (g)}}$$

The protocol developed by IPGRI and DFSC (1999) was followed with certain modifications to determine the seed desiccation tolerance at each of the three-development stages. Seeds were dried in silica gel in a ratio of 1:5 and enclosed in 6 cm x 8 cm perforated nets to allow the easy separation of the small seeds from the silica during re-weighing. For each maturity stage, randomly selected seed samples were dried to four target moisture levels of 20%, 10%, 5%, and 2% that gave a range above and below 12-14% which is the commonly recommended level for many crops. Seeds were dried using the method described in the DFSC/IPGRI protocol (1999):

$$\text{Weight of seed (g) at TMC} = \frac{(100 - \text{IMC})}{(100 - \text{TMC})} \times \text{initial seed weight (g)}$$

Where, TMC is the target moisture content and

IMC is the initial moisture content.

Periodically, seeds were removed from silica gel for re-weighing to monitor water loss and time taken to attain the various target moisture contents noted. To ensure consistent rapid drying of seeds, hydrated silica gel was replaced every five hours in all the containers at the same time and periodic thorough mixing of seeds particularly during re-weighing and changing of silica gel. After achieving the four-desiccation levels (20%, 10%, 5%, and 2% moisture content), germination, electrical conductivity and actual moisture content tests were carried out according to ISTA (2005).

### **Storage experiment**

Storage experiments were set using seeds from yellow pod maturity stage dried using silica gel to four target moisture levels of 20%, 10%, 5% and 2% (from the desiccation experiment above). Dried seeds were sealed in aluminum foil and 30µm-thick polythene packets and stored at three storage temperatures: ambient, 5°C and minus 20°C for six months. Aluminium foil containers are commonly used for seed storage at the Gene bank of Kenya while polythene is more readily available to farmers. For each treatment, 400 seeds were used for germination, 200 seeds for moisture content determination and 100 seeds for electrical conductivity test. After six months storage period, seeds were removed from the storage conditions and percent germination, mean germination time and electrical conductivity tests carried out according to ISTA (1995).

## **RESULTS**

### **Maturity stage of Cleome seeds**

The results shown in Table 1 indicate that there were significant ( $P \leq 0.05$ ) effects of maturity stages on percent germination, mean germination time and electrical conductivity of Cleome seeds (Table 1). Seeds from green pods had the lowest germination and vigour. Seeds from Yellow-green pods were intermediate and those from yellow pods had the highest germination percentage and vigour (Table 1). In general, germination was poor probably due to primary dormancy.

Table 1. Effect of maturity stage on percent germination, mean germination time and electrical conductivity of spiderplant seeds.

Maturity stage	Germination (%)	Mean germination time (days)	Electrical conductivity (µScm <sup>-1</sup> g <sup>-1</sup> )
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Green pods	(-)	(-)	(-)
Y/green pods	12.25 ( $\pm 0.500$ )	2.06 ( $\pm 0.005$ )	27.10 ( $\pm 0.005$ )
Yellow pods	14.50 ( $\pm 0.580$ )	2.04 ( $\pm 0.008$ )	25.94 ( $\pm 0.006$ )
Significance	*	*	*
LSD <sub>0.05</sub>	1.45	0.01	0.93

In brackets are standard deviation values, \*significant at  $P \leq 0.05$  according to LSD test.

(-) no germination recorded

#### **Experiment on Desiccation Tolerance**

The percentage germination improved with decrease in moisture content, for seeds from yellow-green and yellow pod maturity stages (Table 2). Green pods maturity stage recorded zero germination at 5% and 2% moisture contents (Table 2). This implies that seeds at green pod maturity stage were immature and could not tolerate desiccation. Desiccation had no significant effects on mean germination time and electrical conductivity on seeds from yellow pod maturity stage (Table 2). Yellow pod maturity stage took the least time to dry to various target moisture contents (Table 2). This was due to the fact that the initial moisture content was low, at 27.1% (Table 2).

Table 2. Effect of desiccation on percent germination, mean germination time and electrical conductivity of spiderplant seeds harvested at different maturity stages.

Maturity stage	Initial moisture content	Target moisture content	Actual moisture content	Desiccation time (hrs)	Germination (%)	Mean germination time	Electrical conductivity
Green	70.2				1.50	4.18	420.77
		20	12.80	10.00	1.25	4.32	536.65
		10	10.00	10.75	0.75	4.33	543.21
		5	4.70	30.25	0.00	0.00	629.05
		2	2.30	33.42	0.00	0.00	658.48
Mean				0.70 ( $\pm 0.58$ )	2.57 ( $\pm 1.03$ )	557.63 ( $\pm 68.91$ )	
Significance				*	*	*	
LSD <sub>0.05</sub>				0.120	0.001	4.31	
Y/green	41.3				5.00	2.02	22.61
		20	12.13	2.08	6.75	2.04	24.61
		10	10.80	2.75	9.00	2.05	25.75
		5	4.40	26.42	12.00	2.06	27.18
		2	2.10	29.42	11.75	2.14	32.18
Mean				8.90 ( $\pm 2.42$ )	2.062 ( $\pm 0.03$ )	26.261 ( $\pm 2.51$ )	
Significance				*	*	*	
LSD <sub>0.05</sub>				1.25	0.002	0.83	
Yellow	27.1				6.75	2.00	20.51
		20	11.60	1.25	9.25	2.01	20.89
		10	9.80	2.33	11.50	2.01	21.17
		5	4.30	25.58	14.50	2.02	22.94
		2	2.40	28.75	14.00	2.04	24.47
Mean				11.20 ( $\pm 2.08$ )	2.016 ( $\pm 2.01$ )	21.99 ( $\pm 1.37$ )	
Significance				*	Ns	Ns	
LSD <sub>0.05</sub>				0.35	0.05	4.12	

In brackets are standard deviation values. \* Significant at  $P \leq 0.05$ , ns = not significant at  $P > 0.05$  according to LSD test.

### Storage of Cleome seeds

The three temperature regimes used in this study were significantly different ( $P \leq 0.05$ ) in their effects on percent germination, mean germination time and electrical conductivity of spiderplant seeds stored for six months (Table 3). Seeds stored at minus 20°C recorded the highest viability and vigour, while seeds stored at room temperature had the least seed quality (Table 3). Seeds stored at 5°C were intermediate in quality.

Table 3. Effect of storage temperature on percent germination, mean germination time and electrical conductivity of spiderplant seeds stored for 6 months at 5% moisture content.

Storage temperature	Germination (%)	Mean germination time (days)	Electrical conductivity ( $\mu\text{Scm}^{-1}\text{g}^{-1}$ )
Room (25-30°C)	85.0 ( $\pm 0.58$ )	2.33 ( $\pm 0.005$ )	36.24 ( $\pm 0.006$ )
5	89.0 ( $\pm 0.50$ )	2.27 ( $\pm 0.005$ )	31.65 ( $\pm 0.005$ )
-20	95.0 ( $\pm 0.58$ )	2.21 ( $\pm 0.006$ )	29.27 ( $\pm 0.006$ )
Significance	*	*	*
LSD <sub>0.05</sub>	3.5	0.03	1.43

In brackets are standard deviation values. \*Significant at  $P \leq 0.05$  according to LSD test.

Reduction in moisture content had a significant ( $P \leq 0.05$ ) effect on percent germination, mean germination time and electrical conductivity (Table 4). Results of Table 4 show a general trend of seed quality improvement with moisture content reduction up to 5%. However, further drying to 2% moisture content resulted into a decline in seed quality (Table 4). Lowest germination of 55.5% was recorded at 2% moisture content and at 5% moisture content germination was highest at 94.5% (Table 4). Vigour as indicated by mean germination time and electrical conductivity was also lowest at 2% moisture content and highest at 5% moisture content (Table 4).

Table 4. Effect of moisture content on percent germination, mean germination time and electrical conductivity of spiderplant seeds stored for six months at minus 20oC.

Moisture content	Germination (%)	Mean germination time (days)	Electrical conductivity ( $\mu\text{Scm}^{-1}\text{g}^{-1}$ )
20	76.5 ( $\pm 0.58$ )	2.26 ( $\pm 0.006$ )	33.41 ( $\pm 0.006$ )
10	78.8 ( $\pm 0.50$ )	2.23 ( $\pm 0.005$ )	31.99 ( $\pm 0.005$ )
5	94.5 ( $\pm 0.58$ )	2.21 ( $\pm 0.006$ )	29.27 ( $\pm 0.010$ )
2	55.5 ( $\pm 0.58$ )	2.38 ( $\pm 0.005$ )	35.67 ( $\pm 0.005$ )
Significance	*	*	*
LSD <sub>0.05</sub>	11.7	0.01	1.33

In brackets are standard deviation values. \*Significant at  $P \leq 0.05$  according to LSD test.

In this study, foil and polythene did not differ significantly ( $P > 0.05$ ) in their effects on percent germination, mean germination time and electrical conductivity of Cleome seeds stored for six months (Table 5). Results of Table 5 indicate that foil gave higher seed quality than polythene.

Table 5. Effect of container on percent germination, mean germination time and electrical conductivity of spiderplant seeds stored for six months at minus 20oC and 5% moisture content.

Storage container	Germination (%)	Mean germination time (days)	Electrical conductivity ( $\mu\text{Scm}^{-1}\text{g}^{-1}$ )
Foil	94.5 ( $\pm 0.58$ )	2.21 ( $\pm 0.005$ )	29.27 ( $\pm 0.006$ )
Polythene	93.5 ( $\pm 0.58$ )	2.22 ( $\pm 0.005$ )	29.28 ( $\pm 0.006$ )
Significance	ns	ns	ns

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LSD<sub>0.05</sub>

2.8

0.03

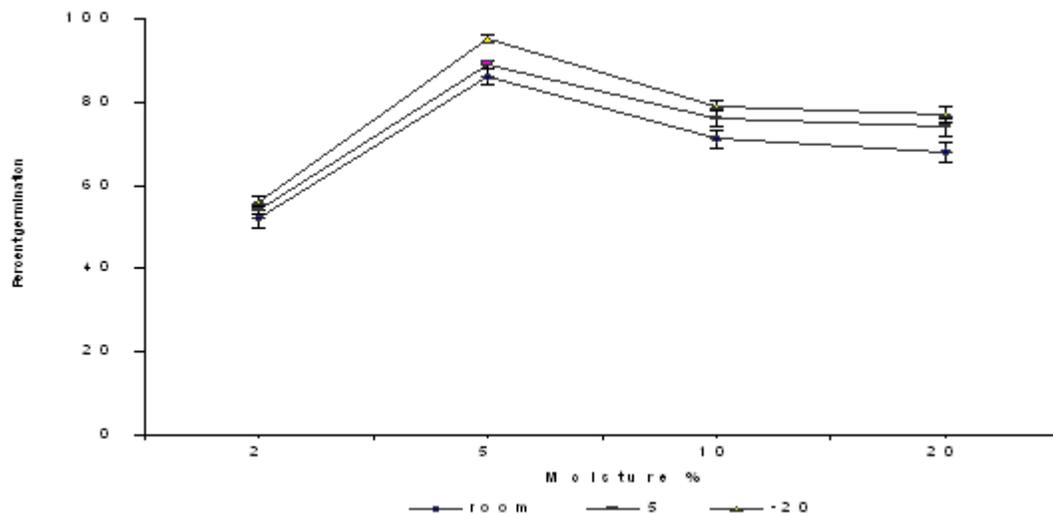
1.15

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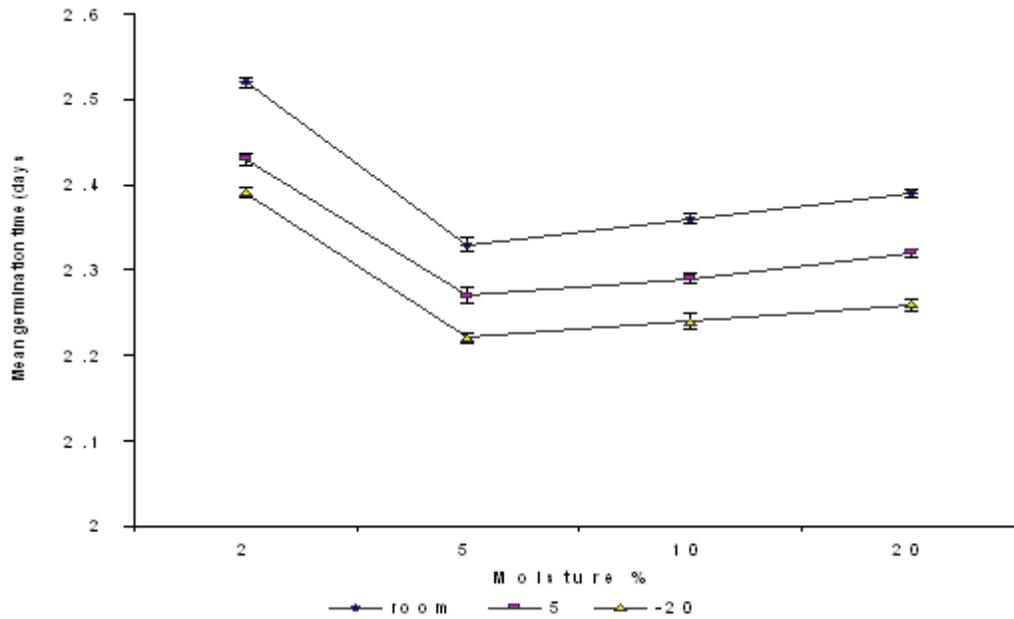
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In brackets are standard deviation values, ns = not significant at  $P > 0.05$  according to LSD test.

Effects of moisture and temperature after six months storage were significant ( $P \leq 0.05$ ) for percent germination, mean germination time and electrical conductivity (Figure 1, 2, 3). Seed stored at 5% moisture content and minus 20°C gave better seed quality than seed stored at 2% moisture content while seeds stored at room temperature had the least quality (Figures 1,2,3). Highest germination of 95% was realized at minus 20°C and 5% moisture content, while the lowest germination of 52% was recorded at room temperatures and 2% moisture content (Figure 1). The least mean germination time and electrical conductivity of 2.11 days and 26.36  $\mu\text{Scm}^{-1}\text{g}^{-1}$  respectively were recorded for seeds stored at minus 20°C and 5% moisture content, while the longest mean germination time of 2.35 days and highest electrical conductivity of 35.13  $\mu\text{Scm}^{-1}\text{g}^{-1}$  were recorded for seeds stored at room temperatures and 2% moisture content (Figure 2,3).



**Fig.1. Effect of moisture and temperature on percent germination of spiderplant seeds stored for six months. Each point is an average of 4 determinations  $\pm$  standard error of the difference (SED). Standard error bars are used to compare points within a temperature regime.**



**Fig.2.** Effect of moisture and temperature on mean germination time of spiderplant seeds stored for six months. Each point is an average of 4 determinations  $\pm$  standard error of the difference (SED). Standard error bars are used to compare points within a temperature regime.

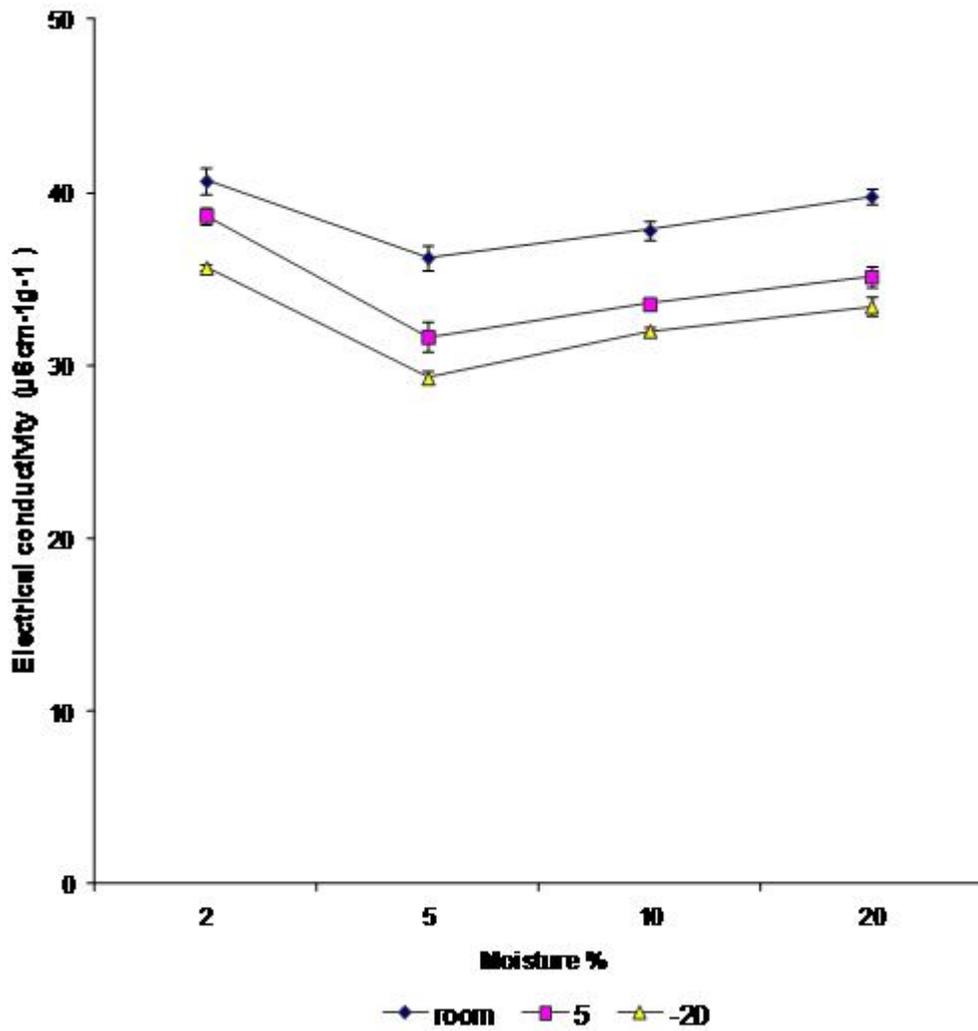


Fig.3. Effect of moisture and temperature on electrical conductivity of spiderplant seeds stored for six months. Each point is an average of 4 determinations  $\pm$  standard error of the difference (SED). Standard error bars are used to compare points within a temperature regime.

## DISCUSSION

### **Maturity Stage of Cleome seeds**

The results of this study showed that there was an increase in germination percentage as well as in vigour as seeds developed to full maturity. Seeds from green pods had the least germination percentage, while seeds from yellow pods had the highest germination percentage and seeds from yellow-green pods were intermediate. According to Harrington (1972), Tekrony and Egli (1997), Muasya *et al.* (2002), highest seed quality is attained at physiological maturity, which in this study could be the yellow pod maturity stage. Xu and Bewley, (1991); Leprince *et al.*, (1993); Bewley and Black, (1994); Kermode, (1995), pointed out that following fertilization, there is the histo-differentiation phase, followed by cell expansion phase and finally physiological maturity. From the findings of this study the green maturity stage was probably at the histo-differentiation stage, the yellow-green stage at cell expansion phase, while the yellow pod maturity stage was close to physiological maturity of spiderplant seeds and hence gave higher seed quality than green and yellow-green pod maturity stages.

### **Desiccation experiment**

In this study the initial germination results obtained were very low and could be attributed to primary dormancy factors. Yepes (1978) observed that freshly harvested seeds of spiderplant exhibit dormancy. Thus, given that spiderplant seeds used in this study were freshly harvested and immediately processed for storage, there was a high possibility of primary dormancy being expressed, at least in the initial germination tests.

Orthodox seeds do not tolerate desiccation at all stages of their development (Kermode *et al.*, 1986). According to Hong and Ellis, (1996), the development ability of seed to tolerate desiccation to very low moisture contents may occur at different developmental stages in different species. Dasgupta *et al.*, (1982) demonstrated that, when immature desiccation-intolerant embryos of bean (*Phaseolus vulgaris* L.) were desiccated, there was a general collapse of the membranes, which was not apparent when more mature, desiccation-tolerant embryos were dried under the same conditions. In this study, no germination was observed when the seeds from green pods were dried to 5% and 2% moisture contents, indicating desiccation tolerance had not been attained or young Cleome could not survive rapid drying. This was in contrast to mustard seeds, which germinated prior to the attainment of desiccation tolerance (Fischer *et al.*, 1988). Tolerance of rapid desiccation usually seems to be delayed until most of the reserve materials have been laid down, close to maximum dry weight or physiological maturity (Ellis *et al.*, 1987). The present study is in

agreement with the above observation as seeds from yellow-green and yellow pods were tolerant to desiccation and viability increased with reduction in moisture content but seed from green pods was intolerant to desiccation and recorded zero germination.

Generally in this study, percentage germination increased with moisture reduction up to 5% but reduced at 2% moisture content. Reduction in vigour status was noticed especially for seed from green and yellow-green pods as indicated by increased mean germination time and electrical conductivity. This could be attributed to the rate at which drying was carried out (1:5; seed: silica gel). Kermode and Bewley (1994) demonstrated that while gradual rates of water loss result in the germination of castor bean seeds as young as 25 days after pollination (DAP), rapid drying over silica gel is fatal to seeds younger than 55 DAP. According to Ellis *et al.*, (1985a), imbibition injury can occur in seeds that have been over dried. This study agrees with this observation especially for spiderplant seed dried to 2% moisture content where low percent germination was recorded across all the maturity stages.

### **Storage experiment**

Viability increased in storage possibly due to loss of dormancy. After-ripening dormancy loss in stored seed has been observed in *Amaranthus retroflexus* (Omami *et al.*, 1992) and *Festuca idahoensis* (Goodwin *et al.*, 1995). Storage temperatures of -20°C gave seeds of highest quality, implying that Cleome seeds are cold tolerant and probably chilling has a dormancy breaking effect.

Removing every last bit of water from seeds is detrimental (Ellis *et al.*, 1985). Reports using numerous species (Chai *et al.*, 1998) have demonstrated that detrimental effects were not initially evident, but became more apparent with time. In other words, the seeds aged more rapidly under extremely dry conditions. Hence it can be concluded that drying to extremely low water contents may shorten seed longevity and for many seeds there is an optimum moisture level for storage at which longevity is maximized and below which seeds are damaged. This is the critical water content (Ellis *et al.*, 1985). In the present study, germination percent tended to increase with moisture reduction up to 5% but the trend declined at 2% moisture content (Table 4). Therefore the findings of this study are in agreement with the aforementioned observation by Ellis *et al.*, (1985) that drying seeds to extremely low water contents could be detrimental and the damage is even more pronounced in storage.

Although germinability increased in storage, there was gradual seed deterioration as indicated by mean germination time and electrical conductivity (Table 4). Seeds stored at room

temperatures and 20% moisture content recorded the lowest vigour while seed stored at minus 20°C and 5% moisture content recorded the highest vigour. This confirms the physiological influence of temperature and moisture content during storage that deterioration of orthodox seeds increases with increase in seed moisture and temperature (Perry, 1981). It has generally long been known that, the greater the moisture content and storage temperature of orthodox seeds, either singly or in combination, the shorter is the period of seed survival (Roberts, 1973a). Therefore, the high percent germination and high vigour (low mean germination time and low electrical conductivity) exhibited by *C. gynandra* seeds stored at 5% moisture content and minus 20°C is in agreement with the above observation. Roberts (1984), has pointed out that, a viability test is limited in detecting quality differences among high germinating seed lots. Tekrony and Egli, (1997) further observed that the results of seed storage are unlikely to adequately reflect the degree of seed deterioration that has taken place. This has been reflected in this study by the high germination of 95%, yet *C. gynandra* seeds had deteriorated in storage as indicated by the electrical conductivity measurements (Table 8). Deteriorated seed lots have high electrolyte leakage and are classified as low vigour, while those with low leakage are considered as of high vigour (ISTA, 1995).

### CONCLUSIONS

The experiments carried out in this study depicted spider plant seed as orthodox (can tolerate desiccation to low moisture content without losing viability) in nature since viability increased with decrease in moisture content. On the basis of this study, spiderplant seeds should be harvested at yellow pod maturity stage. The drastic decrease in percent germination from 5% moisture content to 2% moisture content indicated that the critical moisture content (optimum moisture level for storage at which viability is maximized and below which seeds are damaged) for spiderplant seeds could be between 5% and 3%.

This study has confirmed the beneficial effect of drying seeds to low moisture contents and storing at low temperatures. Based on the results of this study, it may be concluded that, to achieve high seed quality, *C. gynandra* seed should be dried to 5% moisture content and stored at sub zero temperatures (preferably minus 20°C) since a percent germination of 95% was obtained when the seeds were stored at these conditions. However, these conditions can only be available in such places as the gene banks and other institutes that conserve seed for long-term storage. In this study, a germination of 85% was recorded for seed stored at room temperatures (10°C-26°C). The study showed that foil and polythene are similarly good as packaging materials for *C. gynandra* seed (at least

for short-term storage). Therefore farmers can harvest spiderplant seed at yellow pod maturity stage, dry it to about 5% moisture content, package in polythene (since readily available) and store at room temperatures for six months.

#### **ACKNOWLEDGEMENTS**

The study was funded by the International Plant Genetic Research Institute and “Seed for Life Project”.

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### **S2012-24: Optical Properties of TiO<sub>2</sub> Based Multilayer Thin Films**

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#### **Abstract**

Dielectric thin films of TiO<sub>2</sub> have numerous applications ranging from their use in capacitors, optical filters, antireflective coatings, and photocatalysis among others. Optimization of material combinations and coating conditions of multilayer thin films for large scale production has been a challenge to the researcher in the field of material science particularly in the fabrication of TiO<sub>2</sub> based multilayer thin films. This work reports on the optical properties of TiO<sub>2</sub> based multilayer films for a maximum of 5 layers for optical filter applications. An optical filter serve as a light window with bandwidth determined by the upper and lower cutoff frequencies. Samples of TiO<sub>2</sub> thin films of various thicknesses were prepared by spray pyrolysis and its optical constants extracted using Scout code from spectrophotometric data. Using MatLab code, optical properties of multilayer titanium dioxide thin films were modeled using optical data obtained from both literature and experiment. The work shows that with varying combinations of thickness, dielectric type and number of film layers, an optical filter for varying bandwidth ranges can be achieved which can be used as a window layer in optical devices.

Keywords: titanium TiO<sub>2</sub>, multilayer films, optical properties, optical filters

### **S2012-29: Binary Logit Analysis of Household Cooking Fuel Choices for Middle-Income Urban Kenya: Case Study of Nairobi City**

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#### **Abstract**

This study aims to determine the social and demographic factors that influence the choice of household cooking fuel for middle-income urban Kenya. The study first uses descriptive statistics to establish the popular fuels used for cooking. The study then uses binary logistic model to estimate the significance of these factors believed to influence a household's choice of a fuel. Empirical results indicate LPG as the most popular fuel for cooking, followed by charcoal, electricity and kerosene in that order. Firewood is used by a very small proportion of the households and is therefore ignored. Binary logistic empirical results indicate household income, household size, spouse education, spouse age, spouse occupation, house ownership, household head

gender and house type are important factors that influence fuel choice. These factors agree with the hypothesized influence except spouse age and house ownership. Household head occupation and education, spouse and household head religion, spouse and household head marital status and kitchen type do not influence fuel choice. The study thus establishes that not all social and demographic factors influence fuel choice for the middle-income urban Kenya households. This is an indication that households' fuel choices in middle-income urban Kenya are possibly influenced by other factors in addition to social and demographic factors. The study recommends that continual use of charcoal requires that it should be done in a sustainable way by cultivation of fast maturing tree varieties and improvement of the charcoal stove. The study also recommends that further research need to be done to determine if other factors such as the availability of the fuel and the fuel attributes influences households' cooking fuel choice.

**Key words:** *Cooking fuel, binary logistic, urban Kenya*

## **1. Introduction**

Energy is provided by a multiplicity of sources. Each energy source is a commodity with multiple attributes and multiple purposes (Njong & Tabi, 2011). The purposes include cooking, heating, lighting etc. The attributes include energy content, convenience, safety, speed of cooking, quality of light and smoke emitted when burned. Energy sources are intermediate inputs into the utility function (Njong & Tabi, 2011). Utility is derived from the final goods such as cooked food, heat, lighting and entertainment which energy sources help to produce.

In both developing and industrialized countries, issues relating to energy choice and household energy transitions are important for energy policy formulation. Many of these countries advocate and encourage households to make substitutions that will result in more efficient energy use and with less adverse environmental and social impacts. This requires the need to research and analyse the factors that determine the energy and fuel choices for a country. Usage of modern fuels in developing countries increases with income (World Bank, 2003). Households in developing countries practice fuel switching which is either partial or complete. Household partial fuel switching is where a household switches to another fuel but continues to use the old fuel, whereas with complete switching the old fuel is not used. These are energy transitions and can be presented on an energy ladder which rates the quality of household fuels. Figure 1 represents fuel types that might be used by households as their prosperity increases. Households climb the ladder as their income increases. Urban households are more likely to use cleaner technology as their income increase. Fuel switching in developing countries is that households ascend the energy ladder from an inefficient fuel and energy end-use equipment to a more efficient fuel with increasing income levels and urbanisation (Farsi et al, 2004).



Figure 41: Energy ladder

Source: WHO (2002)

## 2. Theoretical Framework

Household fuel choice is thought to be determined by a set of social and demographic factors. Studies (Njong & Tabi, 2011; Ouagadraogo, 2005; Farsi et al, 2004; Mekonnen & Kohlin, 2008; Jiang, & Pachauri, 2008) indicate that the level of education, household income, household size, whether or not a household owns the dwelling unit and whether or not the dwelling unit is traditional or modern are important factors that influence household fuel choices.

Following Pundo & Fraser (2006), the household choice is a function of a set of social factors. For this study the social factors to be considered are gender, age of household head and spouse, level of education of household head and spouse, occupation status, household size, ownership of the dwelling unit and whether or not the dwelling unit is modern or traditional.

## 3. Methodology

The study first uses descriptive statistics to determine the popular fuels for cooking. Binary logistic model is then used to determine and estimate the significance of the social and demographic factors believed to influence households' choice of these fuels.

### 3.1. The model

The study used binary logistic model to estimate the significance of the factors thought to influence household fuel choices. The model examined fuel choices from a set of mutually exclusive household fuels such as firewood, charcoal, kerosene, LPG, and electricity. The probability that a household chooses one type of fuel is restricted to lie between zero and one. The model assumes no changes in fuel prices or fuel attributes, and also that households make fuel choices that maximize their utility.

In binary logistic model, the dependent variable is a dichotomous outcome or event. For this study it is either choosing a particular fuel or not choosing it. Data is entered into the analysis as 0 or 1 coding for dichotomous outcome, continuous values for continuous predictors, and dummy codings (e.g. 0 or 1) for categorical predictors. The model can be expressed as follows;

$$\Pr (Y_i = 1) = \frac{\exp(B_j X_j)}{\sum_{j=0}^k \exp(B_j X_j)} \quad (1)$$

Where:

- $\Pr (Y_i = 1)$  is the probability of choosing either firewood, charcoal, kerosene, LPG or electricity
- $j$  is the number of fuels in the choice set
- $x_j$  is the  $j$ th social factor (variable)
- $B_j$  is the estimated parameter corresponding to  $j$ th social factor

NB: X (predictor) can be categorical or continuous but Y (response) is always categorical

Upon rearranging the logit equation above using algebra, the following regression equation is obtained:

$$P_i = \frac{e^{(B_0 + B_1 X_1 + \dots + B_k X_k)}}{1 + e^{(B_0 + B_1 X_1 + \dots + B_k X_k)}} \quad (2)$$

Where  $P_i$  = Probability (Y = outcome of interest or event)

The equation that will be used to estimate the coefficients is:

$$\ln\left(\frac{P_i}{1 - P_i}\right) = B_0 + B_1 X_1 + \dots + B_k X_k + e \quad (3)$$

The estimated parameters (or coefficients) of the logit model are estimated using the maximum likelihood method i.e. maximizing log-likelihood with respect to parameter vector. This is done by differentiating partially the above log equation with respect to each of the parameter vectors, equating the results to zero and then solving the equations. In maximum likelihood, the aim is to maximize the log-likelihood function (Gujarati D.M, 2003).

The quantity  $\left(\frac{P_i}{1-P_i}\right)$  is called the odds ratio and  $\ln\left(\frac{P_i}{1-P_i}\right)$  is the logit or log odds. The equation expresses the logits (log odds) as a linear function of the independent factors (Xs). The equation allows the interpretation of the logit weights for variables in the same way as in the linear regressions. The estimated coefficients refer to the degree to which the probability of choosing a fuel would change with a unit change of explanatory or predictor variables. The estimated coefficients tell the relationship between the independent variables and the dependent variable, the dependent variable is on logit scale. The dependent variable is the fuel choice (firewood, charcoal, LPG, kerosene or electricity). Estimated coefficients measure the estimated change in the logit for one unit change in the predictor variable while the other predictor variables are held constant. When the estimated coefficient is positive, larger (or smaller) X values are associated with larger (or smaller) logits of Y. Conversely, if estimated coefficient is negative, larger (or smaller) X values are associated with smaller (or larger) logits of Y.

### **3.2. Population and Sample**

The population from which the sample was drawn from was the middle-income households within Nairobi city. Convenient sampling was done within these households. The data was collected from 313 households in six estates in Nairobi i.e. Githurai, Kahawa, Umoja, Buru Buru, Satellite and Ngumo. These areas comprise mainly of the middle income households where majority of city residents live. The study avoided households in the extremes i.e. slums and high income households.

### **3.3. Expected Outputs**

In this study, the social and demographic factors considered were: the age of the household head and that of the spouse, the level of education of the household head and that of the spouse, the occupation of the household head and that of the spouse, gender of the household head and that of the spouse, marital details of household head and that of the spouse, religion of the household head and that of spouse, household size, household income, whether or not the house hold owns the dwelling unit, whether or not the dwelling unit is modern or traditional type house and the kitchen type.

Theoretically, the above social factors are expected to influence household fuel choice in the following manner. As the age of the household head or the spouse increases, this increases the likelihood of the household to use charcoal as a fuel for cooking. The older the household head or the spouse, the more likely the household will continue to use charcoal. The level of education of

household head and spouse is expected to have positive effects on LPG and electricity. The level of education improves knowledge of fuel attributes and preference for better and cleaner fuels. Occupation of wife or husband is expected to have a positive effect on modern and cleaner fuels. This is due to improvements in income and thus ability to afford the modern fuels. The household size is expected to negatively affect choice of the modern fuels. The ownership of dwelling unit is expected to be critical in household fuel choice. If the households dwelling unit is rented, the household is more likely to use traditional fuel alternatives. The disadvantage of traditional fuels especially firewood is that it produces smoke and stains walls and roofs, making it less preferred in rented houses. Also if the dwelling unit is modern type house, the household is more likely to use cleaner fuels unless if the kitchen is detached from the main house.

#### 4. Results and discussions

##### 4.1. Fuels for Cooking

The study established as seen in Table 1 that LPG is used for cooking by 81% of the households, then charcoal, electricity, kerosene and firewood by 59, 45, 41 and 8% of the households respectively. Firewood is used by a small proportion. Therefore for this study firewood was ignored since it was used by few households.

Table 1: Percentages of households using a particular fuel for cooking

	Firewood	Charcoal	Kerosene	LPG	Electricity
Percentage of households using the fuel for cooking	8%	59%	41%	81%	45%

Source: From this study

##### 4.2. Binary Logistic Regression

From the data that was collected, it is established that LPG, charcoal, electricity and kerosene are the fuels used for cooking. Each of these is analysed using the binary logistic regression. To obtain the model for each, the forward stepwise (Wald) method was used and therefore the last step is the one considered. The study explains only the factors that are significant as they influence the model after controlling the other factors. The factors that are not significant do not contribute to the model after controlling the other factors. The categorical variable codings for all of them are the same (see Appendix I).

##### 4.2.1. Cooking (Charcoal)

For binary logistic regression results for cooking with charcoal, see Appendix II. Inclusion of predictor variables increases the percentage of correct classification from 62.3% to 64.8%. The

model explains 9.8% of the variation in the dependent variable based on Cox and Snell R square. The regression equation for the model is:

$$\text{Logit } (P_{\text{Charcoal}}) = 20.382 + 0.38 * \text{Household size} - 0.29 * \text{Household income} - 1.694 * \text{Spouse gender (1)} - 20.144 * \text{Spouse occupation (1)} - 21.309 * \text{Spouse occupation (2)} - \text{Spouse occupation (3)}$$

(See categorical variable coding in Appendix I)

The number of persons (household size) and income of households are significant and thus they contribute to the model after controlling the other factors. The spouse gender for the dummy variable male, spouse occupation dummy variables government employed, private/NGO employed and self employed are not significant and thus they do not contribute to the model, after controlling the other factors.

The odds ratio of household size is 1.463. Therefore when household size increases by one, the likelihood of households to use charcoal for cooking increases by a factor of about 1.5. This concurs with the hypothesized influence and shows that an increase in the household size positively affects a household's choice of charcoal. It is sensible to use a cheaper fuel to cook for many people.

The odds ratio of household income is 0.972. Therefore when household income increases by a thousand, the likelihood of households not to use charcoal for cooking increases by a factor of 1.3. As a household's income increases it can afford the modern fuels which are cleaner and convenient to use for cooking.

#### **4.2.2. Cooking (Kerosene)**

For binary logistic regression results for cooking with kerosene see Appendix III. Inclusion of predictor variables increases the percentage of correct classification from 60.1% to 80.6%. The model explains 39.3% of the variation in the dependent variable based on Cox and Snell R square. The regression equation for the model is:

$$\text{Logit } (P_{\text{kerosene}}) = 4.638 + 1.642 * \text{Spouse education (2)} - 0.081 * \text{Spouse age} - 0.064 * \text{Household income} + 0.918 * \text{Spouse education (1)} - 0.305 * \text{Househead occupation (1)} - 1.614 * \text{Househead occupation (2)} - 0.395 * \text{Househead occupation (3)}$$

(See categorical variable coding in Appendix I)

The spouse education for the dummy variable primary, household head occupation for the dummy variables government employed, private/NGO employed and self employed are not significant and thus they do not contribute to the model, after controlling the other factors. The spouse education for the dummy variable secondary, spouse age and income of households are significant thus they contribute to the model after controlling the other factors.

The odds ratio of spouse education when the dummy variable is secondary is 5.2. Therefore when the spouse education level is secondary, households are 5.2 times more likely to use kerosene for cooking than when the education level is post-secondary. This supports the study's theoretical expectation as level of education improves knowledge of fuel attributes and preferences of better cleaner fuels. Kerosene is above charcoal but below LPG in the energy ladder.

The odds ratio of spouse age is 0.922. Therefore when spouse age increases by one, the likelihood of households not to use kerosene for cooking increases by a factor of 1.08. This supports the study's theoretical expectation that households will continue to use traditional fuels such as charcoal as the age of the spouse increases.

The odds ratio of household income is 0.938. Therefore when household income increases by a thousand, the likelihood of households not to use kerosene for cooking increases by a factor of 1.07. This supports the study's expectation that as a household's income increases, households can afford to switch to fuels higher in the energy ladder.

#### **4.2.3. Cooking (LPG)**

For binary logistic regression results for cooking with LPG see Appendix IV. Inclusion of predictor variables increases the percentage of correct classification from 82.1% to 90.5%. The model explains 37% of the variation in the dependent variable based on Cox and Snell R square. The regression equation for the model is;

$$\text{Logit (P}_{\text{LPG}}) = 15.016 + 3.087*\text{House type (1)} - 2.260*\text{House ownership (1)} + 0.104*\text{Household income} - 16.204*\text{House head occupation (1)} - 15.872*\text{Househead occupation (2)} - 17.604*\text{Househead occupation (3)}$$

(See categorical variable coding in Appendix I)

The household head occupation for dummy variables government employed, private/NGO employed and self employed are not significant and thus they do not contribute to the model after controlling the other factors. The house type for dummy variable modern, house ownership for the dummy variable rental and household income are significant and thus they contribute to the model after controlling the other factors.

The odds ratio of house type when the dummy variable is modern is 21.9. Therefore when the house is modern, households are 22 times more likely to use LPG for cooking than when it is traditional. Households living in modern dwelling units are wealthier and thus can afford LPG.

The odds ratio of house ownership when the dummy variable is rental is 0.104. Therefore when the house is rental, households are 9.6 times more likely not to use LPG for cooking than when they own the house. This does not concur with the theoretical expectation that households living in rented dwelling units are likely to use cleaner fuels such as LPG, fuels that do not produce smoke which stains walls and roofs.

The odds ratio of household income is 1.110. Therefore when household income increases by a thousand, the likelihood of households to use LPG for cooking increases by a factor of 1.1. As household income increases, households can afford to continue using cleaner and convenient fuels such as LPG.

#### **4.2.4 .Cooking (Electricity)**

For binary logistic regression results for cooking with electricity see Appendix V. Inclusion of predictor variables increases the percentage of correct classification from 50.9% to 77.3%. The model explains 38.9% of the variation in the dependent variable based on Cox and Snell R square. The regression equation for the model is ;

$$\begin{aligned} \text{Logit (P}_{\text{electricity}}) = & -9.247 + 2.713*\text{Househead gender (1)} + 0.033*\text{Spouse age} \\ & + 3.605*\text{Spouse occupation (1)} + 0.095*\text{household income} \\ & + 2.665*\text{Spouse occupation (2)} + 1.918*\text{Spouse occupation (3)} \end{aligned}$$

(See categorical variable coding in Appendix I)

The spouse occupation for the dummy variable private/NGO employed and self employed are not significant and thus they do not contribute to the model after controlling other factors. The household head gender for the dummy variable male, spouse age, spouse occupation for the dummy variable government employed and income of households are significant and thus contribute to the model after controlling other factor.

The odds ratio of household head gender when the dummy variable is male is 15.078. Therefore when the household head gender is male, households are 15 times more likely to use electricity for cooking than when the gender is female. Males generally do not cook and therefore they are likely to prefer to use a fuel or an energy source that is fast, clean and convenient such as electricity.

The odds ratio of spouse age is 1.034. Therefore when spouse age increases by one, the likelihood of households to use electricity for cooking increases by a factor of 1.03. This does not agree with the theoretical expectation that households will continue to use traditional fuels as they become older.

The odds ratio of spouse occupation when the dummy variable is government employed is 36.780. Therefore when the spouse is employed by government, households are 37 times more likely to use electricity for cooking than when the spouse is retired. Government employed spouses have monthly income unlike retired spouses, and therefore can afford to pay high electricity bills due to cooking using electricity.

The odds ratio of household income is 1.10. Therefore when household income increases by a thousand, the likelihood of households to use electricity for cooking increases by a factor of 1.1. As household income increases, households can afford to continue using cleaner and convenient fuels.

## **5. Conclusion and Recommendations**

This study reveals a set of factors that determine household cooking fuel choice for middle-income urban Kenya. In the choice of charcoal as the household cooking fuel, both household size and household income are significant and also concur with the theoretical expectation. For kerosene, spouse education for dummy variable secondary, spouse age and household income are significant and also concur with the hypothesized influence in the choice of the fuel. In the choice of LPG as the household cooking fuel, house type for the dummy variable modern and household income are significant and also concur with the hypothesized influence but house ownership for the dummy variable rental is significant do not concur with theoretical expectation. In case of electricity, household gender for the dummy variable male, spouse occupation for the dummy variable government employed and household income are significant and also concur with the theoretical expectation but spouse age is significant and do not concur with the theoretical expectation.

Thus the study establishes that household income, household size, spouse education, spouse age, spouse occupation, house ownership, household head gender and house type are important factors that influence fuel choice. All these factors concur with the hypothesized influence except house

ownership and spouse age in some cases. Spouse education and occupation, household head occupation and household income were expected to strongly influence cooking fuel choice but this was not true for all cases. The influence due to household income is weak in all cases. Household head education, spouse religion, household head religion, spouse marital status, household head marital status and kitchen type do not influence fuel choice. Factors such as household head education and kitchen type were highly expected to influence households' cooking fuel choice. Therefore not all social and demographic factors influence fuel choice for the middle-income urban Kenya households. This is an indication that households' fuel choices in middle-income urban Kenya are possibly influenced by other factors in addition to social and demographic factors.

The study also shows that LPG and charcoal are fuels used for cooking by most household in middle-income urban Kenya. The continual use of charcoal will negatively impact on the environment through deforestation, soil erosion and loss of natural habitat for wildlife. Solutions to these environmental consequences require that modern cooking fuels be made accessible and affordable. Also charcoal production and use should be made sustainable by cultivation of fast maturing tree varieties and improvement on the charcoal stove. The study also recommends that further research need to be done to determine if other factors such as the availability of the fuel and the fuel attributes influences households' cooking fuel choice.

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**S2012-30: Comparative Diuretic Effect of *Aloe seccundiflora* (Aloe), *Azadirachta indica* (Neem) and *Urtica Dioica* (Stinging nettle) in Newzealand Male Rabbits**

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**Abstract**

Herbal medicine has been extensively used across the globe dating back to the Ayurvedic medicine. Existing literature and practices show that *Aloe seccundiflora* (Aloe), *Azadirachta indica* (neem) and *Urtica Dioica* (stinging nettle) are among the most commonly used plant extracts in the treatment of hypertension. Studies show that some antihypertensive herbal medicines reduce blood pressure by decreasing extra cellular fluids. This leads to loss of serum electrolytes such as sodium, chloride and potassium. Consequently, over dosage or long term use of such plant materials may lead to excessive loss of body fluids and serum electrolytes. This study comparatively investigated the potential diuretic effect of *A. indica* and *U. dioica* 60% ethanolic leaf extract, and *A. seccundiflora* juice in Newzealand white male rabbits. The animals were administered 80mg/kgbw of formulated extract syrup of the three plants, Furosemide (g) and placebo in the morning, and urine collected from a slanting cage after 12 hours. *A. seccundiflora*, *U. dioica* syrups and Furosemide showed significant increase in mean urine volume ( $p < 0.0001$ ) by 27.5ml (36.7%), 59.33ml (44.9%) and 67ml (47.2%) respectively compared to the placebo whereas the effect was insignificant for *A. indica*, 11.83ml (13.6%). The study concluded that *A. seccundiflora* and *U. dioica* syrups possess significant diuretic effect and should therefore be used with care, as over dosage or overuse may lead to serious loss of serum electrolytes and related physiological side effects.

**Key Words:** *A. seccundiflora*, *U. dioica*, *A. indica*, Furosemide, 60% ethanolic extract, diuretic effect.

## S2012-31: Inhibitory Action of Some Essential Oils on Growth of Various Moulds Isolated from Maize

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### Abstract

Moulds destroy more than 30% of crop yields in developing countries and produce potentially poisonous mycotoxins. The aim of this study was to determine the sensitivity profile of mould strains isolated from maize to some essential oils. The assayed mould strains were *Fusarium spp* and *Aspergillus spp*. Five essential oils were extracted from aromatic plants (*Tarhonoranthus camphoratus*, *Artemisia vulgare*, *Piper capense*, *Foeniculum vulgare* and *Rosmarinus officinalis*) using hydro-distillation. The antifungal activity tests showed that all the essential oils screened were active against 12 *Aspergillus* and 14 *F*

*usarium* species. These results show that the essential oils screened has antifungal activities against *Aspergillus* and *Fusarium* species that are the producers of poisonous mycotoxins found in maize. This oil can be used in food preservation systems to inhibit the growth of moulds and retard subsequent mycotoxin production.

### Introduction

Moulds are opportunistic biological agents of ubiquitous nature (Ryan and Ray, 2004). Because of their powerful arsenal of hydrolytic enzymes, these microorganisms can cause a high degree of deterioration when present in foods and are responsible for considerable economic losses (Souza *et al.*, 2005). Furthermore, they can act as potential producers of toxic metabolites, named mycotoxins, which are potentially poisonous to consumers' health. The most common moulds that develop on foods and feeds include those from the genera *Aspergillus*, *Penicillium*, *Fusarium*, *Rhizopus* and *Mucor*.

It is well established that some plants contain compounds able to inhibit microbial growth (Naqui *et al.*, 1994; Matasyoh *et al.*, 2007, 2009). These compounds can have different structures and different action when compared with conventional antimicrobials used to control microbes (Nascimento *et al.*, 2000). The potential antimicrobial properties of plants had been related to their ability to synthesize several chemical compounds of relatively complex structures with antimicrobial activity (Nychas, 1996).

The wide and indiscriminate use of chemical preservatives has been the cause of the appearance of resistant micro-organisms, leading to occurrence of emerging food borne diseases (Akinpelu, 2001; Gibbons, 1992; Kaur and Arora, 1999). Due to this, there is an increasing interest to obtain alternative antimicrobial agents to use in food conservation systems.

One of the main procedures used in the research of biologically active substances is the systematic screening of the interaction between microorganisms and plant products. This procedure has been source of useful agents to control the microbial survival in different microbiology application fields (Salvat *et al.*, 2001). Plant products of recognized antimicrobial spectrum could appear in food conservation systems as main antimicrobial compound or as adjuvants to improve the action the action of other antimicrobial compound (Kaur and Arora, 1999). The aim of this study was to evaluate the sensitivity profile of moulds strains isolated from foods to some essential oils and phytochemicals with emphasis for a possible future use of the ones as alternative antimould compounds.

## **Materials and Methods**

### **Extraction of essential oils**

The target aromatic plants that were used in the extraction of essential oils were selected from *Lamiaceae*, *Asteraceae*, *Piperaceae* and *Apiaceae* families which are known to contain antimicrobial essential oils (Matasyoh, *et al.*, 2005; 2006; 2007). Fresh leaves of *Artemisia vulgare*, *Foeniculum vulgare*, *Piper capense*, *Tarchonanthus camphoratus* and *Rosmarinus officinalis* were collected from Kakamega forest and the nearby fields and packed into two litre flasks up to three-quarter full and weighed. About 500 ml of tap water was added and the leaves were subjected to hydro-distillation, using modified Clevenger- type apparatus for 4 hours as described by Matasyoh *et al.* (2008). The resultant mixture of steam and essential oil were passed through a Liebig condenser and cooled by a continuous flow of cold water. Essential oils are less dense than water and were separated as an upper layer, floating on the distillation water. The oil was then collected by decanting into sample bottles and dried using anhydrous sodium sulphate (Na<sub>2</sub>SO<sub>4</sub>). The procedure was repeated until a sufficient amount of oil for anti-microbial tests was obtained. The oils were stored in a sealed glass vial (Bijoux bottle) at 4°C for further analyses.

### **Mould strains**

Maize samples were collected from various households and market centres in Western Kenya. Moulds were isolated from these samples using the direct plating technique. The grains were surface sterilized in 2.5% sodium hypochlorite for 30 seconds and rinsed in three changes of sterile distilled water. The grains were blotted with sterile filter papers and plated on czapex dox and potato dextrose agar containing 7.5% sodium chloride and 1 gm streptomycin sulphate (for 1 litre of media). The plates were incubated at 25°C and monitored daily for fungal growth for seven days. The resulting cultures were identified based on cultural and morphological characteristics using

taxonomic keys (Matasyoh *et al.*, 2009; Klich, 2001). Target moulds were sub-cultured to obtain pure single-spore cultures.

### **Screening for antimould activity**

Paper disc diffusion inhibition test was used to screen for antimould activity of the essential oils as described by Souza *et al.* (2005). One hundred microliters of mould suspension (approximately  $10^6$  spores/ml measured using a haemocytometer) prepared with sterile 0.85% physiological saline solution was uniformly spread on the sterile potato dextrose agar in a petri dish. Sterile filter paper discs (Whatman No. 1, 6mm in diameter) were soaked with 10 $\mu$ l of the essential oil and placed at the centre of the inoculated culture plates. The plates were incubated at 25°C for 7-10 days. At the end of the incubation period, diameters of the inhibition zones were measured to the nearest millimeter (mm) and recorded. Nystatin discs were used as the reference standard to control the moulds.

### **Statistical analysis**

Data on inhibition zones was analyzed using Microsoft office Excel 2003 to derive means and standard deviations. Separation of means for antimould activity was done using LSD.

### **Results and Discussions**

All the five essential oils extracted from *Tarchonanthus camphoratus*, *Rosmarinus officinalis*, *Artemisia vulgare*, *Foeniculum vulgare* and *Piper capense* were screened for their activity and they presented inhibitory action on 14 *Aspergillus* and 13 *Fusarium* species assayed. Screening results for antimould activity of the phytochemicals on the mould strains are shown in Table 1 and 2. The best results for *T. camphoratus* were on *A. nidulans* at an inhibition zone of 14.3 mm in diameter followed by *A. fumigatus* (12.3 mm) and the least antifungal activity of the oil was observed against *A. terreus* with an inhibition zone of 6.7 mm in diameter. The highest activity of the oil on the genus *Fusarium* was observed against *F. oxysporum* with the largest inhibition zone of 24.3 mm as compared to 11 mm inhibition by Nystatin. This was followed by activity against *F. solani* (21.3 mm) and lastly *F. nivale* at (11.3 mm). The best result for *Rosmarinus officinalis* was exhibited on *A. nidulans* with an inhibition zone of 18.3 mm. The inhibition is considered high compared to the standard Nystatin that had an inhibition of 20 mm in diameter. The oil showed least activity on *A. niger* with a diameter of 6.3 mm. The oil did not show any inhibition on *A. tamaritii*. For *Fusarium* species, *R. officinalis* had good activity against *F. trincinctum* at 17.3 mm and the least activity was exhibited on *F. graminearum* at 6.3 mm. Though in some species there was minimal activity, the oil had activity on all the *Fusarium* species tested. *Artemisia vulgare* showed best results on *A.*

*nidulans* with a zone of 21.3 mm which compared to Nystatin (20 mm) was higher. This was followed by an activity on *A. fumigatus* at 11.7 mm. The least inhibition was however exhibited on *A. parasiticus*, *A. flavus*, *A. humicola* and *A. ustus*. The oil did not show any antifungal activity against *A. ochraceus*, *A. tamarii*, *A. flavipes*, *A. wentii*, *A. terreus* and *A. versicolor*. *Artemisia vulgare* had activity on all the *Fusarium* species screened. The oil had good activity on *F. semitectum* at 15.7 mm and least activity was exhibited on *F. graminearum* and *F. moniliforme*. The essential oil *Foeniculum vulgare* had good antifungal activity against *A. nidulans* at 12.3 mm. Though this is low compared to the standard (Nystatin=20 mm), it was the highest zone of inhibition. Least antifungal activity was shown on *A. wentii* at 6 mm. However, no activity was exhibited on *A. parasiticus*. *Piper capense* had good activity on *A. fumigatus* with an inhibition zone of 18.3 mm, followed by *A. niger*. The least activity was exhibited on *A. flavus* at a diameter of 6.7 mm. There was no activity against *A. parasiticus*, *A. tamari*, *A. nidulans* and *A. versicolor*. The essential oil *F. vulgare* had good activity on *F. semitectum* and least activity on *F. solani* and *F. trincinctum*. No antifungal activity was exhibited by the oil on *F. avenaceum* and *F. moniliforme*. *Piper capense* had a good activity on *F. nivale* at 14.33 mm. This zone was higher than the standard which was 10 mm. The least activity was on *F. avenaceum* and *F. scirpi* at 6.7 mm. However, the oil had activity against all the *Fusarium* species screened.

The high antifungal activity of *Tarchonanthus camphoratus* oil could be mainly due to the presence of the two isomers; geranial and neral, although other minor constituents like  $\alpha$ -pinene have been reported to be the main cause of the antifungal activity of the oil from *Pistacia lentiscus* (Anacardiaceae) (Matasyoh *et al.*, 2010). The antifungal activity of the oil varied with its concentration and the kind of fungal species, indicating that its activity is proportional to its concentration. According to Matasyoh *et al.* (2007), the essential oil of *T. camphoratus*, obtained by hydro-distillation, was analyzed by gas chromatography–mass spectrometry (GC–MS) and was found to be dominated by monoterpenes, which accounted for 80.9% of the oil. The study indicated the presence of a high percentage of oxygenated monoterpenes (62.3%), of which the main constituents were fenchol (15.9%), 1, 8-cineole (14.3%) and  $\alpha$ -terpineol (13.2%). Other monoterpenes present in fairly good amounts were  $\alpha$ -pinene (6.87%), *trans*-pinene hydrate (6.51%), terpinen-4-ol (4.74%) and camphene (3.76%). These could explain the good antimould activity exhibited by the oil on different fungal species screened. Literature shows that *R. officinalis* has antimicrobial activities against a variety of bacteria, fungi, moulds and viruses (Salehi *et al.*, 2007).

The antimicrobial activity of the oil was tested on various microorganisms and it showed promising antimicrobial activity according to Antony, . This explains why the oil had good antimould activity against the *Aspergillus* and *Fusarium* species screened in this study. *Artemisia vulgare* oil has been evaluated and results presented a great variety of sesquiterpenes that could be considered answerable for the antimicrobial activity. Although they usually occur as complex mixture, their activity may generally account for in terms of their major components (Glauciemar *et al.*, 2009). The oil of *F. vulgare* has been shown to be effective against fungal pathogens causing diseases in plants and human beings according to Sunita and Mahendra, 2008. According to their findings, the oils are important source of fungi toxic compounds and they may provide a renewable source of useful fungicides that can be utilized in antimycotic drugs against *A. fumigatus* and *A. niger*. The results support the notion that plant essential oils have a role as pharmaceuticals and preservatives. The good activity of *Piper capense* owes to the leaves having a high content of sesquiterpenes (65.2-89.5%), (Tchoumboungang *et al.*, 2009). The most prominent compound in the leaves was found to be  $\alpha$ - pinene (12.8%) and  $\beta$ -pinene (50.1%). Consequently research shows that the oil is quantitatively rich in monoterpenes (80.8%). The activity of this oil against *Aspergillus* and *Fusarium* species can be attributed to the monoterpenes found in the oil. The result is similar to one done in Cameroon where *P. capense* was shown to possess high levels of insecticidal activity.

In general, the essential oils evaluated in this work have a great variety of phytochemicals that could be considered as responsible for a higher or lower antimicrobial activity. Phytochemicals are chemical substances characterized as organic biomolecules found and isolated from different plant derivatives products as teas, decocts, infusions, extracts and essential oils. These compounds are responsible for the biological activities exerted by several plants and their derivative products (Souza *et al.*, 2005). In general, the inhibitory action of natural products on mould cells involves cytoplasm granulation, cytoplasmic membrane rupturing and inactivation and/or synthesis inhibition of intercellular and extracellular enzymes. These actions can occur in isolate or concomitant way and culminate with the mycelium germination inhibition (Souza *et al.*, 2005).

## **Conclusions**

The essential oils of *T. camphoratus*, *R. officinalis*, *A. vulgare*, *F. vulgare* and *P. capense* tested in this study possess varying levels of antifungal activity against *Aspergillus* and *Fusarium* species.

## **Recommendation**

The results obtained justify future researches emphasizing the antimicrobial properties of essential oils and their possible use as viable alternatives to control microbial growth and mycotoxin production in foods.

It would be important to establish the actual bioactive component/s and the mode of action of the essential oils against the *Aspergillus* and *Fusarium* species. Of interest also would be to determine the effect of the oil on mycotoxin production ability of the moulds.

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of *Piper capense* L., *Piper giuneense* Schum.et Thunn., *Piper nigrum* L. and *Piper umbellatum* L. grown Cameroon. *African Journal of Biotechnology* 8(3): 424-431.

Table 1: Inhibition zones (mm) induced by essential oils of *Tarhchonanthus camphoratus*, *Rosmarinus officinalis*, *Artemisia vulgare*, *Foeniculum vulgare* and *Piper capense* on *Aspergillus* species isolated from maize samples after 14 days of incubation.

Mould species	Essential oils <sup>a</sup>						
	<i>T. camphoratus</i>	<i>R. officinalis</i>	<i>A. vulgare</i>	<i>F. vulgare</i>	<i>P. capense</i>	STD <sup>b</sup>	Control
<i>A. flavus</i>	8.00	7.67	6.33	7.00	6.67	12	0
<i>A. ochraceus</i>	10.67	7.00	0	9.00	8.67	17	0
<i>A. parasiticus</i>	8.33	9.67	6.33	0	0	14.5	0
<i>A. niger</i>	10.66	6.33	6.00	10.33	13.67	20.5	0
<i>A. tamaritii</i>	10.17	0	0	8	0	13	0
<i>A. fumigatus</i>	12.3	13.00	11.67	10.67	18.33	20.5	0
<i>A. flavipes</i>	9.83	6.33	0	6	10	20.5	0
<i>A. ustus</i>	10.3	6	6.33	8.33	7.33	15.5	0
<i>A. nidulans</i>	14.33	18.33	21.33	12.33	0	20	0
<i>A. wentii</i>	8.5	5.67	0	5.67	10.67	16	0
<i>A. sparsus</i>	10.17	7.33	8.67	12	9.33	13.33	0
<i>A. versicolor</i>	9.3	8.00	0	8.67	0		0
<i>A. terreus</i>	6.67	6.33	0	7.33	6	18.33	0
<i>A. humicola</i>	8.33	7	6.33	10.33	7	12.33	0

<sup>a</sup> absolute concentration; <sup>b</sup> control: Nystatin

Table 2: Inhibition zones (mm) induced by essential oils of *Tarhchonanthus camphoratus*, *Rosmarinus officinalis*, *Artemisia vulgare*, *Foeniculum vulgare* and *Piper capense* on *Fusarium* species isolated from maize samples after 14 days of incubation.

Mould species	Essential oils <sup>a</sup>						
	<i>T. camphoratus</i>	<i>R. officinalis</i>	<i>A. vulgare</i>	<i>F. vulgare</i>	<i>P. capense</i>	STD <sup>b</sup>	Control
<i>F. avenaceum</i>	14.0	14.67	15.00	0	6.67	12.5	0

<i>F. sporotrichiodes</i>	11.3	9.00	10.33	6.33	8.67	11.5	0
<i>F. subglutinans</i>	14.3	9.67	8.67	7.67	7.67	12	0
<i>F. culmorum</i>	11.5	7.67	7.33	6.67	9.67	11.5	0
<i>F. trincinctum</i>	12.00	17.33	11.33	6	10.33	12	0
<i>F. oxysporum</i>	24.3	13	16	6.63	12.33	11	0
<i>F. proliferatum</i>	21	12.33	17	8.67	13	9	0
<i>F. semitectum</i>	19	16.67	15.67	11	10.33	19.5	0
<i>F. scirpi</i>	15.5	14.67	15	8.67	6.67	20	0
<i>F. nivale</i>	11.3	11	9.67	6.33	14.33	10	0
<i>F. graminearum</i>	14.5	6.33	6	6.67	12	34.5	0
<i>F. moniliforme</i>	16.8	6.67	6	0	7.67	13.5	0
<i>F. solani</i>	21.33	10.67	8.33	6	7.67	28	0

<sup>a</sup> absolute concentration; <sup>b</sup> control: Nystatin

### **S2012-32: Impact of Climate Variability on Food Security and Biodiversity Conservation in Nyeri County, Kenya**

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#### **Abstract**

Climate variability has a great significance on food security and biodiversity conservation in rural livelihoods in Nyeri County. The adverse effects of climate variability, leads to variations of weather patterns and global warming causing crop failure, reduced yields and loss of biodiversity. Hence there is need to carry out research on climatic variability to determine socioeconomic consequences. The purpose of the study was to assess the impact of climate variability, identifying the socio-economic response and establishing viable alternatives and sustainable means of rural livelihoods. Purposive sampling was used to select the study area, while random sampling assisted in identification of the respondents. Document analysis was used to examine climatic data of temperatures and precipitation which was obtained from the Kenya Meteorological Department and Water Resource Management Authority (WRMA). Data collected was analyzed using Statistical

package for social sciences (SPSS) software that generated frequencies, trend analysis, regression and chi-square. The study observed that drought occurs consistently after 3-4 years, and consequently contributes to food insecurity and loss biodiversity. To cope with the adverse effects of climate variability the community should be encouraged to grow drought resistant crops, intensify food preservation, storage and planting of indigenous trees. The farmers should be advised to adopt water harvesting strategies such as damming of flush floods and from rooftops. Proper utilization of harvested water for domestic use and farming through efficient irrigation such as drip irrigation should be encouraged. This enhances sustainable utilization of resources in the County and eventually will help the rural communities to conserve the environment, reduce food shortage and poverty.

**Key words:** Climate variability, Biodiversity, Food security

## **1.0 BACKGROUND**

The third assessment report of the UNEP/WMO Intergovernmental Panel on Climate Change (IPCC) notes a warming of approximately 0.7°C over most of the African continent during the 20th century based on historical records and is considered highly vulnerable to climate variability. Observational records show that the continent of Africa has been warming through the 20th century at the rate of about 0.05°C per decade with slightly larger warming in the June-November seasons than in December-May (Hulme, 2001). This is due to variation of daytime temperature and prevailing winds. By the year 2000, the 5 warmest years in Africa had all occurred since 1988, with 1988 and 1995 being the two warmest years (Hulme, 2001). This rate of warming is not dissimilar to that experienced globally, and the periods of most rapid warming the 1910s to 1930s and the post 1970s occur simultaneously in Africa and the world.

In Kenya, adverse effects of climate variability have also been experienced including variations in weather patterns and global warming. According to NEMA (2008), related climate variability includes prolonged and frequent droughts, floods, resurgence of diseases, pests and environmental disasters. For instance the *La nina* of 1999-2001 was the longest and most severe which caused devastating effects especially on human livelihoods (NEMA, 2008). The drought affected four million people due to crop failure as well as reduced yields. Droughts have caused starvation, loss of life and massive degradation. Climate variability have become more pronounced in Kenya in

recent years, particularly affecting agricultural production, the main livelihood activity of most Kenyans, (Awour, 2010).

According to UNDP in UNEP (2009), the mean annual temperature in Kenya has increased by 1.0°C since 1960 representing an average rate of 0.21°C per decade. It is projected to increase from 1.0°C to 2.8°C by 2060. By the year 2100, the temperature in Kenya could increase by about 4°C causing variability in rainfall by up to 20% (Kabubo and Karanja, 2007). Exposure to impacts of climate variability and extremes, most particularly drought, poses substantial risks to people living in Central Kenya causing widespread famine (Ogolla *et al.*, 1997).

## **1.1 PURPOSE OF STUDY**

To establish impact of climate variability on food security and biodiversity conservation in central province of Kenya particularly focusing in Nyeri county.

## **1.2 STUDY OBJECTIVES**

The main objective of the study was to examine the impact of climate variability on food security and biodiversity conservation Nyeri County

- i. To establish the influence of rainfall on climate variability in Nyeri county
- ii. To examine the effects of drought on food security and biodiversity conservation
- iii. Establish the coping strategies on food insecurity and biodiversity conservation.

## **NULL HYPOTHESIS**

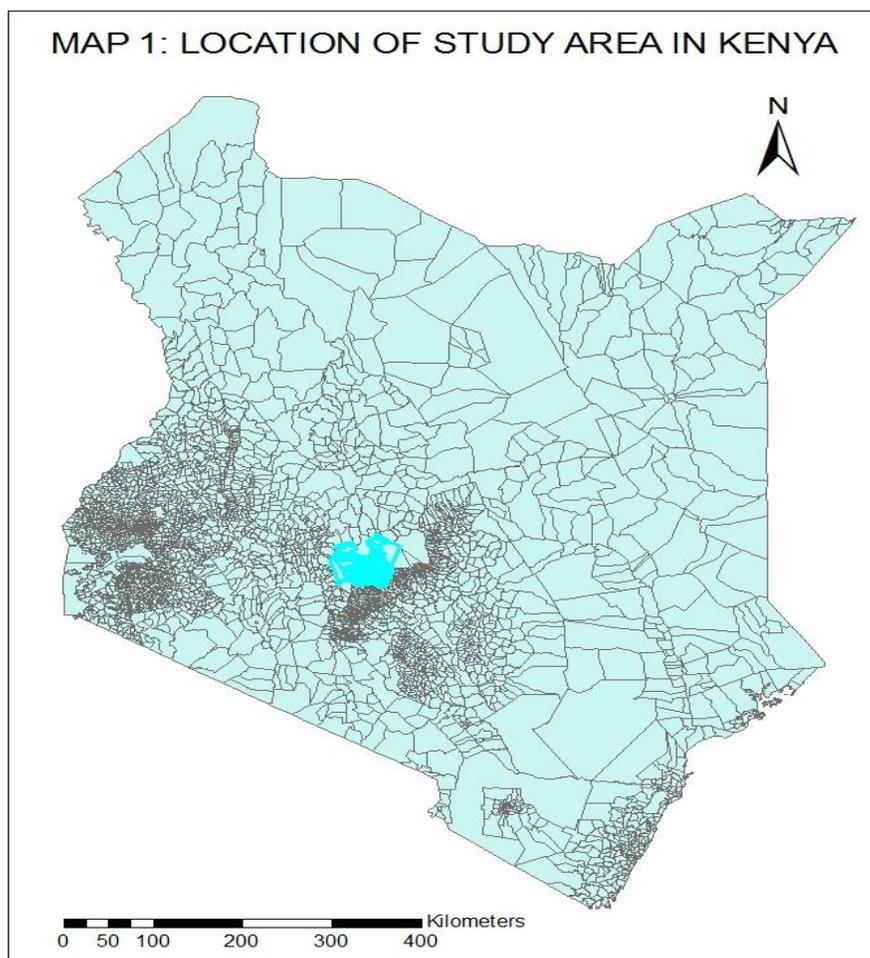
- i. There is no influence of rainfall on climate variability.
- ii. There is no significant relationship between the effect of drought and food security
- iii. There are no coping strategies for food security and biodiversity conservation.

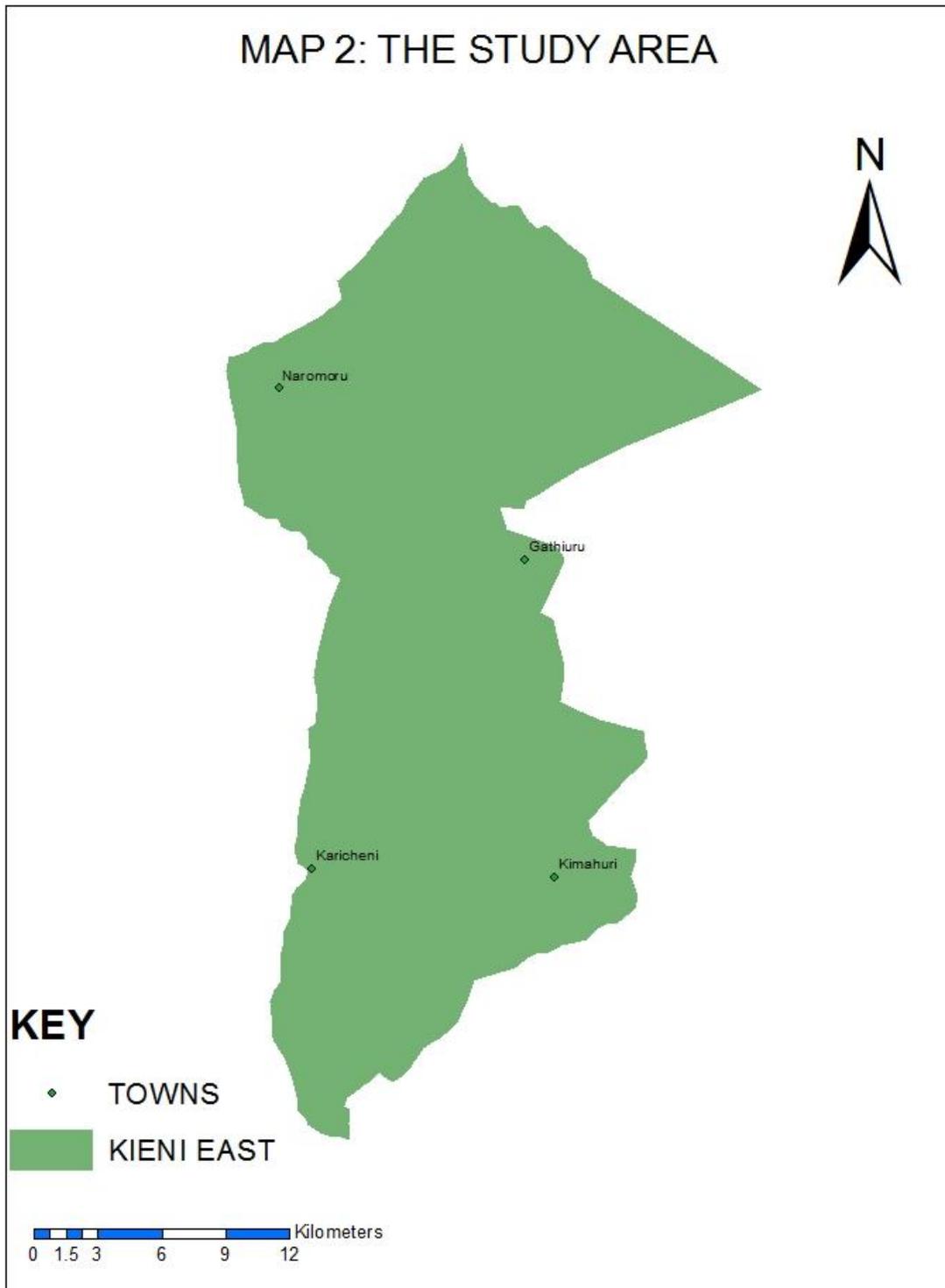
## **2.0 METHODS**

Document analysis was used to examine climatic data of precipitation for the last 30 years, which was obtained from the Kenya Meteorological Department, Nairobi from the observations made in Nyeri meteorological station located at Nyeri hill. Both primary and secondary sources of data

were used. Secondary sources included journal articles, Government reports, theses and dissertation and books.

Transect walk across the Nyeri Central district was conducted to ensure a cross section of the area was covered by the study. Trend analysis supplemented hypothesis one to show the trends of rainfall with time which was summarized in terms of annual averages and plotted with independent variable (time) on x-axis and dependent variable (rainfall) on y axis. Hypothesis two was to test the relationship between effects of rainfall on biodiversity and food security using chi-square Test.





### 3.0 LITERATURE

Climate variability refers to a shift in the state of the climate that can be identified by changes in the mean and/ or the variability of its properties and that persists for an extended period; typically decades or longer. Climate variability may be due to natural internal processes or external forces or to persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2008). Successive assessments of the Inter-governmental Panel on Climate Change have brought out the role of greenhouse gases such as carbon dioxide and methane in promoting global warming and climatic destabilization.

The world is warming, this has been observed at both regional and global levels including the reduction in mountain glacier, frequent and prolonged droughts, heat waves, flooding, landslides, resurgence of pests and diseases and loss of diversity (NEMA, 2008). The primary cause is combustion of coal, oil, and natural gas.

### **3.1 Impact of climate variability on food security and biodiversity**

#### **3.1.1: Water dynamics and precipitation**

Precipitation is one of the most important climatic variables that may be altered with anticipated climate variability due to enhanced green house gas especially carbon dioxide (Ogolla *et al.*, 1997). In Africa precipitation has decreased, especially in Sahel during the period 1960-1980 (VARCC, 2009).

More than 70% of the population in Eastern Africa is rural and practices subsistence agriculture (WHO/UNICEF, 2000). Rapid population growth and increasing demands for food combined with high rainfall variability and frequent droughts put pressure on natural resources (UNEP, 2008). There is increasing competition for access and use of fresh water resources. Persistent low rainfall and high temperature in the region has resulted in persistent low water levels in rivers, reservoirs and aquifers (VARCC, 2009). This has influenced biodiversity conservation and water use for domestic, industrial and irrigation purposes.

In Kenya, water is an important resource in all sectors including domestic, industrial or agricultural. A fall in its supply will usually have far reaching effects in food security and biodiversity conservation. Agriculture accounts for the highest consumption (76%), followed by domestic use

(20%), industrial use lagging at only 4% (UNEP, 2000b). Water is a critical sector and climate variability affects the whole water cycle and water ecosystems (COP 15, 2009).

### ***3.1.2 Socio economic factors***

Population increase means higher demands on natural resources. This factor, in combination with low rainfall and climate variability, challenges biodiversity management (UNEP, 2002). Climate variability is slowly encroaching and engulfing countries thus rendering them unproductive due to variations in weather patterns and global warming (NEMA, 2009). As human population grows further, the natural distribution of vegetation on earth has been altered (William and Roger, 1995). For example the hardwood forests of France and Germany have been removed in order to permit large areas of agricultural production. Vegetation loss due to human activities can cause deserts. Overpopulation can denude the vegetation as the populace uses firewood and clear land for agriculture. Forests are currently under pressure from demand for firewood and charcoal as energy sources and from the export of forest products such as timber, nuts, fruit and gum. This has led to deforestation and degradation of African forests.

### ***3.1.3 Conservation of biodiversity***

Unsustainable human activities such as quarrying and farming along wetlands take place in already fragile areas and are aggravated by natural calamities such as drought or flooding leading to land degradation and desertification. According to William and Roger (1995), these human activities are disturbing the land and include domestic grazing of semi arid regions, urbanization, farming along the wetlands, and alterations in species composition due to introduction of exotic species and grasses. These conditions are exacerbated by frequent droughts and an influx of people from the high potential areas to the dry lands. Overgrazing and subdivision of land into uneconomic land parcel sizes have further worsened them making conservation of biodiversity an issue (GOK, 2002).

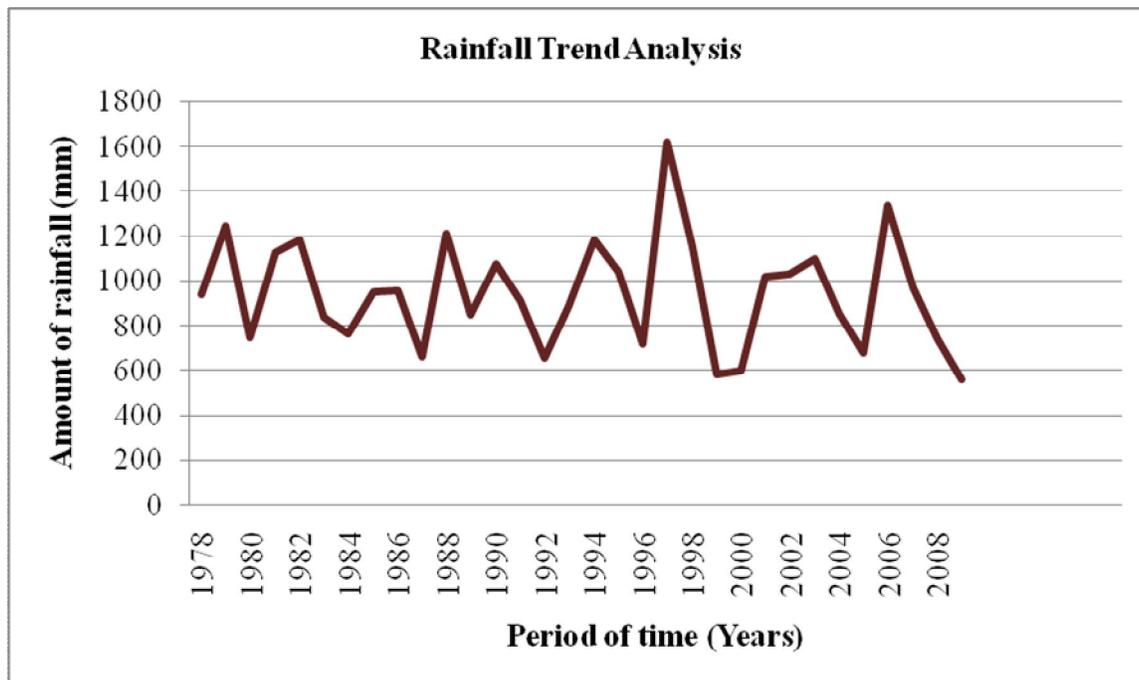
## **4.0 RESULTS AND DISCUSSION**

### **4.1 Rainfall Trend Analysis in Nyeri County**

The survey revealed that the rainfall received in Nyeri County from 1978 to 2009 has drastically been changing. The mean annual amount of rainfall for that period was 976mm. It was observed that after every 3 or 4 years the amount of rainfall dropped. In the year 1980/4, 1987/1992, 1996/7, 1999/2000, 2005 and 2009 the amount of rainfall received was minimal. This concurs with a study done in Kenya which indicated that drought was intense in the year 1996/7, 1999/2001 and

2003/2006 (UNEP 2008, UNEP 2009). During the same period the area experienced severe drought. This led to crop failure resulting to scarcity of pasture, water and food to the rural community.

As illustrated in Figure 1, the highest rainfall in the study area occurred in 1997/1998 and 2006/2007. The findings of this study agreed with other studies which reported that El-Nino Southern Oscillation (ENSO) occurs after every 4-7 years indicative change occurring in with the most 1997/98 (NEMA, 2008). During the period under study, 1997/8 was the year that experienced El-Nino Southern Oscillation (ENSO) and caused flooding in most parts of the country. 1999/2000 was recorded as the time that had minimum rainfall and this caused severe drought. This agrees with COP 15 (2009) report that indicated that El-Nino Southern Oscillation (ENSO) (1997/98) and La Niña (1999/2000) episodes were the most severe in the last 50 years.

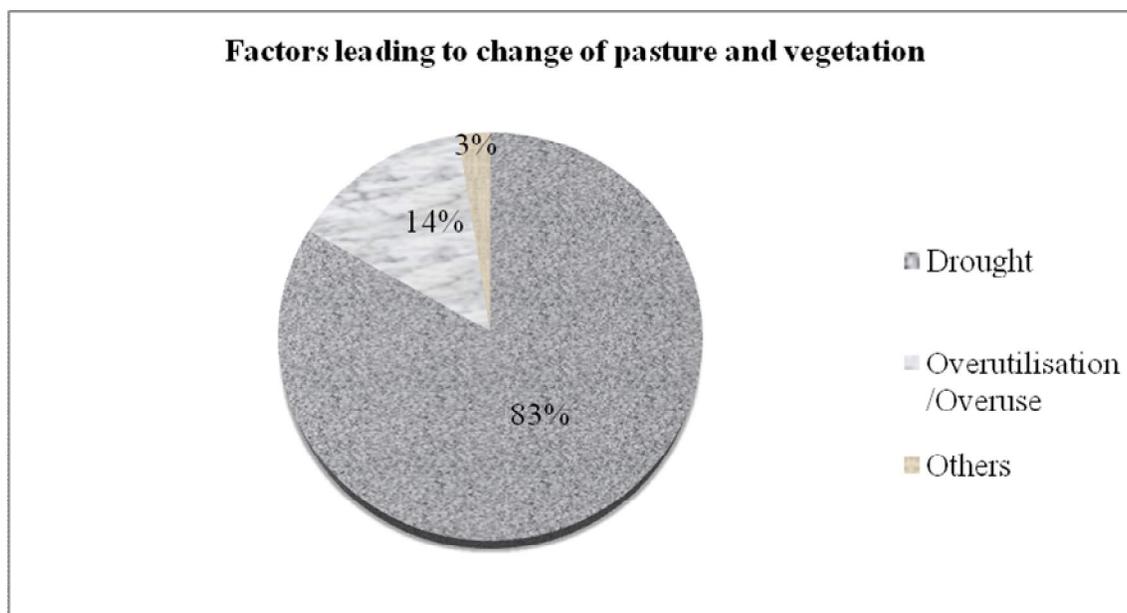


**Figure 1: Rainfall trend analysis for Nyeri County for the years between 1978-2009**

#### 4.2 Influence of rainfall on vegetation and pasture

The major impact of climate variability on the livelihood is drought. As indicated in Figure 2, the study showed that 83.3% of the respondents reported that drought is the cause of change in vegetation and pasture, while overuse contributed to 14.2%. This meant that drought affects their livelihoods. This concurs with NEMA (2008) which reported that drought has become widespread even in parts of Central Province, Kenya more so in year 1980, 1983/84, 1985/6 and 1999/2000.

Drought is mostly felt, when the amount of rainfall is not reliable hence the rate of adaptability is very low due to poverty. This leads to crop failure and declined livestock production. This agrees with (NEMA, 2008), that the year 1999-2001 suffered drought that resulted to loss of animals in Laikipia which share the same region. Changing rainfall patterns and increases in frequency of droughts have always adversely affected yields of rain fed crops and livestock productivity in the County.



**Figure 2: Factors leading to change of pasture and vegetation.**

#### 4.2.1: Months that experience drought in Nyeri County

According to the data from Kenya Meteorological Department in the table 1, impact of climate variability was severe in July-September of every year, followed by January-March. Less impact of occurred between October –December, and between April and June. The months between July – September experienced dry spell and consequently drought occurred during these months of the year. These findings conform to other parts of Kenya particularly western Kenya where dry spell occurs in August and September (WRI, 2007).

**Table 1: Quarterly climate variability in Nyeri County (1977-2009)**

Months	Average rainfall(mm)
Jan-march	2301.9
April-June	5686.2
July-Sept	1227.9
Oct-Dec	4071.3

#### 4.2.2: Impact of increased drought frequency

As reported in Table 2, if drought became twice as frequent, majority (61.7%) would wipe out their animals if the drought became double frequent which would be triggered by shortage of pasture and vegetation.

**Table 2: Impact of drought persistence on sources of livelihood**

	Frequency	%
Loss of livestock	29	48.3
Sell livestock	20	33.3
Livelihood diversification	6	30.0
Others	5	8.3
<b>Total</b>	<b>60</b>	<b>100</b>

#### 4.2.3: Impact of drought on food

The type of food eaten during drought consisted mainly *githeri* (mixture of beans and maize). This indicates that the main source of food was relief from government and NGOs. Majority the relief food consists of maize and beans. Inadequate rainfall, lead the community to suffer food insecurity.

**Table 3: Food eaten during drought**

Types of food	(%)
Sweet potatoes	6.7
Yams and Cassava	11.7
Githeri	65.0
Others	16.7
<b>Total</b>	<b>100.0</b>



**Plate 1: Farmers cultivating along the wetlands during dry season**

**Food eaten during wet season**

During the wet season the main diet consisted of vegetables (81.75%) (Table 4) with the main reason being that rainfall is plenty and vegetables are easily available on the farms. During the same period vegetables are also cheap and available in the market. Vegetables supplement many diets such as *githeri* and *ugali*.

**Table 4: Food eaten during wet season**

<b>Types of food</b>	<b>(%)</b>
Vegetable	81.7
Ugali	8.3
Githeri	6.7
Others	3.3
<b>Total</b>	<b>100.0</b>

#### 4.2.4: Level of drought severity

As indicated in table 5, the study revealed that drought was found to be very severe (45%). This can be explained by the fact that, rainfall was not reliable and could not support agricultural activities. Increased uncertainty means that, in general, the food production will become less predictable and this will have an adverse effect upon food security (GoK, 2007). This concurs with studies done in Nyeri (Karugia, 2003) which stated that Kieni region suffers prolonged period of drought. Household food security is a function of activities that make up their livelihoods where each agro-ecological zone has distinctive challenges in maintaining food security in light of climate variability.

**Table 5: Level of drought severity**

<b>Level of drought</b>	<b>Frequency</b>	<b>Percent</b>
Very Severe	27	45.0
Severe	29	48.3
Not severe	4	6.7
<b>Total</b>	<b>60</b>	<b>100.0</b>

Food and Agriculture Organization (FAO) estimates that over a billion rural people have too little land to meet even meager needs for food and fuel. Adding the quest for firewood, forests are being cut to provide firewood faster than it can regenerate, much of it being East Africa. This leads to opening new land for agriculture, cultivation of marginal areas and clearance of important natural habitats such as forests and wetlands (UNEP, 2002a). This has led to loss biodiversity, reducing vegetation cover and exposing soils to wind and water erosion in many parts of Africa. Soil erosion has increased the rate of siltation in dams and rivers and at the same time reducing the productivity of the land. Anyone who doesn't have a way to grow sufficient food must gain enough income to buy it or engage in alternative means of livelihoods which are unsustainable such quarrying and charcoal burning.

Conversion of natural habitats for human uses, high harvesting rate of resources from the environment, cultivation and grazing practices that fails to protect soils from degradation and pollution of air and water. This reduces the robustness of systems to cope with variations or change in climate (IPCC, 2001). Such pressures make systems and the population that derive goods, services and livelihoods from them highly vulnerable to climate variability. Population pressure and the increased pace of human activities in water shed are straining water supplies (UNEP, 2009). In

addition, sediment loads are increasing due to poor land use practices in the catchments. This is due to increased agricultural activity and deforestation, particularly in the upper elevations where rainfall is much heavier.

### Testing hypothesis 2

**H<sub>0</sub>: There is no significant relationship between the effects of drought and food security**

The results indicated that there is a significant relationship between the extent of drought and the level of food security ( $\chi^2 = 16.99$ ,  $p = 0.02$ ). This implies that the more the drought is severe, the higher the level of food insecurity. Whenever the drought arises there is rainfall deficiency which leads to crop failure and this leads to food insecurity. This means that the null hypothesis is rejected and alternate hypothesis adopted. It agrees with studies done in Laikipia which indicated that drought goes in hand with food insecurity (Gordon *et al.*, 2010). As indicated earlier in the rainfall trend analysis (Figure 1) whenever the amount of rainfall was below 800 mm the area experienced drought.

### 4.3: Household coping strategy in Nyeri County

#### 4.3.1: Coping with food shortages

As indicated in Table 6, food relief was the main way of coping with food shortages. About 28.3% of the household depended on relief food. This indicates that there are high chances of crop failure. Farming along wetlands was least preferred as way of coping with food shortages, though this had negatively impacted the availability of water resources such as loss of biodiversity, water pollution and siltation.

**Table 6: Coping with food shortages**

Coping with food shortages	Frequency	(%)
Sale of livestock	4	6.7
Farming on wetlands	6	5.0
Food relief	47	78.3
Others	6	10.0
<b>Total</b>	<b>60</b>	<b>100.0</b>

#### 4.3.2: Coping with drought

Majority of the households preferred preserving and storing food if drought occurred twice in the study area. About 75% of the households would cope with drought through food preservation. During the wet spell the farmers had bumper harvest in the semi-arid area and their only way of

coping with drought was through the storage of surplus produce (Table 7). Coping mechanisms whether traditional or conventional assist in subduing impact of drought. Irrigation practices in areas where water can be harnessed or harvested are a useful drought coping mechanism.

**Table 7: Coping with drought**

<b>Ways of coping</b>	<b>(%)</b>
Harvesting water	5.0
Preserving food	75.0
Reduce the number of livestock	5.0
Drought resistance crops	10.0
Farming along wetlands	5.0
Others	0.0
<b>Total</b>	<b>100</b>

#### 4.3.3: Coping with pasture shortages

During drought, most households preferred preserving pasture (54.3%) and buying animal feeds (43.5%) (Table 8). The farmers depended on preserving pasture, where farm sizes were large the households would preserve pasture such as hay and crop residue for use during dry spell.

**Table 8: Coping with shortages of pasture and vegetation.**

	<b>Frequency</b>	<b>Percent</b>
Preserving pasture	25	54.3
Selling livestock	0	0.0
Buying animal feeds	20	43.5
Migration	1	2.2
<b>Total</b>	<b>46</b>	<b>100.0</b>

## 5.0 CONCLUSION AND RECCOMENDATION

Rainfall in Nyeri County varies every 3 to 4 years. In this period the area experiences severe drought, but during the El-Nino Southern Oscillation (ENSO) which occurs after 4-7 years, the area receives high rainfall and a resultant bumper harvest. Rainfall is an important determinants of crop harvests, and unfavourable realizations of the amount or the temporal distribution of rainfall triggers food shortages and famine. July to September are months that are hardly hit by drought with less impacts being felt between April to June.

### 5.1 Effects of climate variability on food security

The major impact of climate variability in Nyeri County was drought, which led to change of biodiversity and food insecurity. This is felt more where the amount of rainfall is not reliable. Changing rainfall patterns and increase in frequency of droughts have always affected yields of rain fed crop and livestock productivity.

Dependence on rain fed agriculture means that production is vulnerable to climate variability which severely affects food and human security. Food security is critically dependent on water when rainfall was inadequate and the area was more vulnerable to drought.

Food preservation and storage was the main way to cope with drought while livelihood diversification was the least preferred. During the El-Nino Southern Oscillation (ENSO) spell, the community could get a bumper harvest but due to ignorance they sell the surplus at a cheap price. Creating awareness on the importance of food preservation as well as animal pasture such as hay and crop residues is the most preferred way of coping with drought.

Planting drought tolerant crops such as yams, cassava and sweet potatoes were the traditional practices that helped the community to adapt to drought. These crops were able to tolerate high temperatures and low rainfall. These crops were well adapted to drought and were of great importance to food security of the study area.

### ***5.2: Recommendation***

Access to affordable and appropriate technologies should be embraced. In agricultural sector more efficient technologies like drip irrigation which reduces water wastage should be encouraged where water is limited. It is the only sure way of water preservation as compared to overhead irrigation where there is high evapo-transpiration due to high temperatures.

The community should embrace adaptation options such as crop diversification, using different crop varieties, short growing crop varieties, increased use of labor input per unit of land, increased use of soil and water management techniques, planting more trees at plot, use of external fertilizer at plot level and borrowing lost crops from community. These will help them to cope with effects of climate variability at community level.

The government and the stakeholders should put mechanisms of rain water harvesting through water tank and dams for domestic and agricultural uses during dry spell. Food and pasture preservation and storage should be encouraged when there is surplus. This would mitigate the community during drought.

Creation of awareness and early warning should be emphasized so that the community can be well prepared for such natural disasters. This can be done through media. Kenya Meteorological Department should forecast and inform the community on the likelihood of such extremes events.

Other coping opportunities that exist on the study area include; Modern farming techniques such as agro forestry, poultry keeping, dairy goat farming, zero grazing, greenhouse and horticulture. These were less vulnerable to impact of climate variability

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## **S2012-33: A Survey on Cyber Crime Perpetration and Prevention: A Review and Model for CyberCrime prevention**

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### **Abstract**

Threats posed to organizations by cyber crimes have increased faster than potential victims or cyber security professionals can deal with them, placing targeted organizations at considerable risk. The growth of the threat of cyber crime has outpaced that of other cyber security threats. At the moment cyber criminals are increasingly skillful at gaining unnoticed access and maintaining a relentless low profile. In this paper we review on cyber crime prevention methods. We first explore on the types of cyber crime, how it is perpetrated and how to prevent it and finally reviewed models for CyberCrime preventions. From the study we recommend a development of CyberCrime prevention Model.

**Keywords:** *CyberCrime, Cyberstalk, Net crime, Computer crime*

### **Introduction**

The growth of the threat of cyber crime has outpaced that of other cyber security threats. Nowadays cyber criminals are increasingly skillful at gaining unnoticed access and maintaining a relentless low profile. In the meantime, many organizations may be leaving themselves susceptible to cyber crime based on a false sense of security, using agile security tools and processes. Many fail to recognize cyber crimes in their IT environments and misallocating limited resources to minor threats.

Cyber crime may be committed irrespective of organizations trying to prevent hackers and blocking pornography. This has generated major risk exposure, including exposure to financial losses, regulatory issues, data loss, damage to brand, and loss of client and public assurance.

According to Manali (2012), Computer crimes are criminal activities, which involve the use of information technology to gain an illegal or an unauthorized access to a computer system with intent of damaging, deleting or altering computer data. Computer crimes also include the activities such as electronic frauds, misuse of devices, identity theft and data as well as system interference. Computer crimes may not necessarily involve damage to physical property. They rather include the

manipulation of confidential data and critical information. Computer crimes involve activities of software theft, wherein the privacy of the users is hampered. These criminal activities involve the breach of human and information privacy, as also the theft and illegal alteration of system critical information. The different types of computer crimes have necessitated the introduction and use of newer and more effective security measures.

Koenig, (2002) defines Cyber Crime as A criminal offense that has been created or made possible by the advent of computer technology, or a traditional crime which has been so transformed by the use of a computer that law enforcement investigators need a basic understanding of computers in order to investigate the crime. There are two distinct sub-categories: Computer Crime and Computer-related Crime.

Computer crime refers to any crime that involves a computer and a network. Moore, (2005) argues that the computer may have been used in the commission of a crime, or it may be the target as also supported by Warren et al (2002). According to Mann (2011) Netcrime refers to criminal exploitation of the Internet. Jaishankar (2011) defines cybercrimes as offences that are committed against individuals or groups of individuals with a criminal motive to intentionally harm the reputation of the victim or cause physical or mental harm to the victim directly or indirectly, using modern telecommunication networks such as Internet (Chat rooms, emails, notice boards and groups) and mobile phones such as SMS or MMS. Such crimes may threaten a nation's security and financial health.

Govil (2007) regards Cyber crime as computer-mediated activities which are either illegal or considered illicit by certain parties and which can be conducted through global electronic networks. Cyber crimes describe criminal activity in which the computer or network is a necessary part of the crime. From this definition it is evident that the computer is the key source of cyber crime. Cyber crime is increasing in the list of internet- Aided offenses. This crime is almost overtaking street crimes, because street crime is almost contained and may soon be regarded as the thing of the past. Street crimes do take place but computer crime is more expedient. Cyber crime has demonstrated to be accurate, easy, and reliable; detection is difficult and hence it has become hard to prevent it.

Cyber crimes can be principally divided into three major categories, Cyber crimes against persons, Cyber crimes against property, Cyber crimes against government. All these Cyber crime categories affect us in one way or another. In this paper we explore on the types of Cyber crime, ways in which cyber crime is perpetrated and some prevention methods.

## **CyberCrime**

Computer crime is where a perpetrator uses special knowledge about computer technology. Cyber crime on the other hand, is where a perpetrator uses special knowledge of cyberspace. CyberCrimes are offences that are committed against individuals or groups of individuals with a criminal motive to intentionally harm the reputation of the victim or cause physical or mental harm to the victim directly or indirectly, using modern telecommunication networks such as Internet (Chat rooms, emails, notice boards and groups) and mobile phones (SMS/MMS). Cyber crime also may target a computer by emitting computer viruses, Denial of service attacks and attacks done through malware as argued by Indika, (2011)

Computer crimes involve the unauthorized use of computer technology to manipulate critical user data. In this section we present the types of Computer Crimes.

### ***Hacking***

Hacking is a form of computer crime where one breaks into a computer system to achieve an unauthorized access to data or Information. The act of defeating the security capabilities of a computer system in order to obtain an illegal access to the information stored on the computer system. The unauthorized revelation of passwords with intent to gain an unauthorized access to the private communication of an organization of a user is one of the widely known computer crimes. Another highly dangerous computer crime is the hacking of IP addresses in order to transact with a false identity, thus remaining anonymous while carrying out the criminal activities as per Oak (2012) and Sabadash(2004).

### ***Phishing***

Phishing is the act of attempting to acquire sensitive information like usernames, passwords and credit card details by disguising as a trustworthy source. Phishing is carried out through emails or by luring the users to enter personal information through fake websites. Criminals often use websites that have a look and feel of some popular website, which makes the users feel safe to enter their details there as defined by Oak (2012) and Josang. et al. (2007)

### ***Computer Viruses***

These are computer programs that can copy themselves to a computer and which eventually harms the computer systems on a network without the understanding of the system users. Viruses multiply to other computers through network file system, through the network, Internet or by the way of detachable devices like USB drives and Compact Disc. Computer viruses are any way, some form of malicious codes written with an aim to harm a computer system and destroy information.

Scripting computer viruses is a criminal activity as virus infections can break down computer systems, in that way destroying enormous amounts of significant data as argued by Oak (2012), Kendall (2010), Germain (2009) and Rohas (2008)

### ***Cyber stalking***

Cyber stalking involves torturing other individuals, false accusations, transmission of threats and damage to data and equipment, using communication technology, primarily the Internet. Cyber stalkers frequently target the users by means of chat rooms, online forums and social networking websites to collect user information and harass the users on the basis of the information gathered. Obscene emails, abusive phone calls and other such serious effects of cyber stalking have made it a type of computer crime as per Oak (2012), Sankary (2006), Rodriguez (2005) and Nagpal (2008)

### ***Identity Theft***

Identity is a severe fraud that may involve stealing money and obtaining other gains using other's identity. In this case one behaves to be someone else by using someone else's identity as his or her own. Financial identity theft is the use of a false identity to obtain goods and services and a commercial identity theft is using of someone else's business name or credit card details for commercial purposes. Identity cloning is the use of another user's information to pose as a false user. Identity theft makes illegal migration, terrorism and blackmail to be possible as described by Hamilton, (2010) and Stroup (2012).

### ***Cyber bullying***

Cyber bullying is the use of cell phones, instant messaging, e-mail, chat rooms or social networking sites such as [Facebook](#) and Twitter to harass or threaten or coerce others. Children who have more and more early access to internet technologies eventually resort to cyber bullying. A bully can hide behind an electronic veil, disguising his or her true identity which makes it difficult to trace the source and encourages bullies to behave more uncompromisingly than they would on a face-to-face scenario as stated by TechTarget (2008), Dunn (2009) and Harmon (2004).

### ***Malware***

Malware refers to viruses, Trojans worms and other software that gets onto your computer without you being aware of them. Justin (2010) and Brenner (2009) say that those who write this software find it amusing they exploit security flaws just to find out they can spread. Malware pretend to be genuine software and may ask for money. Some malware when they attack successfully will require money to remove from the computer. This is also supported by CCRC (2005)

### ***Spam***

Spam is flooding the Internet with many copies of the same message, in an attempt to force the message on people who would not otherwise choose to receive it. Most spam is commercial advertising, often for dubious products. Spam costs the sender very little to send most of the costs are paid for by the recipient or the carriers rather than by the sender. Spam is an Electronic junk mail or junk newsgroup postings which are defined as any unsolicited e-mail. Specifically spam is generally e-mail advertising for some product sent to a mailing list or newsgroup as argued by Justin (2010). Spam is an endless repetition of worthless text that waste people's time with unwanted e-mail and consumes a lot of network bandwidth. Many organizations and/or individuals are fighting spam with a variety of techniques. Since the Internet is public, it is hard to prevent it, so is it to prevent junk mail. Nevertheless, there exist some online services who have instituted policies to prevent spammers from spamming their subscribers this is also supported by Kunz & Wilson (2004).

### ***Child Pornography***

Child pornography is any visual depiction, photograph, film, video, picture, or computer or computer-generated image or picture, which can be produced by electronic, mechanical, or other means, of sexually explicit conduct, where the production of the visual depiction involves the use of a minor engaging in sexually explicit conduct or the visual depiction is a digital image, computer image, or computer-generated image that is, or is indistinguishable from, that of a minor engaging in sexually explicit conduct or the visual depiction has been created, adapted, or modified to appear that an identifiable minor is engaging in sexually explicit conduct this is argued by Wolak, et. al, (2005), Carr, (2003) and Akdeniz (2003).

### ***Cyber Crime Perpetration methods***

In this section we discuss cyber crime perpetration methods.

#### ***Theft of Information Services***

Here the perpetrators gain access to the PBX board of an organization, and make their own calls or sell call time to third parties this is said by Venkatraman (2010), In theft of services, people use a variety of techniques to obtain services without paying for them. In all forms, a person is obtaining services without providing the service provider or the person who is paying for those services with compensation in exchange. Theft of services can be seen with utilities like phones, electricity, water, cable, and Internet. Theft of services happens when people tamper with devices which are

used for metering with intend to pay less, or use devices which make them bypass metering altogether and to get services for free. A common theft of services which became a problem in some areas of the world in the 2000s was theft of wireless Internet services, where people bypassed router security to access a wireless access point for which they were not paying for.

### ***Communications as an auxiliary for Criminal Conspiracies***

Communications as an auxiliary for criminal conspiracies involves use of information systems to further criminal activities such as being used in gambling, drug trafficking, money laundering and weapons business as per Venkatraman (2010)

### ***Telecommunications Piracy***

Digital technology allows perfect reproduction and easy dissemination of print, graphics, sound, and multimedia combinations. Venkatraman (2010) argues that this has produced the temptation to reproduce copyrighted material either for personal use or for sale at a lower price. Emerging technologies in money transfer systems has made it easier to conceal the origin and destination of funds transfer. Thus money laundering comes to the living room. woda (2006) asserts that money laundering is an offence committed by some individuals locally and intentionally placed that signifies the conversion and transfer of assets of an illicit origin. The objective of this action consists of disguising the true origin, location, nature, disposition, movements and transfer of assets that are derived from illegal activities. Participation, support or facilitation of the realization of illegal activities, such as transfer of money of illicit origin to several banks accounts and afterwards converted into legal financial products.

### ***Electronic Vandalism and Terrorism:***

Lejk (2006) argues that Cyber terrorism is the premeditated, politically motivated attack against information, computer systems, computer programs, and data which result in violence against noncombatant targets by sub national groups or clandestine agents. Kolo (2009) and Venkatraman (2010) define vandalism as deliberately destroying or damaging property of another. Thus computer vandalism may be any kind of physical harm done to the computer of any person. Such acts may be theft of a computer, some part of a computer or a peripheral attached to the computer or by physically damaging a computer or its peripherals.

### ***Sales and Investment Fraud***

Online auction comes with several activities which constitute fraudulent behaviors. According to Venkatraman (2010) Sales and investment Fraud include:

- i. Non-delivery-Bidding for no item or seller doesn't want to sell the item.
- ii. Misrepresentation- The seller deceives the buyer as to the true value of the item.

- iii. Non-payment-The buyer places the highest bid to win the auction but doesn't pay for merchandise.
- iv. Triangulation-The buyer buys the merchandise using stolen identities and credit card numbers.
- v. Fee stacking-The seller adds separate charges for postage, handling, and shipping making the buyer to pay more than anticipated.
- vi. Black-market goods-The goods are delivered without a box, warranty, or instructions.
- vii. Multiple bidding- A buyer places multiple bids (some high and some low) using different aliases. The multiple high bids cause the price to escalate, and scares off other potential buyers from bidding. Then, in the last few minutes of the auction the same buyer withdraws their high bids, only to purchase the item with their lowest bid.

### ***Illegal Interception of Information***

Improvements in telecommunications and data transfer over the Internet have resulted in better speed and capacity but this as introduced greater vulnerability. It is now easier for unauthorized people to gain access to sensitive information. Electromagnetic signals that are emitted by a computer can now be intercepted where cables act as broadcast antennas. To make matters worse there no existing laws to prevent the monitoring of remote signals from a computer. Under such circumstances information is more and more vulnerable to unauthorized users as per Venkatraman (2010).

### ***Logic Bomb***

This is an event dependent program. This implies that this program is created to do something only when a certain event occurs (e.g. the Chernobyl virus).

Logic bomb is a piece of computer code that executes a malicious task, such as clearing a hard drive or deleting specific files, when it is triggered by a specific event. It is secretly inserted into the code of a computer's existing software, where it lies dormant until that event occurs. This event might be a positive trigger, such as a specific date and time or the removal of an employee's name from the salary database; or it might be a negative trigger, such as a particular employee failing to input a command by a certain time meaning he or she is probably not at the company anymore.

A logic bomb doesn't have much use outside of targeting a specific computer or network, and IT employees are usually the only ones with the access and know-how to implement them according to Layton (2012)

A logic bomb which is called slag code is a programming code, inserted secretly or deliberately, that is designed to execute (or explode) under circumstances such as the lapse of a certain amount of time or the failure of a program user to respond to a program command. It is in effect a delayed-action computer virus or Trojan horse. A logic bomb, when "exploded," may be designed to display or print a spurious message, delete or corrupt data, or have other undesirable effects as said by TechTarget (2012) and Kolo (2009).

### ***Internet time theft***

Some an unauthorized person may use Internet time paid for by someone else. Nagpal (2008) connotes the usage by an unauthorized person of the Internet hours paid for by another person.

### ***Salami attack***

Salami attack is used to commit financial crimes. Here the idea is to make the modification so small that in a single case it would go unnoticed. A bank employee, for instance, can deduct five cent US dollars from every customers account. Customers account holders may not notice this little change but the bank staff will make large amounts of Money as according to Nagpal (2008)

In the salami technique, criminals steal money or resources a bit at a time. It refers to slicing the data thinly. A programmer can create salami attack by modifying arithmetic routines, such as interest computations. Typically, the calculations are carried out to several decimal places beyond the customary two or three kept for financial records. For example, a programmer arranges to collect money in fractions of pennies in a separate account; a sizable fund can grow with no warning to the financial institution as according to Kabay (2002).

### ***Data diddling***

This kind of attack involves altering the raw data before it is processed by a system and re-altering it after processing as said by Nagpal, 2008.

Kabay, (2008) argues that data diddling is associated with electronic data processing where illegal or unauthorized data is altered. The changes can happen before and during data input or before output.

### ***E-mail bombing***

Nagpal (2008) explains this as sending a large number of mails to the victim resulting in the victims mail account (in case of individual) or server (in case of corporations) crashing.

Email bombing is a form of denial of service attack that floods an inbox and mail server with messages. So many messages are sent that eventually the systems may be overloaded and they will stop working. Kolo (2009) explains email bombing that it may be coordinated in two ways namely:

- Sending large numbers of email directly, often using multiple accounts and scattering the emails out over many accounts that makes it harder to pin down the source of the attack. A virus can be written to hijack email accounts held by other people and use them to bomb the target.
- List bombing where the subject is signed up for large numbers of mailing lists.

### ***Virus/Worm attack***

A virus is a program that is able to attach itself to one or more files or a system and then circulates to other files and to other computers via a network. Standler (2002) explains it as a being able to affect computers by either altering or deleting data from it. Worms do not interfere with data but multiply until they fill all the memory space on the computer

Computer viruses are small software programs that are designed to spread from one computer to another and to interfere with computer operation. A virus might corrupt or delete data on the victim's computer, use the victim's e-mail program to spread itself to other computers, or even erase everything on the victim's hard Disk. Viruses can be disguised as attachments of funny images, greeting cards, or audio and video files. Viruses can also spread through downloads on the Internet. They can be hidden in illicit software or other files or programs.

Worms, unlike viruses do not need the host to attach themselves to. They merely make functional copies of themselves and do this repeatedly till they eat up all the available space on a computer's memory.

### ***Cyber stalking***

This involves following a person on the Internet and causing harassment as explained by Standler, (2002), Nagpal (2008) and Venkatraman (2010)

### ***CyberCrime prevention methods:***

This section provides common cyber crime prevention methods.

### ***Firewalls***

These are programs, which protect a user from unauthorized access attacks while on a network. They provide access to only known users, or people who the user permits. A firewall works directly with a router program, which examines each network packet to determine whether to forward it toward its destination. A firewall works with a proxy server that makes network requests on behalf of workstation users.

A firewall if it is a program is installed in a particularly designated computer separate from the rest of the network so that no incoming request can penetrate directly at private network resources. A

number of firewall screening methods exist. A simple one is to screen requests to make sure they come from acceptable domain name and Internet Protocol addresses. For mobile users, firewalls allow remote access in to the private network by the use of secure logon procedures and authentication certificates as explained online by [howstuffworks.com](http://howstuffworks.com).

There are two major types of firewalls which are network firewalls and host-based firewalls. Network firewalls, for example, the software-based Microsoft's Internet Security and Acceleration (ISA) Server or the hardware-based Nortel Networks Alteon Switched firewall System, protect the perimeter of a network by watching traffic that enters and leaves. Host-based firewalls, such as Internet Connection Firewall (ICF—included with Windows XP and Windows Server 2003), protect an individual computer regardless of the network it's connected to source

### ***Frequent password changing***

With the advent of multi-user systems, security has become dependent on passwords. Thus one should always keep passwords to sensitive data secure. Changing them frequently and keeping them sufficiently complex in the first thing to do.

If someone had hacked your password and has been accessing your account without your knowledge will immediately be shut out once your password is changed. There is need to schedule the change of password in a period like six months. This is necessary because some people can sell an old computer and forget to erase passwords they may have saved for dialing in or for accessing their email.

If you change your password at least every three months, hackers who may be trying to crack your password using brute force essentially need to start over again because the changed password could now be possessing new pattern which they might have already tried and rejected.

It is good idea to force a password change because it discourages users from using the same password on multiple accounts. Changing password frequently poses the danger of picking on poor passwords. This makes the situation even worse, because it now allows attacks that would have otherwise not been possible explained by Ingham (2002) and Tyson (2012).

### ***Safe surfing***

This is a practice, which should be pursued by all users on a network. Secure surfing involves keeping ones e-mail address confidential, not chatting on open systems, which do not have adequate defense techniques and visiting secure sites. Accept data from only known users, be cautious when downloading and more so from known sites to reduce cyber crime risk.

### ***Frequent virus checks***

One should frequently check his/her computer for viruses and worms. Check any external media such as floppy disks and CD ROMS for viruses before running. Computers used in business environment should use up-to-date anti-virus software. When anti-virus programs are activated they help keep computers safe from malware in two ways.

- i. It can get rid of known malware – The anti-virus software scrutinizes the computer’s hard drive for known viruses and eliminates any detected malware
- ii. It avoids new malware – The anti-virus software keeps track of running computer procedures and will obstruct any suspicious computer code or files

**Email filters**

Email filters are programs which monitor the inflow of mails to the inbox and delete automatically any suspicious or useless mails thus reducing the chances of being bombed or spoofed. Email Filtering is one of the most readily available spam prevention techniques. There are two key forms of filtering, Content Based Filters and Bayesian Spam Filters.

Content Based Filters is broken into two main sections which are Spam Filters which are responsible for removing something on the basis of a rule previously set and Anti-filter screens which filters and sorts all received mail in form of wanted and unwanted emails, Anti-filter will keep junk mail in a separate folder, and thus averts those irritating emails from appearing in the inbox.

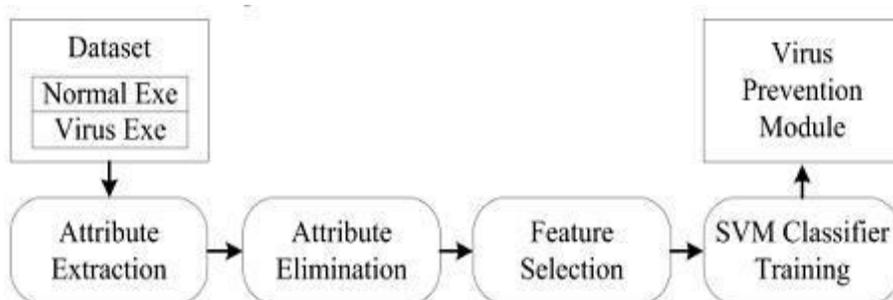
Bayesian Filtering calculates the likelihood of a message being spam based on its contents. It improves its filtering capability according to the mail that is grouped as spam and non-spam. Some of the issues that are taken into account are words in the body, headers, code, Links, Word pairs and Phrases.

**Existing CyberCrime prevention models**

In this section we review CyberCrime prevention models.

**Virus prevention model**

Wang et al. (2009) presented the *Virus prevention model*, which is a new technique of identifying the virus activity. Figure1 below shows this model.



**The process of VPM**

Fig 1. Virus prevention model (Source: Wang et al. (2009) from Askerniya Imran et al. n.d

In this model, the researchers identified the viruses by their behavior, which is very different compared to the normal software behavior. However, merely looking at code-block (signature) is easily evaded by obfuscated viruses; but it is very hard to manage them. This is a good reason to detect viruses by their program behaviors rather than their code signatures.

***Cybercafes, Cybercrime Detection and Prevention***

E.B. Ajala, (2007) in his work suggested that the following ten preventive measures can be adopted to prevent or prosecute cybercrime.

- i. States should ensure that their laws and practices eliminate safe havens for those who criminally misuse information technologies.
- ii. Law enforcement cooperation in the investigation and prosecution of international cases of criminal misuse of information technologies should be coordinated among all concerned states.
- iii. Information should be exchanged between States regarding the problems that they face in combating the criminal misuse of information technologies.
- iv. Law enforcement personnel should be trained and equipped to address the criminal misuse of information technologies.
- v. Legal systems should protect the confidentiality integrity and availability of data and computer systems from unauthorized impairment and ensure that criminal abuse is penalized.
- vi. Legal systems should permit the preservation of and quick access to electronic data pertaining to particular criminal investigations.
- vii. Mutual assistance regimes should ensure the timely investigation of the criminal misuse of information technologies and the timely gathering and exchange of evidence in such cases.
- viii. The general public should be made aware of the need to prevent and combat the criminal misuse of information technologies.
- ix. To the extent practicable, information technologies should be designed to help to prevent and detect criminal misuse, trace criminals and collect evidence.

- x. The fight against the criminal misuse of information technologies requires the development of solutions taking into account both the protection of individual freedoms and privacy and the preservation of the capacity of governments to fight such criminal misuse.

### ***CyberCrime detection Model***

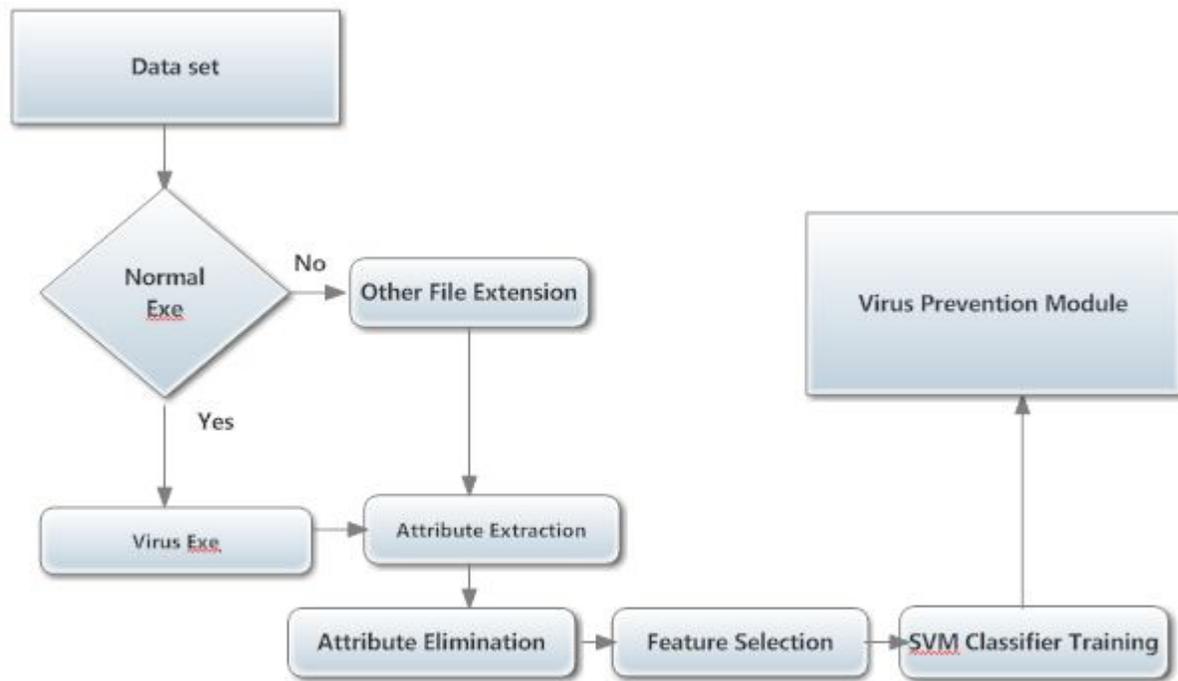
CyberCrime is the latest and perhaps the most specialized and dynamic field in cyber laws. Some of the Cyber Crimes like network Intrusion are difficult to detect and investigate even though most of crimes against individual like cyber stalking, cyber defamation and cyber pornography can be detected and investigated through the following steps. From the report of (V.S. Kumar,(nd)

After receiving mail

- i. Give command to computer to show full header of mail.
- ii. In full header find out the IP number and time of delivery of number and this IP number always is different for every mail. From this IP number we can know the Internet service provider for that system from which the mail had come from.
- iii. To know about Internet Service Provider from IP number, take the service of search engine like nic.com, macffvisualroute. Com, apnic.com, arin.com.
- iv. After opening the website of any of above mentioned search engine, feed the IP number and after some time name of ISP can be obtained.
- v. After getting the name of ISP we can get the information about the sender from the ISP by giving them the IP number, date and time of sender.
- vi. ISP will provide the address and phone number of the system, which was used to send the mail with bad intention.

After knowing the address and phone number criminal can be apprehended by using conventional law enforcement methods.

### ***A New Cybercrime Detection Model***



**A New Cybercrime Detection Model**

***Discussion***

There are several risks associated with cyber crime which result in monetary or data loss especially on online transactions. The risk of cyber crime is geared to data, information, assets, and online transactions which are continually evolving, whereas the available cyber security cannot cope with the menace. Organizations remain uninformed of their security models and no effective prevention methods against cyber criminals who seem to heavily invest part of their major profits in developing new capabilities for committing cyber crime exist.

The antivirus vendors have found it difficult to contain the amount of new malware. Cyber criminals normally exploit the resulting vulnerabilities.

The present danger is that criminals and criminally minded enterprises have hired, purchased, or otherwise acquired the ability to infiltrate systems with new penetration techniques while developing a criminal e-business network. A number of hackers have discovered that they can make more money using online crime.

Computer crime is committed using a computer and the network therefore computer networks may be vulnerable to many threats along many avenues of attack.

There are so many ways of preventing CyberCrime but the cyber criminals are good at by passing the security measures that may be in place. Some of the CyberCrime are committed internally by insiders; such crimes are more costly and damaging than attacks from outside. There are several security measures that are more effective in protecting an organization from a CyberCrime.

To curb CyberCrime there is need for businesses to Conduct periodic penetration tests of their systems, Implement periodic security education and awareness programs for their employees and Deliver regular communication about security from senior management.

The businesses should identify insider threats by monitoring the online activities of employees who may be discontented or have resigned this is where recession security risks have increased among employees who have been fired or laid off.

The Virus prevention model (VPM) discussed in section 5 above identifies the viruses by their behavior. This model proves to be better than those that look at code-block (signature) which is easily evaded by obfuscated viruses and are very hard to manage them. The Process of the VPM in Fig 1 above start with a dataset which filters the Normal exe files and the Virus exe, this model can be improved by including files with different extensions like the .zip, .rar, .jpg which are known to be used by attackers to disguise virus introduction.

### ***Conclusion***

Information theft has led to the compromise of intellectual property, credit card information, electronic funds, identity theft, and a host of other negative consequences. Electronic theft or cyber crime affects individuals, corporations and government entities. Breaches are routinely perpetrated by, ill intended employees, ex-employees, organized crime groups, and foreign government sponsored espionage groups.

One of the ways of curbing cyber crimes by all intent and purpose is through counseling. As advised by Omoluabi (2008), parents need to monitor their children especially when they spend time out of the home. In addition, there is need for law enforcement agencies to have a tighter control of cyber café operators because they aid and assist criminals. When such cases of cyber crimes are detected, the owners of cyber cafes should be prosecuted.

This research has highlighted the importance of awareness as a tool to decrease/ prevent cyber crime.

Our model extends the VPM models in that the VPM process includes an additional dataset which examines the behavior of files with different extension rather than only examining .exe files.

In future, we plan to validate our model empirically.

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## **S2012-34: Anti-plasmodial Activity of Some Medicinal Plants used for Treatment of Malaria and Synergism of Methanolic Extracts of *Carissa edulis* and *Artemisia annua***

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### **Abstract**

The increasing prevalence and distribution of malaria has been attributed to a number of factors, one of them being the emergence and spread of drug resistant parasites. Efforts are now being directed towards the discovery and development of new chemically diverse anti-malarial agents. The present study reports on the *in vitro* anti-plasmodial activity of 15 selected medicinal plants used widely by the traditional healers to treat malaria in the North Rift parts of Kenya. The plant extracts were tested for *in vitro* activity against chloroquin-sensitive (D6) strains of *plasmodium falciparum* parasites. Of the 15 species assayed, 40% showed promising anti-plasmodial activity of  $IC_{50} \leq 10 \mu\text{g/ml}$ , while another 40% showed moderate activity of  $IC_{50}$  between 10 – 50  $\mu\text{g/ml}$  and 20% had weak activity of  $IC_{50}$  between 50 – 100  $\mu\text{g/ml}$ . These results justify the correlation between traditional uses of the plants with their bioactivity. Synergism between total extract of *Atemisia annua* and *Carissa edulis* were also analyzed using combination ratios of 10:90 to 90:10 respectively against *P.falciparum* parasites. This led to the identification of anti-malarial combination therapy of methanolic extracts of the two plants with sum of fraction inhibiting concentration (FIC) of 0.74 at 50% combination ratios. These results support a rational rather than random approach to the selection of anti-plasmodial screening candidates, and identify a number of promising plants for further investigation as plant-based anti-malarial agents.

**Key Words:** *Carissa edulis*, *Plasmodium falciparum*, *Atemisia annua* combination therapy.

### **INTRODUCTION**

One of the biggest challenges of controlling malaria disease is the spread of multi-drug resistance *plasmodium falciparum* parasites (Bloland, 2001). Most of the conventional anti-malarial drugs have developed resistance except for the plant derived drugs that are in use currently. The anti-malarial drugs that are effective are those obtained from medicinal plants used traditionally for treatment of malaria and were developed using plant-derived chemical structure as templates. For example, quinine was developed from *cinchona* sp (Simon *et al.*, 1990) and artemisinin from *Atemisia annua*, where the parent molecule was used as a template and modified to its derivatives artemether, arteether and artesunate that are currently used in combination with conventional drugs for treatment of malaria (Nosten *et al.*, 2000). Therefore there is an urgent need to discover and develop new drug combination therapy.

The use of combination chemotherapy is the current innovative strategy in controlling malaria disease; it involves the use of a short half-life acting anti-malarial drug in combination with long

half-life drug. Example being artemether-lumifantrine and artesunate-mefloquine drugs (Nosten, 2000). The short half-life drug kills the parasites and excreted rapidly, resulting in re-emerging of the parasites after a period of time. Therefore use in combination with longer half-life anti-malarial drug result in achieving full eradication of the parasites preventing the recrudescence that occur with use of mono-therapy (Walsh, *et al.*, 2007). Medicinal plants are important sources for exploration in obtaining good combination of drugs.

In Kenya, plant extracts are still widely used in the treatment of malaria (Kokwaro, 2009) but most of these plants have not been subjected to scientific screening for anti-malarial activity. In continuation of the efforts to verify the efficacy of traditional anti-malarial preparations, fifteen medicinal plants used by traditional healers in North Rift Valley of Uasin-Gishu for treatment of malaria were subjected to *in vitro* anti-plasmodial screening. The most active plant was further subjected to *in vitro* analysis in combination with the total extract of *Atemisia annua* in order to obtain drug combination therapy.

## **MATERIALS AND METHODS**

### **Collection and Solvent extraction**

Following a survey on the ethno uses of anti-malarial medicinal plants in Uasin-Gishu District in the Rift-Valley province of Kenya through interviews with traditional health practitioners, fifteen (15) were identified to be the most commonly used medicinal plant for treatment of malaria. Parts used for treatment were collected and botanical identification was done by a taxonomist and voucher specimens were deposited at the Botany Department Herbarium, Moi University, Eldoret - Kenya.

Insert name of taxonomist and the voucher number

The plants parts were chopped into small pieces, air dried at room temperature for two weeks, and grounded into powder form. One kilogram of each powder was soaked in methanol for 3 days to extract the compounds. A dark yellow filtrate (for the roots or bark stem) and green filtrate (for the leaves) were concentrated under reduced pressure using Rota-vapour to a dark brown and green semi-solid substance respectively. The concentrates obtained weighed between 45 – 70 gms of each crude. The methanolic concentrates were then subjected to anti-malarial test.

The most active methanolic extracts was found to be *Carissa edulis* and was further screened in combination with total extract of *Atemisia annua*.

### **ANTI-MALARIAL TEST**

### ***Stock solution***

Stock solution (100 µg/ml) for *in vitro* assay of methanolic extracts of the plants parts were prepared in deionized autoclaved water and re-sterilized by passing through 0.22 µm micro-filters in a laminar flow hood. The water-insoluble extracts were dissolved in 100% DMSO (dimethylsulfoxide) from Sigma Chemical Co; St Louis, MO USA, followed by a subsequent dilution to lower the concentration of DMSO to less than 1% to avoid solvent carrying over solvent effect (Dominique *et al.*, 2001). Stock solutions (1 µg/ml) of chloroquine diphosphate were similarly prepared for use as reference drugs. Each drug was filter-sterilized with syringe adaptable 0.22 µm filters into sterile Bijoux bottles and was stored at -20° C until required for bioassay.

### ***Parasite culture***

Test samples were screened against *P. falciparum* D6 (CQ-sensitive) strain from Sierra Leone. The strains were obtained from the Division of Experimental Therapeutics, Walter Reed Army Institute of Research (WRAIR), Nairobi. The parasites were cultivated by a previously described *in vitro* technique (Trager *et al.*, 1976). Complete culture medium (CMS) was prepared and consisted 10.4 g/l of RPMI 1640 (Rosewell Park Memorial Institute), 25 mM (5.94 g/l) HEPES buffer and 31.5 mM sodium bicarbonate supplemented with 10% human serum (Schlichtherle *et al.*, 2000). Uninfected human blood group O Rh-positive erythrocytes less than 28 days old served as host cells. The cultures were incubated at 37 °C in an atmosphere of 3% CO<sub>2</sub>, 3% O<sub>2</sub> and 92% N<sub>2</sub> obtained from BOC gas Nairobi.

### ***In vitro anti-plasmodium assay***

The *in Vitro* anti-malarial test was based on the inhibition of [G-<sup>3</sup>H] – hypoxanthine (Amersham International, Buckinghamshire, UK) uptake by *P. falciparum* cultured in human blood (Desjardins, 1979). Twenty five microliters of aliquots of the complete culture medium (CMS) were added to all the wells of 96-well flat bottomed micro-culture plates (Falcon, Becton Dickinson, Franklin Lakes, NJ), followed by addition in duplicate of 25 µl of the test solution (plant extracts) to the first row wells, a Titertek motorized hand diluter (Flow laboratories, Uxbridge, UK) was used to make serial twofold dilutions of each sample over a 64-fold concentration range. Negative controls treated with solvent (DMSO) alone were added to each set of experiment (Azas *et al.*, 2001) to check for any solvent effects. The susceptibility tests were carried out with initial parasitemia (expressed as the percentage of erythrocytes infected) of 0.4% by applying 200 µl, 1.5% hematocrit, *P. falciparum* culture to each well. Two hundred microliters of culture media without parasites was added into

four wells on the last row of each plate to serve as a background (controls). Parasitized and non-parasitized erythrocytes were incubated at 37 °C in a gas mixture containing 3% CO<sub>2</sub>, 5% O<sub>2</sub> and 92% N<sub>2</sub> for 48 hours after which 25 µl of culture medium containing 0.5 µCi, of [G-<sup>3</sup>H] – hypoxanthine was added to each well. The culture plates were further incubated for 18 hours. At the end of incubation period, the radio-labeled cultures were harvested onto glass-fiber filters using a 96-well cell harvester. [G-<sup>3</sup>H] hypoxanthine uptake was determined using a micro-beta trilux liquid scintillation and luminescence counter (Wallac MicroBeta Trilux). The drug concentration capable of inhibiting 50% of the *P. falciparum* (IC<sub>50</sub>) was determined by logarithmic transformation of drug concentration and radioactive counts per minute (cpm) using the formula:

$$IC_{50} = \text{antilog} (\log X_1 + [(\log Y_{50} - \log Y_1) \times (\log X_2 - \log X_1)] / (\log Y_2 - \log Y_1)).$$

Where  $Y_{50}$  is the cpm value midway between parasitized and non-parasitized control cultures and  $X_1$ ,  $Y_1$ ,  $X_2$ , and  $Y_2$  are the concentrations and cpm values for the data points above and below the cpm midpoints (Sixsmith *et al.*, 1984). The analysis of IC<sub>50</sub> values was done using the computer software called GraFit-4 database.

#### Drug Combination bioassay Methanolic extract *Carissa edulis* and Total extract of *Atemisia annua*

Template plates were used in preparation of drugs combinations. Test drugs were dispensed into an extra plate in various ratios of blends. The combined test samples were well mixed and transferred to multiple daughter plates or test plates, such that 2 daughter plates were made per two drugs pair. One daughter plate was used for the assay and the other kept at -20 °C for running a repeat test on a different day at the end of which the average of the two experiments was given as the final result.

The method described by Canfield *et al.*, (1995) was adopted. The solutions of initial concentrations 20-50 times the estimated IC<sub>50</sub> values were combined in various ratios of various drugs. Thus fixed ratios of predetermined concentrations needed to inhibit parasite growth by 50% (IC<sub>50</sub>) was used to determine the interaction of two drugs. Single and combined drug solutions were dispensed into the 96 well microtitre plates to give nine combinations ratios of 90:10 to 10:90 (extract A:extract B) (Fivelman *et al.*, 1999). Incubation and subsequent procedures were followed as previously described in section of *in vitro* anti- plasmodium assay. Corresponding IC<sub>50</sub> values were determined for each drug alone and in combination using the method of Sixsmith *et al.*, (1984). The degree of

synergy was evaluated according to the method of Berenbaum (1978). Fraction inhibition concentration (sum FIC) was calculated using the formula;

$$A_c/A_e + B_c/B_e = K \quad (\text{sum FIC})$$

where  $A_c$  and  $B_c$  are the equally effective concentrations ( $IC_{50}$ ) when used in combination, and  $A_e$  and  $B_e$  are the equally effective concentrations when used alone. When  $FICs < 1$  it indicates synergism,  $sum\ FICs \geq 1$  and  $< 2$  it indicates additive interaction and  $sum\ FIC \geq 1$  it indicates antagonism (Gupta *et al*, 2002).

## RESULTS AND DISCUSSION

### *Anti-plasmodium results of Plants extracts*

The anti-plasmodium activity criteria in the *in vitro* assay were defined as high when  $IC_{50}$  value was below 10  $\mu\text{g/ml}$ , moderate when between 10 – 50  $\mu\text{g/ml}$  and low when between 50 – 100  $\mu\text{g/ml}$ . Drug samples with  $IC_{50} > 100 \mu\text{g/ml}$  was considered to be inactive. The anti-plasmodia activities of the fifteen medicinal plants against CQ sensitive *P. falciparum* ( $D_6$  strain) are summarized in table I

**Table I: In vitro anti-plasmodial activity ( $IC_{50}$ ) of methanolic extracts of Medicinal plants**

Plant	Plant code	Plant part	$IC_{50}$ ( $\mu\text{g/ml}$ )
<i>Momordica foestida</i> Schumach	MF - R	Roots	23.46
<i>Albizia gummifera</i> (J.F.Gmel)	AG – B	Stem bark	22.12
Harms			
<i>Erythrina abyssinica</i> DC	EA - B	Stem bark	3.50
<i>Clutia abyssinica</i> Jaud & Spach	CA – L	Leaves	29.19
	CA - R	Roots	7.71
<i>Vernonia amygdalina</i> . Del.	VA - R	Roots	> 100
<i>Cassia didymobotya</i> Fres.	CD – L	Leaves	> 100
	CD - R	Roots	> 100
<i>Clerodendrum myricoides</i> (Hochst).	CM –L	Leaves	41.00
	CM - R	Roots	> 100
<i>Kanahia laniflora</i> Forssk.	KL - R	Roots	8.81
<i>Clemantis simensis</i> Fres.	CS - R	Roots	27.29
<i>Toddalia asiatica</i>	TA - R	Roots	7.22
Lam			

<i>Fagara chellybea</i> Engl.	FC - B	Stem bark	26.41
<i>Zehneria scabra</i> (L.F) Sond.	ZS -R	Roots	16.11
<i>Croton macrostachyus</i> Del.	CMR - L	Leaves	> 100
<i>Teclea nobilis</i> Del.	TN - L	Leaves	5.71
<i>Carissa edulis</i> (Forsk) Vahl	ED - R	Roots	1.95
Chloroquine	CQ		7.49 ng/ml

Six medicinal plants showed promising antiplasmodial activity with IC<sub>50</sub> of  $\leq 10$   $\mu\text{g/ml}$ , of which two plants *Carissa edulis* and *Erythrina abyssinica* were found to be highly active with IC<sub>50</sub> values of  $\leq 5$   $\mu\text{g/ml}$  (reported by Kebenei *et al*, 2011). Six plants showed moderate activity of IC<sub>50</sub> between 10 – 50  $\mu\text{g/ml}$  and three plants, *Vernonia amygdalina*, *Cassia didymobotya*, and *Croton macrostachyus* were inactive with IC<sub>50</sub>  $\geq 100$   $\mu\text{g/ml}$ . For *Clerodendrum myricoides* the leaves extract was moderately active but the roots extract is inactive. Therefore the activity varies with the different parts of the plant, meaning different constituents of compounds present in different parts of the plant.

The results of *Vernonia amygdalina* differ from what is reported in literature from a Tanzanian *Vernonia amygdalina* plant with IC<sub>50</sub> 20  $\mu\text{g/ml}$  (Ohigashi *et al*, 1993) but the Kenyan plant from Uasin Gishu district is inactive but widely used traditionally for treatment of malaria. *Toddalia asiatica* is widely used and showed a higher activity of IC<sub>50</sub> 7.22  $\mu\text{g/ml}$  corresponding to what is reported in literature (Gakunju, 1993). Therefore factors such as environmental parameters, chemo types, harvesting and storage conditions could collectively influence the plant secondary metabolites prior to and following harvesting, which in turn would be reflected in the bioactivity.

### *Anti-plasmodial Activity of combination of Drugs*

Drug combination is one of the effective means to counter parasite resistance in anti-malarial chemotherapy (White and Olliaro, 1996). Combinations also help reduce risk of drug resistance development (Olliaro and Taylor 2003; Anne *et al.*, 2001).

The methanolic extract of *Carissa edulis* was further subjected to synergistic analysis with total extract of *Artemisia annua* and the following results in table 2 were obtained.

**Table II: Interaction of methanolic extract of *Carissa edulis* with Total extract of *Artemisia annua***

Combination ratios (%)	90:10	80:20	70:30	60:40	50:50	40:60	30:70	20:80	10:90
Sum FIC	0.98 <sup>a</sup>	0.93 <sup>a</sup>	0.88 <sup>a</sup>	0.82 <sup>a</sup>	0.74 <sup>a</sup>	0.73 <sup>a</sup>	0.74 <sup>a</sup>	0.71 <sup>a</sup>	0.62 <sup>a</sup>

a – synergistic

The interaction of EDR with *Artemisia annua* extract showed synergism at all combination ratios but decreases with increase in the concentration of *Artemisia annua* extract.

The results of the interaction study of combined test samples showed that some of the *in vitro* effects of plant extracts on parasite development were clearly synergistic these results highlight the interest in combinations of plants for the treatment of malaria. Synergism permits the quantity of each drug to be reduced, enhance efficacy and delay resistance. Drug combination is one of the effective means to counter parasite resistance in anti-malarial chemotherapy (White and Olliaro, 1996). Combinations also help reduce risk of drug resistance development (Olliaro and Taylor 2003; Anne *et al.*, 2001). Therefore combination chemotherapy for malaria should take advantage of synergistic interactions, as these would enhance therapeutic efficacy and lower the risk of resistance emergence since the combined drugs protect each partner against emergence of resistance (Woodrow *et al.*, 2005).

### **CONCLUSION**

The methanolic crude extract of the roots of *Carissa edulis* (EDR) with the highest activity of IC<sub>50</sub> = 1.95 µg/ml among all plant analyzed showed high synergism with total extract of *Artemisia annua* in ratios of combination. Therefore the methanolic crude extract of *Carissa edulis* and

*artemisia annua* at ratio of 9:1 respectively has high potential of being developed into a combination therapy for treatment of malaria.

## **ACKNOWLEDGMENTS**

The authors acknowledge the Kenya Medical Research Institute (KEMRI), Malaria Unit section for allowing anti-malarial assays work done in their laboratory, Mr James W. Gathirwa of KEMRI, Malarial Unit section for assisting in the anti-malarial analysis and Kabarak University for the partial funding of research work at KEMRI.

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### **S2012-35: Effects of Onion Thrips on Onion Crop Development, Bulb Yield and Quality**

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#### **Abstract**

Bulb onion, grown by many smallholder farmers in Kenya is an important crop for domestic market. However, its production is affected by many factors including pests and diseases; Onion thrips, *Thrips tabaci* Lindeman, is the primary pest of onion. Thrips cause damage to onions by using their rasping- sucking mouthparts to abrade the plant epidermis and suck up the exuding plant sap. Field studies to investigate the effects of thrips on the development, bulb yield and quality of some of the most commonly grown onion varieties in Kenya were conducted at Kenya Agricultural Research Institute (KARI) Centres at Mwea and Thika. Five onion varieties namely

Red Creole, BSS 230 Hybrid, Bombay Red, Texas Grano and Red Comet were evaluated. A split plot design incorporating protected and unprotected main onion plots was used. In the protected plot, onion thrips were controlled using blanket application of appropriate insecticides. Onion crop parameters including number of leaves, fresh weight, bulb yield and quality of the selected varieties were determined in the laboratory. Results indicated that infestations by high population density of onion thrips adversely affected the growth of onion crop. Further it was established that more leafy onion varieties tended to harbour more thrips than the less leafy varieties. It was also evident that yield capacities of onion varieties were dependent on crop pest burden among other factors. Results indicated that Texas Grano produced the highest yield followed by BSS 230 Hybrid, Red Creole, Bombay Red and Red Comet in that order. Quality of onion bulbs was affected by the number of onion thrips infesting various onion varieties. Red Comet was least tolerant to injuries by onion thrips since it produced onion bulbs of the lowest quality in spite of the low thrip burden observed from the variety. Texas Grano, BSS 230 Hybrid, Bombay Red and Red Creole were good varieties which could be recommended to be grown by farmers in Kenya.

**Key words:** *Onion, bulb yield, bulb quality, onion thrips, onion varieties and crop growth*

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## 1.0 INTRODUCTION

Onion crop is attacked by both larval and adult thrips at all stages of growth resulting in reduction in onion quality and yield (Waiganjo *et al.*, 2008). The most serious effect of thrips infestation is the resultant reduction in bulb yield (Coviello and McGiffen, 1995). Yield losses ranging between 18% and 60% caused by population thresholds of 19.6- 62.0 thrips per plant have been reported in Kenya (Waiganjo, 2004). Onion thrips population densities of 17.9 thrips per plant and below were found not to affect onion yield (Waiganjo, 2004). Records from many parts of the world indicate heavy losses because of *T. tabaci* infestation in onions. For example, in Portugal, Boica *et al.* (1987) showed that onion thrips were responsible for yield loss of 62%. In Quebec (Canada), heavy infestation by onion thrips resulted in losses of 43% and 34.5% in 1988 and 1989 respectively (Fournier *et al.*, 1995). Research by Sanderson (1995) demonstrated that thrips feeding had the potential to significantly reduce onion yields. The reduction was in form of smaller onion bulbs that resulted from the feeding activity after bulbing. Yield reduction due to reduced bulb size is the primary crop loss caused by onion thrips and increased plant maturity and senescence due to thrips injury may truncate the bulb growth period (Alston and Drost, 2008).

The aim of the present study was to evaluate the effects of the population densities of onion thrips on onion crop growth, yield and bulb quality. The findings of these studies are presented in this paper.

## 2.0 MATERIALS AND METHODS

The trial sites and materials and methods used to evaluate the effects of onion thrips on onion crop growth, yield and bulb quality are described in the sub-headings that follow:

### **2.1 Field Sites**

On-farm field trials were conducted at two localities. One station was located at KARI-Mwea (0° 37' S 37° 20' E) in Kirinyaga County of Central Kenya. The altitude is 1,158m above sea level. The area receives a bimodal rainfall pattern with an average of 850mm per year. The soils are fertile and of moderate drainage, very deep, dark reddish brown to black, friable to firm, slightly cracking clay with humid top soil (vertisols). Mean temperature is about 21.6°C. The centre is in the cotton agro-ecological zone (Jaetzold and Schmidt, 1983).

The second site was at KARI-Thika (01° 05' S 37° 00' E) with an altitude of about 1,600m above sea level. The area receives a bimodal rainfall pattern with an average of 1,018mm per year. Mean temperature is 19.2°C. The soils are moderately fertile, well drained, very deep, and red to red brown in colour. The site is in marginal coffee agro-ecological zone in Kiambu County of Central Kenya (Jaetzold and Schmidt, 1983).

### **2.2 Experimental Design and Treatments**

A split plot design incorporating unprotected (observation) and protected onion plots was used. The two main plots were separated by a distance of 5m to prevent inter-plot influences. The two plots were each sub-divided into sub-plots measuring 3m x 3m to accommodate the selected onion varieties which were assigned at random. The plots were replicated four times. All the plots were surrounded by a walking path of 1-1.5m width to facilitate carrying out of crop management practices and also to prevent inter-plot influences

Five bulb onion varieties namely: Bombay Red, BSS 230 Hybrid, Texas Grano, Red Comet and Red Creole were used for the trials. Red Creole, the most popular variety among onion growing farmers in Kenya was used as local check. The onion crops were grown for two seasons in the two sites. The first crop was raised during the dry season while the second crop was during wet season. The two season crops at each site were important to assess the effects of weather on thrips population changes.

In the unprotected onion plot, no pesticides were used to control onion thrips. However, in the protected main plot, thrips were controlled using blanket application of appropriate pesticides. Pesticides of choice were Malathion 50 EC and Polytrin 440 EC® (Profenofos 400g/l and Cypermethrin 40g/l) applied at rate of 100ml and 40 ml in 20 litres of water respectively. The

insecticides were applied on rotation to reduce build up of pesticide resistance and on a weekly basis. The application of insecticides was started two weeks after transplanting of onion seedlings.

Diseases were controlled in the two main plots using Dithane M45 ® (Mancozeb) at an application rate of 1-1.5 Kg/acre or 50g in 20 litres of water sprayed at 14 days interval. Rindomil Gold Bravo ® (Metalaxyl) was applied every 14 days at a rate of 40g/20l of water but in rotation with Dithane M45 to avoid build up of chemical resistance. Other standard crop management practices were the same for the protected and unprotected onion plots.

### **2.3 Susceptibility of onion varieties to onion thrips infestations**

Onion thrips population on onion plants were monitored on a weekly basis. Absolute density estimation method, obtained by cutting and bagging of whole plant was used (Freuler and Fischer, 1984). During sampling, a self-locking polythene bag was inverted onto onion plant and the plant cut at the leaf base using a sharp knife or secateur. The bag was sealed and taken to the laboratory for onion thrips extraction, counting, recording and identification.

Two crop rows from each side of the sub-plot were used for destructive sampling after leaving the outer row on each side of the plot and about 30 cm each from the other two edges. This was necessary because thrips tend to accumulate along the edges of the plot (Dent, 1991). Ten consecutive plants selected at random were used for each sampling.

In laboratory, thrips were extracted using the method described by Bullock (1963) but with slight modifications. Each onion plant in the bag was washed in clean water in 500ml transparent plastic container and shaken vigorously. Onion leaves were separated using a pair of forceps and swirled to dislodge thrips. Thrips in water were then filtered through a clean muslin cloth whose mesh sizes would not allow passing through of thrips. The cloth was secured to the transparent plastic container using rubber rings to form a concave shape.

Thrips collected were counted using a hand lens (magnification x10). Larvae and adults were counted separately using tally counters and their numbers recorded separately for each plant. Some adults were preserved in 60% alcohol for later differentiation using identification keys (Stiller, 2001).

Data from on-farm trials was analyzed using Statistical Analysis System Program (SAS, 8.1; SAS Institute, 2000). The data was subjected to analysis of variance (ANOVA). Data on mean number of thrips was transformed by  $\log_{10}(n+1)$  in cases where coefficient of variation was high to

obtain normal distribution. Means were separated using Student-Newman-Keul multiple range test. Probability level of significance of  $P= 0.05$  was used unless otherwise stated.

#### **2.4 Yield Capacities of Onion Varieties and Effects of Onion Thrips on Onion Crop Growth, Bulb Yield and Quality**

The growth of onion plants was monitored starting from the third week and second week after transplanting for the first and second season crops respectively. Thereafter, sampling was done after every two weeks until the crop exhibited signs of harvest maturity. The parameters determined included the number of leaves and the fresh weight (fresh biomass) of each sampled plant. Five onion plants selected randomly from the rows that were used for sampling of thrips were uprooted and taken to the laboratory for the assessments. The samples were put in polythene bags, sealed to minimize loss of moisture and kept in a cool place. They were also carefully handled to ensure that leaves remained intact before they were weighed and counted. Assessments of the variables were carried out as soon as the samples reached the laboratory. In the laboratory, the number of leaves and fresh weight of each sampled plant were determined and recorded. Weighing was done using a digital balance for accuracy. The reductions in crop growth due to attack by onion thrips were calculated using the formulae:

- i) Reduction in number of leaves = number of leaves in protected plot - number of leaves in unprotected plot.
- ii) Reduction in fresh weight = weight from protected plot – weight from unprotected plot.

Investigations on yield capacities of various onion varieties in protected and unprotected onion plots were carried out at the two trial sites for two cropping seasons. Onion bulbs were harvested when about 20-50% of the pseudo-stems of onion plants had lodged. Three middle rows of each plot were harvested for yields determination, leaving 30 cm from each edge of the rows. The maximum effective area harvested was 2.16 m<sup>2</sup>. The stems and roots of each harvested plant were trimmed off. Bulbs were then air-dried for three days before weighing them. The average weight of harvested bulbs per plot was determined using a digital balance and the yield extrapolated to metric tonnes per hectare. Yield of onion bulbs per hectare and percent reductions in yield due to attack by onion thrips for each onion variety were calculated using the formulae:

- i) Bulb yield (t/ha) = 
$$\frac{\text{Total weight of bulbs per plot (Kg)} \times 10}{\text{Effective harvested area (m}^2\text{)}}$$

$$\text{ii) \% reduction in yield} = \frac{\text{Yield of protected plot} - \text{Yield of unprotected plot}}{\text{Yield of protected plot}} \times 100$$

The effects infestation of onion thrips on quality of onion bulbs obtained from various onion varieties were evaluated in terms of mean bulb diameter, bulb weight and mean reductions in onion grades 1, 2 and 3. The diameters of onion bulbs were determined using a vernier caliper. Grading of onion bulbs was done as suggested by Nguthi *et al.* (1994). All harvested bulbs were counted and sorted into grade 1 ( $\geq 5$  cm bulb diameter), grade 2 ( $< 5$  cm but  $> 3$  cm bulb diameter) and grade 3 ( $\leq 3$  cm bulb diameter). The average weight of bulbs per plot was determined. The reduction in onion grade was evaluated using the formula:

- Reduction in grade of onions = weight of the grade in protected plot – weight of the grade in unprotected plot.

Data was analyzed using Statistical Analysis System program (SAS, 8.1; SAS Institute, 2000). Data on bulb yield, percent reduction in yield, number of leaves, fresh weight, bulb diameter, bulb weight and reductions in various onion grades were subjected to analysis of variance (ANOVA). Means of the above variables were separated using Student- Newman- Keuls multiple range test. The probability level of significance of  $P= 0.05$  was used unless otherwise stated.

### 3.0 RESULTS

#### 3.1 Effects of infestations of Onion thrips on Growth of Onion Crop

Results of the effects of infestations of onion thrips on growth of onion crop are contained in tables 1 and 2. Referring to table 1, it was evident that there were no significant differences in the mean reductions in the number of leaves and fresh weight due to infestations by onion thrips between the onion varieties ( $F= 1.68$ ,  $P= 0.1531$ ;  $F= 0.46$ ,  $P= 0.7659$  for the number of leaves and fresh weight respectively). However, a close examination indicated that highest reductions in number of leaves and fresh weight were recorded for Bombay Red followed by BSS 230 Hybrid and Red Comet, Red Creole, and Texas Grano in that order.

Results from KARI-Mwea indicated that there were significant differences in the mean number of leaves and fresh weights between onion varieties during the first cropping season ( $F= 54.14$ ,  $P= 0.0001$ ;  $F= 21.78$ ,  $P= 0.0001$  for leaves and fresh weight respectively).

**Table 1:** The pooled mean ( $\pm$  S.E) reductions in number of leaves and fresh weight (gm)

	Treatment	Mean reductions in leaves/ fresh weight	
a) Leaves	Bombay Red BSS 230 Hybrid Texas Grano Red Comet Red Creole	0.53 ± 0.13a 0.35 ± 0.12a 0.06 ± 0.11a 0.21 ± 0.09a 0.26 ± 0.13a	F= 1.68 P= 0.1531
b) Fresh weight	Bombay Red BSS 230 Hybrid Texas Grano Red Comet Red Creole	7.28 ± 2.23a 6.84 ± 2.06a 3.83 ± 2.81a 8.35 ± 2.28a 5.50 ± 2.17a	F= 0.46 P= 0.7659

Means marked by the same letter(s) in the same column in a blocked row are not significantly different (P=0.05, SNK)

**Table 2:** Mean (± S.E) number of leaves and fresh weight in the unprotected plots at KARI-Mwea and KARI-Thika during wet and dry seasons

Site/Season	Variety	Number of leaves	Fresh weight
KARI-Mwea / Wet Season	Bombay Red	8.05 ± 0.23b	92.15 ± 6.5b
	BSS 230 Hybrid	8.97 ± 0.25a	105.60 ± 7.21b
	Texas Grano	7.38 ± 0.25c	128.02 ± 9.90a
	Red Comet	5.32 ± 0.23d	72.27 ± 5.13c
	Red Creole	8.46 ± 0.22ab	95.07 ± 6.55b
KARI-Mwea / Dry Season	Bombay Red	8.48 ± 0.49a	67.33 ± 7.82a
	BSS 230 Hybrid	7.74 ± 0.33b	63.18 ± 6.61a
	Texas Grano	6.14 ± 0.23d	70.22 ± 8.36a
	Red Comet	4.62 ± 0.19e	28.13 ± 3.99b
	Red Creole	7.00 ± 0.35c	63.00 ± 7.64a
KARI-Thika / Wet Season	Bombay Red	7.32 ± 0.28ab	56.43 ± 4.48bc
	BSS 230 Hybrid	7.60 ± 0.24a	64.87 ± 4.66b
	Texas Grano	6.83 ± 0.25b	78.78 ± 6.55a
	Red Comet	5.62 ± 0.19c	53.08 ± 0.45c
	Red Creole	7.27 ± 0.28ab	58.29 ± 4.59bc
KARI-Thika / Dry Season	Bombay Red	5.31 ± 0.14a	18.00 ± 1.53b
	BSS 230 Hybrid	5.08 ± 0.14a	13.81 ± 1.12c
	Texas Grano	5.20 ± 0.14a	22.77 ± 2.41a
	Red Comet	3.71 ± 0.10b	7.27 ± 0.73d
	Red Creole	5.12 ± 0.18a	14.64 ± 1.60c

Means marked by the same letter(s) in the same column in a blocked row are not significantly different (P=0.05, SNK)

During the first season at the site, BSS 230 Hybrid significantly produced the highest number of leaves followed by Red Creole, Bombay Red and Texas Grano in that order while Red Comet significantly produced the lowest number of leaves. At the same time Texas Grano significantly recorded the highest fresh weight while Red Comet registered the lowest. There were no significant differences in mean fresh weights between BSS 230 Hybrid, Red Creole and Bombay Red.

During the second season at KARI-Mwea in the unprotected plots, results indicated that there were significant differences in the number of leaves and fresh weight between onion varieties ( $F= 49.63$ ,  $P= 0.0001$ ;  $F= 18.28$ ,  $P= 0.0001$  for leaves and fresh weight respectively). During the season, Bombay Red and Red Comet significantly produced the highest and the lowest number of leaves respectively. The second highest numbers of leaves were significantly produced by BSS 230 Hybrid followed by Red Creole and Texas Grano. During the period, Texas Grano, Bombay Red, BSS 230 Hybrid and Red Creole significantly registered the highest mean fresh weight while Red Comet significantly registered the lowest mean fresh weight.

Results from KARI-Thika trial site indicated that there were significant differences in the number of leaves and fresh weights between the onion varieties during the first cropping season ( $F= 17.42$ ,  $P= 0.0001$ ;  $F= 10.25$ ,  $P= 0.0001$  for leaves and fresh weight respectively). During the season BSS 230 Hybrid significantly recorded the highest number of leaves followed by Bombay Red and Red Creole. The second lowest number of leaves was significantly noted for Texas Grano while the lowest was significantly observed from Red Comet. The fresh weights recorded at the site were significantly higher for Texas Grano followed by BSS 230 Hybrid. Red Creole and Bombay Red significantly registered the third highest fresh weight while Red Comet significantly registered the lowest fresh weight.

During the second season at the KARI-Thika site in the unprotected plots, results revealed that there were significant differences in the number of leaves and fresh weights between the onion varieties ( $F= 24.40$ ,  $P= 0.0001$ ;  $F= 22.62$ ,  $P= 0.0001$  for leaves and fresh weight respectively). Bombay Red, Texas Grano and Red Creole significantly produced the highest numbers of leaves while Red Comet significantly produced the lowest. The second highest number of leaves was significantly recorded by BSS 230 Hybrid. Considering fresh weights, Texas Grano, significantly recorded the highest fresh weight, followed by Bombay Red. Red Creole and BSS 230 Hybrid significantly registered the second lowest fresh weight. Red Comet significantly had the lowest fresh weight during the season at the site.

### 3.2 Yield capacities of Onion Varieties and Effects of onion Thrips on Bulb Yield

The results of onion yields and yield reductions associated with infestations of onion varieties by onion thrips at KARI-Mwea and KARI-Thika sites are shown in tables 3 and 4. It was evident that there were variations in yield between sites, seasons and varieties. Considering the results obtained from the protected plots at KARI-Mwea, it was shown that

**Table 3:** Mean ( $\pm$  S.E) onion yields (t/ha) of varieties grown in protected and unprotected plots at KARI-Mwea and KARI-Thika sites.

Variety	Mwea/ Rainy season	Mwea/ Dry season	Thika/ Rainy season	Thika/ Dry season
<b>a) Protected Plots</b>				
Bombay Red	27.80 $\pm$ 2.12c	50.50 $\pm$ 2.30b	26.32 $\pm$ 2.99a	14.50 $\pm$ 1.76ab
BSS 230 Hybrid	35.08 $\pm$ 2.07bc	55.60 $\pm$ 3.99b	30.55 $\pm$ 2.24a	20.60 $\pm$ 1.02ab
Texas Grano	55.50 $\pm$ 3.42a	71.62 $\pm$ 3.63a	39.25 $\pm$ 7.80a	22.60 $\pm$ 3.50a
Red Comet	40.65 $\pm$ 3.83b	39.52 $\pm$ 1.77c	27.28 $\pm$ 4.25a	11.60 $\pm$ 2.35b
Red Creole	37.28 $\pm$ 2.80b	48.52 $\pm$ 1.01b	27.02 $\pm$ 2.69a	15.10 $\pm$ 2.56ab
<b>b) Unprotected Plots</b>				
Bombay Red	26.45 $\pm$ 2.88b	45.40 $\pm$ 1.58b	16.75 $\pm$ 2.58bc	9.05 $\pm$ 1.11b
BSS 230 Hybrid	29.78 $\pm$ 2.05b	43.10 $\pm$ 2.35b	20.60 $\pm$ 2.56b	7.38 $\pm$ 1.02b
Texas Grano	47.70 $\pm$ 4.49a	67.88 $\pm$ 3.54a	31.82 $\pm$ 3.85a	14.75 $\pm$ 1.99a
Red Comet	30.38 $\pm$ 5.78b	36.18 $\pm$ 2.42b	12.98 $\pm$ 2.14c	3.32 $\pm$ 0.46c
Red Creole	31.60 $\pm$ 2.70b	41.48 $\pm$ 2.54b	20.00 $\pm$ 1.81b	7.72 $\pm$ 0.64b

Means marked by the same letter(s) in the same column in a blocked row are not significantly different (P=0.05, SNK)

**Table 4:** Mean ( $\pm$  S.E) reductions in bulb yield (%) of onion varieties grown at KARI-Mwea and KARI- Thika sites

Variety	Mwea/ Rainy season	Mwea/ Dry season	Thika/ Rainy season	Thika/ Dry season
Bombay Red	3.84 $\pm$ 10.41a	9.74 $\pm$ 4.04a	36.71 $\pm$ 4.68ab	33.64 $\pm$ 12.37a
BSS 230 Hybrid	13.45 $\pm$ 10.38a	21.86 $\pm$ 4.13a	32.64 $\pm$ 5.80ab	64.56 $\pm$ 3.45a
Texas Grano	14.54 $\pm$ 3.05a	5.12 $\pm$ 2.79a	15.72 $\pm$ 6.46b	34.17 $\pm$ 2.68a
Red Comet	26.09 $\pm$ 9.50a	8.31 $\pm$ 6.02a	51.71 $\pm$ 4.44a	66.32 $\pm$ 9.41a
Red Creole	15.22 $\pm$ 4.03a	14.66 $\pm$ 3.50a	25.43 $\pm$ 4.02b	41.33 $\pm$ 14.72a

Means marked by the same letter(s) in the same column in a blocked row are not significantly different (P=0.05, SNK)

yields ranged from 27.8-55.5 t/ha and 39.5-71.6 t/ha in the first and the second cropping seasons respectively. Higher yields were obtained during the second season compared to the first season for

all the varieties tested at the site. There were significant differences in yields between various onion varieties during the first and second cropping seasons at the site ( $F=17.78$ ,  $P= 0.0001$ ;  $F= 19.06$ ,  $P= 0.0001$  for the first and second seasons respectively). During the first season, Texas Grano significantly produced the highest yield while Bombay Red significantly had the lowest yield. The second highest yield was significantly obtained from BSS 230 Hybrid. There were no significant differences in bulb yield between Red Comet and Red Creole during the season.

During the second season at the site in the protected plots, Texas Grano once again significantly produced the highest yield while Red Comet significantly had the lowest yield. There were no significant differences in yields between BSS 230 Hybrid, Bombay Red and Red Creole during the season

Results obtained from KARI-Thika in the protected plots, indicated that yields ranged from 26.3-39.2 t/ha and 11.6-22.6 t/ha in the first and second seasons respectively. During the first season at the site results indicated that there were no significant differences in yields between onion varieties ( $F= 3.54$ ,  $P= 0.0483$ ). However, Texas Grano gave the highest yield followed by BSS 230 Hybrid, Red Comet, Red Creole and Bombay Red in that order. During the second season at the site, results indicated that there were significant differences in yield between the onion varieties ( $F= 2.19$ ,  $P= 0.1426$ ). During the period, Texas Grano significantly produced the highest yield while Red Comet significantly had the lowest yield. There were no significant differences in yield between BSS 230 Hybrid, Bombay Red and Red Creole.

Comparing yields obtained from the unprotected plots at KARI- Mwea and KARI-Thika sites, it was evident that yields were higher at Mwea than at Thika. It was also shown that higher yields were obtained during the first season compared to the second season.

Results obtained from KARI-Mwea site in the unprotected plots indicated that there were significant differences in yields between the various onion varieties during the first and second cropping seasons. ( $F= 12.71$ ,  $P= 0.0003$ ;  $F= 19.10$ ,  $P= 0.0001$  for first and second seasons respectively). During the first season at the site, yields ranged from 26.4-30.4 t/ha for the varieties tested. Texas Grano significantly produced the highest yield. There were no significant differences in yields between the rests of the varieties. However, Red Creole produced the second highest yield followed by Red Comet, BSS 230 Hybrid and Bombay Red in that order. During the second season at KARI-Mwea site yields ranged from 36.2-67.9 t/ha for the varieties tested. Texas Grano significantly produced the highest yield. Yields from the rest of onion varieties were not

significantly different although Bombay Red produced the second highest yield followed by BSS 230 Hybrid, Red Creole and Red Comet in that order.

Considering results obtained from KARI-Thika in the unprotected onion plots, yields ranged from 13.0- 31.8 t/ha and 3.3- 14.8 t/ha in the first and second seasons respectively for the varieties tested. There were significant differences in yields between onion varieties during the first and second cropping seasons ( $F= 15.39$ ,  $P= 0.0001$  and  $F= 24.35$ ,  $P= 0.0001$  for the first and second seasons respectively). During the first season at the site, Texas Grano significantly produced the highest yield while Red Comet significantly produced the lowest yield. The second highest yield was significantly produced by Bombay Red, followed by BSS 230 Hybrid and Red Creole respectively. But there were no significant differences in yields between BSS 230 Hybrid and Red Creole.

During the second season at the site, Texas Grano significantly produced the highest yield while Red Comet significantly had the the lowest yield. The second highest yields were got from Bombay Red and this was followed by Red Creole and BSS 230 Hybrid. There were no significant differences in yields between Bombay Red, Red Creole and BSS 230 Hybrid.

Results on per cent reductions in yield associated with infestations of onion varieties by onion thrips are contained in Table 4. Analysis of variance indicated that there were no significant differences in per cent yield reductions between various onion varieties during the first and second seasons at Mwea ( $F= 1.17$ ,  $P= 0.3604$ ;  $F= 1.21$ ,  $P= 0.3472$  for the first and second seasons respectively). However, there were significant differences in yield reductions between onion varieties at KARI-Thika during the first season ( $F= 1.22$ ,  $P= 0.0459$ ) but during the second season there were no significant differences ( $F= 2.17$ ,  $P= 0.1447$ ). Generally, during the first season at KARI-Mwea, the per cent reductions in yield due to infestations of onion thrips on onion varieties were higher for Red Comet compared to the rest of the varieties. The per cent reductions recorded for the onion varieties in order of decreasing importance were Red Comet, Red Creole, Texas Grano, BSS 230 Hybrid and Bombay Red. During the second season at the site, the reductions in yield in order of decreasing importance included BSS 230 Hybrid, Red Creole, Bombay Red, Red Comet and Texas Grano.

At KARI-Thika during the first cropping season, there were significant differences in per cent yield reductions between the varieties. The highest reduction was significantly recorded for Red Comet, followed by Bombay Red and BSS 230 Hybrid. The lowest reductions were significantly registered by Texas Grano and Red Creole.

During the second season at the site, there were no significant differences in per cent reductions in yield between onion varieties. However, Red Comet had the highest loss of yield, followed by BSS 230 Hybrid, Red Creole, Texas Grano and Bombay Red in that order.

### **3.3 Effects of Infestations of Onion Thrips on Quality of Onion Yield**

Results of the capacities of various onion varieties to produce onions of high quality are shown in tables 5 and 6. At KARI-Mwea in the protected plots, results indicated that there were significant differences in the mean diameter of onion bulbs between various onion varieties during the first and second cropping seasons ( $F= 15.65$ ,  $P= 0.0001$ ;  $F= 29.75$ ,  $P= 0.0001$  for first and second seasons respectively). During the first season at the site, Texas Grano significantly produced bulbs with largest diameter while the lowest were significantly produced by Red Comet. The second largest bulbs were significantly produced by BSS 230 Hybrid and were followed by those of Bombay Red and Red Creole respectively.

During the second season at the site, Texas Grano significantly produced bulbs with the largest diameter while the lowest were significantly produced by Red Comet. There were no significant differences in bulb diameters between Bombay Red, BSS 230 hybrid and Red Creole during the period.

Results from KARI-Thika in the protected plots indicated that there were significant differences in bulb diameter between various onion varieties during the first and second cropping seasons ( $F= 8.39$ ,  $P= 0.0018$ ;  $F= 7.61$ ,  $P= 0.0027$  for the first and second seasons respectively). During the first season at the site, Texas Grano, BSS 230 Hybrid, Red Creole and Bombay Red significantly produced bulbs with the largest diameter although there were no significant differences between them. Red Comet significantly produced the smallest bulbs during the period. The same trend was observed during the second season at the site.

Considering results obtained at KARI-Mwea in the unprotected plots, it was evident that there were significant differences in mean bulb diameter between various onion varieties during the first and second cropping seasons ( $F= 16.74$ ,  $P= 0.0001$ ;  $F= 28.83$ ,  $P= 0.0001$  for the first and second seasons respectively). During the first season at the site, Texas Grano, Bombay Red and BSS 230 Hybrid significantly produced the largest bulbs although there were no significant differences between them. The smallest bulbs were significantly produced by Red Comet while Red Creole produced medium sized bulbs. During the second season at the site, the same trend was observed.

**Table 5:** Mean ( $\pm$  S.E) bulb diameter (cm) recorded in protected and unprotected plots at KARI-Mwea and KARI-Thika sites during two cropping seasons

Variety	Mwea/ Rainy season	Mwea/ Dry season	Thika/ Rainy season	Thika/ Dry season
<b>a) Protected Plots</b>				
Bombay Red	6.32 $\pm$ 0.18b	5.92 $\pm$ 0.14a	4.98 $\pm$ 0.13a	2.80 $\pm$ 0.17a
BSS 230 Hybrid	6.55 $\pm$ 0.05ab	5.88 $\pm$ 0.11a	5.50 $\pm$ 0.12a	3.30 $\pm$ 0.11a
Texas Grano	6.98 $\pm$ 0.17a	5.95 $\pm$ 0.13a	5.52 $\pm$ 0.34a	3.18 $\pm$ 0.29a
Red Comet	5.35 $\pm$ 0.21c	4.20 $\pm$ 0.20c	4.30 $\pm$ 0.17b	1.92 $\pm$ 0.24b
Red Creole	6.25 $\pm$ 0.25b	5.22 $\pm$ 0.15b	5.08 $\pm$ 0.23a	2.55 $\pm$ 0.31a
<b>b) Unprotected Plots</b>				
Bombay Red	5.95 $\pm$ 0.18b	5.52 $\pm$ 0.12a	4.42 $\pm$ 0.26a	2.05 $\pm$ 0.13b
BSS 230 Hybrid	5.92 $\pm$ 0.17b	5.40 $\pm$ 0.13a	4.60 $\pm$ 0.28a	1.80 $\pm$ 0.20b
Texas Grano	6.70 $\pm$ 0.22a	5.72 $\pm$ 0.11a	5.00 $\pm$ 0.19a	2.50 $\pm$ 0.23a
Red Comet	4.68 $\pm$ 0.20c	3.85 $\pm$ 0.25c	3.28 $\pm$ 0.19b	0.70 $\pm$ 0.11c
Red Creole	5.72 $\pm$ 0.21b	4.80 $\pm$ 0.12b	4.38 $\pm$ 0.16a	1.72 $\pm$ 0.10b

Means marked by the same letter(s) in the same column in a blocked row are not significantly different (P=0.05, SNK)

**Table 6:** Mean ( $\pm$  S.E) bulb weight (gm) recorded in protected and unprotected plots at KARI-Mwea and KARI-Thika sites during two cropping seasons

Variety	Mwea/ Rainy season	Mwea/ Dry season	Thika/ Rainy season	Thika/ Dry season
<b>a) Protected</b>				
Bombay Red	86.8 $\pm$ 3.98c	151.50 $\pm$ 6.84bc	71.82 $\pm$ 4.95a	43.60 $\pm$ 5.35ab
BSS 230 Hybrid	105.22 $\pm$ 6.27bc	166.85 $\pm$ 12.02b	91.62 $\pm$ 6.68a	61.78 $\pm$ 3.07ab
Texas Grano	172.00 $\pm$ 7.26a	214.88 $\pm$ 10.96a	117.78 $\pm$ 23.41a	66.85 $\pm$ 10.35a
Red Comet	121.88 $\pm$ 11.48b	121.02 $\pm$ 4.98c	81.85 $\pm$ 12.72a	34.80 $\pm$ 7.05b
Red Creole	111.80 $\pm$ 8.36b	145.55 $\pm$ 3.00bc	81.00 $\pm$ 8.03a	45.25 $\pm$ 7.67ab
<b>b) Unprotected</b>				
Bombay Red	76.38 $\pm$ 6.21b	136.25 $\pm$ 4.65b	50.28 $\pm$ 7.75bc	27.10 $\pm$ 3.35b
BSS 230 Hybrid	86.05 $\pm$ 2.47b	129.35 $\pm$ 7.03b	61.78 $\pm$ 7.70b	22.05 $\pm$ 3.06b
Texas Grano	143.08 $\pm$ 13.43a	203.52 $\pm$ 10.59a	94.02 $\pm$ 11.49a	44.12 $\pm$ 5.97a
Red Comet	91.15 $\pm$ 17.31b	108.48 $\pm$ 7.27b	37.45 $\pm$ 6.90c	10.00 $\pm$ 1.43c
Red Creole	94.80 $\pm$ 8.06b	123.40 $\pm$ 6.64b	59.98 $\pm$ 5.43b	23.18 $\pm$ 1.96b

Means marked by the same letter(s) in the same column in a blocked row are not significantly different (P=0.05, SNK)

Results from KARI-Thika in the unprotected plots indicated that there were significant differences in bulb diameters between various onion varieties during the first and second cropping seasons ( $F= 12.27$ ,  $P= 0.0003$ ;  $F= 35.40$ ,  $P= 0.0001$  for the first and second seasons respectively). During the first season at the site, Texas Grano, BSS 230 Hybrid, Bombay Red and Red Creole significantly produced the largest sized bulbs although there were no significant differences between them. Red Comet significantly produced the smallest bulbs during the season.

Considering the second season, it was observed that Texas Grano significantly had the largest bulbs. The second largest bulbs were significantly produced by Bombay Red, BSS 230 Hybrid and Red Creole although there were no significant differences between them. Red Comet significantly produced the smallest bulbs during the season. It was generally observed that large sized bulbs were produced in the protected plots compared to the unprotected ones at the two trial sites during the two cropping seasons. Large sized bulbs were produced more common at Mwea than Thika. It was also observed that large sized bulbs were more common during the first season compared to the second season at the two trial sites.

Results of the mean bulb weight recorded at KARI-Mwea and KARI-Thika sites during two cropping seasons are contained in table 6. At KARI-Mwea in the protected plots, results indicated that there were significant differences in bulb weight between onion varieties during the first and the second growing seasons ( $F= 24.47$ ,  $P= 0.0001$ ;  $F= 17.59$ ,  $P= 0.0001$  for the first and second seasons respectively). During the first season at the site, Texas Grano significantly produced the heaviest bulbs followed by BSS 230 Hybrid. Red Comet and Red Creole produced bulbs of medium weight while Bombay Red significantly produced the lightest bulbs.

During the second season at the site, Texas Grano significantly produced the heaviest bulbs followed by BSS 230 Hybrid. Bombay Red and Red Creole significantly produced bulbs of medium weight. Red Comet significantly produced the lightest bulbs.

Considering results from KARI-Thika in the protected plots, it was noted that there were no significant differences in bulb weight between onion varieties during the first season ( $F= 2.78$ ,  $P= 0.0762$ ) but the converse was true during the second season ( $F= 4.24$ ,  $P= 0.0229$ ). During the first season at the site, Texas Grano produced the heaviest bulbs followed by BSS 230 Hybrid, Red Comet, Red Creole and Bombay Red in that order although there were no significant differences between them. During the second season at the site, Texas Grano significantly produced the

heaviest bulbs. Bulbs of medium weight were produced by BSS 230 Hybrid, Red Creole and Bombay Red although there were no significant differences between them. The lightest bulbs were significantly produced by Red Comet.

Results from KARI-Mwea in the unprotected onion plots, indicated that there were significant differences in bulb weights between various onion varieties during the first and second cropping seasons ( $F= 10.85$ ,  $P= 0.0006$ ;  $F= 20.19$ ,  $P= 0.0001$  for the first and second seasons respectively). During the first season at the site, Texas Grano significantly produced the heaviest bulbs compared to the rest of the varieties. There were no significant differences in bulb weight between Red Creole, Red Comet, BSS 230 Hybrid and Bombay Red. The same trend was observed during the second season at the site.

Considering results from KARI-Thika in the unprotected plots, it was noted that there were significant differences in mean bulb weight between various onion varieties during the first and second cropping seasons ( $F= 15.47$ ,  $P= 0.0001$ ;  $F= 20.10$ ,  $P= 0.0001$  for the first and second seasons respectively). During the first season at the site, Texas Grano significantly produced the heaviest bulbs followed by Bombay Red. Bulbs of medium weight were produced by BSS 230 Hybrid and Red Comet. The lightest bulbs were significantly produced by Red Comet. During the second season at the site, Texas Grano significantly produced the heaviest bulbs while the lightest bulbs were significantly produced by Red Comet. Bombay Red, Red Creole and BSS 230 Hybrid produced bulbs of medium weight although there were no significant differences between them.

It was generally observed that onion bulbs obtained from KARI-Mwea were heavier than those from KARI-Thika. Heavier bulbs were produced in the protected plots compared to the unprotected ones at the two sites. At KARI-Mwea, heavier bulbs were produced during the second season compared to the first season. On the contrary, heavier bulbs were produced during the first season at KARI-Thika compared to those recorded at KARI-Mwea.

Results on reductions in grades of onions recorded at KARI-Mwea and KARI-Thika sites during the trials are indicated in table 7. The losses in various onion market grades due to infestations of onion thrips were evaluated in the present study as a measure of onion bulb quality. Results indicated that there was no significant reduction in grade one (jumbo or colossal grade) between sites, seasons and varieties ( $F=0.24$ ,  $p= 0.6255$ ;  $F= 0.67$ ,  $p = 0.4160$ ;  $F= 0.60$ ,  $p= 0.6035$  in that order). Considering reduction in grade two (medium grade), results indicated that there was significant difference between the sites and seasons but not between the varieties ( $F= 18.36$ ,  $p= 0.0001$ ;  $F= 18.75$ ,  $p= 0.0001$ ;  $F= 0.39$ ,  $p= 0.8148$  in that order).

**Table 7:** The pooled mean ( $\pm$  S.E) reductions in onion grades (Kg) due to infestation by onion thrips recorded at KARI-Mwea and KARI-Thika trial sites

Onion Grades	Treatment	Mean ( $\pm$ S.E) reduction in grade (Kg)	
Grade 1	Mwea	1.15 $\pm$ 0.20a	F=0.24 P=0.6255
	Thika	1.01 $\pm$ 0.26a	
Grade 2	Mwea	- 0.18 $\pm$ 0.08b	F= 18.36 P=0.0001
	Thika	0.63 $\pm$ 0.22a	
Grade 3	Mwea	-0.05 $\pm$ 0.02a	F=0.02 P=0.8775
	Thika	-0.04 $\pm$ 0.07a	
Grade 1	Season 1	1.20 $\pm$ 0.23a	F= 0.67 P=0.4160
	Season 2	0.97 $\pm$ 0.16a	
Grade 2	Season 1	-0.18 $\pm$ 0.10a	F=18.75 P=0.0001
	Season 2	0.64 $\pm$ 0.14a	
Grade 3	Season 1	-0.04 $\pm$ 0.15a	F= 0.02 P=0.8859
	Season 2	-0.05 $\pm$ 0.14a	
Grade 1	Bombay Red	0.93 $\pm$ 0.30a	F= 0.60 P=0.6635
	BSS 230 Hybrid	1.51 $\pm$ 0.34a	
	Texas Grano	0.94 $\pm$ 0.35a	
	Red Comet	0.95 $\pm$ 0.33a	
	Red Creole	1.08 $\pm$ 0.27a	
Grade 2	Bombay Red	0.08 $\pm$ 0.18a	F=0.39 P=0.8148
	BSS 230 Hybrid	0.41 $\pm$ 0.41a	
	Texas Grano	0.30 $\pm$ 0.20a	
	Red Comet	0.12 $\pm$ 0.21a	
	Red Creole	0.23 $\pm$ 0.22a	
Grade 3	Bombay Red	-0.05 $\pm$ 0.05a	F= 2.26 P=0.0710
	BSS 230 Hybrid	-0.13 $\pm$ 0.08a	
	Texas Grano	-0.13 $\pm$ 0.07a	
	Red Comet	0.15 $\pm$ 0.17a	
	Red Creole	-0.09 $\pm$ 0.04a	

Means marked by the same letter(s) in the same column in a blocked row are not significantly different (P=0.05, SNK). Minus means a gain in onion grade

The highest reductions in grade two were significantly experienced at KARI-Thika site. There were also significantly more reductions during the first season compared to the second season. Results indicated that there were gains in onion grade three (small or inferior quality) due to onion thrips which were not significant between the sites, season and onion varieties (F= 0.02, p= 0.8775; F= 0.02, p= 0.8857; F= 2.26, p= 0.0710 in that order).

#### 4.0 DISCUSSION

It was established from the this study that infestations by a large number of onion thrips adversely affected the growth of onion crop. Although there were no significant differences in the overall reductions in number of leaves and fresh weight due to attack by thrips observed between the varieties, close observations from individual trial sites suggested otherwise. The high reductions in these parameters of growth observed for Bombay Red and BSS 230 hybrid onion varieties were related to the heavy infestations recorded from the varieties. Red Creole was noted to show medium susceptibility to attack by thrips since it registered medium reductions in the number of leaves and fresh weight. On the other hand, Texas Grano which was noted to be second least attractive to infestations by onion thrips displayed the least susceptibility in terms of losses of growth. Red Comet which was found to harbour the least number of thrips recorded the highest losses of growth implying that it was least tolerant to injuries by onion thrips. It was also observed that the number of leaves and fresh biomass recorded by the varieties tested were higher during the wet season which was marked by low number of thrips. During the dry season, the converse was also true. This finding implied that heavy infestations by onion thrips led to losses in the growth of onion crop. The regional differences in the number of thrips observed between KARI-Mwea and KARI-Thika were also suggestive as to the role played by thrips in growth of onion crop. Higher growth losses were noted for KARI-Thika which was also marked by heavy infestations by onion thrips compared to KARI-Mwea site. The losses in onion growth were associated with the damages caused by onion thrips to the onion leaves which led to reduced photosynthetic ability and nutrient availability to plants as was reported by Coviello and McGiffen (1995). The reductions in the number of leaves could be attributed to greater ethylene production in onions damaged by thrips which enhanced foliage senescence as was reported by Kendall and Bjostad (1990).

It was established from the present study that there was a direct relationship between the number of leaves produced by a particular onion variety and the number of thrips recovered from them. It was evident that BSS 230 Hybrid and Bombay Red produced more leaves while Texas Grano and Red Comet produced less leaves. The varieties producing more leaves also harboured more onion thrips. The converse was also true. The bushy growth habit of some of the onion varieties provided better hiding places for onion thrips against adverse weather conditions and natural enemies as was suggested by Coudriet *et al.* (1979) and Fournier *et el.* (1995). It was established from the present study that there was a direct relationship between the fresh weight and the bulb yield. The varieties that recorded high fresh weight also produced high bulb yield. It

implied that fresh weight determination during the growth of onion crop could be used by farmers to generally evaluate the yield potential of various onion varieties.

The present study revealed that yield capacities of onion varieties grown in Kenya were dependent on many factors including the agro-ecological zone, the crop pest burden and the season. The results indicated that all the varieties had a higher yield potential at Mwea agro-ecological zone than at Thika zone. This meant, therefore, that onions performed well in Mwea than in Thika. This finding seemed to support the reason why Mwea was selected in the campaign for enhanced commercial production of bulb onions in 1950s as reported by Kimani and Mbatia (1993).

It was evident from the results of this investigation that majority of onion varieties available in Kenya had the potential of yielding more than 30 tonnes/ha in situations where all recommended agronomic practices were observed and in environments where thrips burdens were low. The observed high yield capacities were far above the world average of 17.7 t/ha as reported by FAO (2000) and Msuya *et al.* (2001). These yields were comparable to the high yields realized in countries like China, Spain and Japan as documented by Kimani and Mbatia (1993), Nguthi *et al.* (1994) and FAO (1999). However, in an agro-ecological area where thrip burdens were high, yields fell drastically to as far as 3.3 t/ha as was witnessed at KARI-Thika in the present study. These revelations reinforced the findings of Waiganjo *et al.* (2002) who suggested that the low yield and poor quality supply of bulb onions from Kenya was attributed to lack of appropriate pest management techniques among other factors.

The present study revealed that onions performed well in Mwea during the dry season compared to the wet season. Low onion yields were realized during the long rains probably due to prolonged flooding and increased incidences of bulb rot. The disease was quite rampant during the season. It was observed that land topography at Mwea was generally flat and the area had clay soils which made the area to be prone to flooding.

In Thika, yields were higher during the long rainy season compared to the dry season. This was probably due to less flooding during rainy season as a result of the common slopy topography observed at the site. There were also less incidences of bulb rot. The rainy season was characterized by low thrips load possibly due to the effects of rainfall where heavy rain was reported by Harris *et al.* (1936) to affect thrips population by washing them off plants and down to the soil surface, causing sudden sharp declines in their population density

The current study revealed that different onion varieties significantly differed in yield capacities. Texas Grano was shown to significantly outweigh other varieties in yield in protected

and unprotected onion plots. Red Comet significantly registered the lowest yield in the unprotected plots and therefore was less tolerant to infestation by onion thrips. There were no significant differences in yield between Red Creole, Bombay Red and BSS 230 Hybrid. These findings were supported by findings of other scientists. For example, in equivalent work carried out in Tanzania, Msuya *et al.* (2001) reported that Texas Grano significantly produced the highest yield and the largest bulbs while the yield of Red Creole was significantly below average. Although Texas Grano had the highest yield, it was reported by Msuya *et al.* (2001) to have less pungent smell compared to the red onion varieties. In Kenya and indeed many other tropical and sub-tropical countries, red, pungent onions were reported by AVRDC (1993), Kimani and Mbatia (1993), Mohamedali (1994), Singh and Rana (1994), Vimala *et al.* (1994) and Mulungu *et al.* (1998) to be much more preferred than yellow or white, sweet onions. On basis of yield and pungency, Red Creole, BSS 230 Hybrid and Bombay Red were good varieties which could be recommended for cultivation in Kenya.

The present study revealed that the population densities of onion thrips at KARI-Mwea ranged from 0.98-1.60 and 2.02-3.35 thrips/plant for the wet and dry seasons respectively. On the other hand, the population densities recorded from KARI-Thika ranged from 2.78-8.38 and 4.51-9.29 thrips/plant respectively. It was noted that these numbers were not high enough to cause any significant loss in yield. This was in agreement with the findings by Waiganjo (2004) who established a minimum threshold of 19.6 onion thrips/plant as the density that was sufficient enough to cause significant loss of onion yield in Kenya. However, it was clear that infestation by onion thrips had the potential of causing economic losses in onion production. Increased loss of onion yield was registered at Thika trial site than at Mwea and this phenomenon corresponded well with the increased population densities of onion thrips noted for Thika. The highest loss in yield occurred at a time when the highest mean number of thrips per plant was observed.

Among the onion varieties tested, Red Comet gave the highest loss in yield although it had the lowest number of thrips. This meant that the variety was less tolerant to thrips injuries. BSS 230 Hybrid showed the second highest loss in onion yield in most instances. BSS 230 Hybrid significantly attracted the highest mean number of thrips per plant during the trial period at the two sites. Red Creole which was used as the local check was also quite susceptible to thrips as it registered the third highest loss in yield. Bombay Red although had significantly attracted the second highest number of thrips per plant gave a moderate loss in yield meaning that it was abt tolerant to thrips injuries. The lowest loss of yield was given by Texas Grano which had the second

lowest number of thrips in most cases implying that its susceptibility level to onion thrips infestations was quite low. The loss in bulb yield due to attack of onion crop by onion thrips was in agreement with the findings reported by other authors. For instance, Kendall and Capinera (1987) reported that the most serious effect of infestation by thrips was the resultant reduction in bulb yield. Onion yield losses ranging between 18% and 60% in Kenya were reported by Waiganjo (2004).

The potential of various onion varieties in producing high quality onion bulbs for market was studied at Mwea and Thika experimental sites. The study focused on mean bulb diameter and mean bulb weight as variables determining onion market quality. The present research indicated that Mwea agro-ecological zone had a higher potential of producing quality onions compared to Thika zone. This could be a pointer as to why the zone was selected for promotion of commercial onion production in 1950s as reported by Kimani and Mbatia (1993). Results of the present research revealed that chemical thrips control and growing of onions during the rainy season could promote production of quality onions for market. These observations were tied to the low number of thrips associated with such conditions. It was shown in the present research that delayed peaking of thrips infestation until crop maturation period did not seriously affect onion quality as was evidenced at Mwea trial site during the second season.

In thrips controlled environment, there were no significant differences in onion bulb quality produced by the tested onion varieties save Red Comet which significantly produced the lowest quality bulbs. In a situation where thrips were uncontrolled, the results of the present study indicated that Texas Grano and Red Comet had the potential of significantly producing the highest and the lowest quality bulbs respectively. There were no significant differences in bulb weight and bulb diameter observed in other onion varieties. It was established from the present research that the per cent reduction in onion grade two which was considered to be of higher market quality was positively related to the number of onion thrips attracted to the onion varieties. The effects of thrips infestations on onion market quality have been reviewed by many authors. For example, Tschirley *et al.* (2004) observed that the low yield and poor quality supply of bulb onions from Kenya was attributed to lack of appropriate onion thrips management techniques among other factors. Research by Sanderson (1995) demonstrated that thrips feeding had the potential to significantly reduce onion yields. The reduction was in form of smaller onion bulbs and occurred from feeding activity after bulbing.

In conclusion, it was established from the present study that infestations by high population density of onion thrips adversely affected the growing of onion crop. It was also clear that the number of onion thrips recovered at Mwea and Thika sites were not sufficient enough to cause any significant differences in yields between various onion varieties. It was established that more leafy onion varieties tended to harbour more thrips than the less leafy varieties. Further, it was evident that yield capacities of onion varieties were dependent on crop pest burden among other factors. Results indicated that Texas Grano produced the highest yield followed by BSS 230 Hybrid, Red Creole, Bombay Red and Red Comet in that order. Quality of onion bulbs was affected by the number of onion thrips infesting various onion varieties. Red Comet was least tolerant to injuries by onion thrips since it produced onion bulbs of the lowest quality in spite of the low thrip burden observed from the variety.

## 5.0 ACKNOWLEDGEMENTS

The authors of this paper would like to sincerely thank and appreciate the invaluable efforts of Messrs Simon Ndambiri, Josphat Muhia, and Patrick Mwangi in data collection throughout the research period. Special thanks also go to Mr. Simon Buyayi Wepukhulu of Biostatistics Section at KARI-Thika, Kenya who assisted in data analysis.

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### **S2012-36: Fluid Geochemistry of Badlands Elementaita Geothermal Prospect, Naivasha-Nakuru Basin.**

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#### **Abstract**

Geochemistry is the study of the chemical composition of the earth. The basic philosophy behind using geochemical methods for geothermal exploration is that fluids on the surface reflect the

physical, chemical and thermal conditions in the geothermal reservoir. The most important contribution of Geochemistry to Geothermal Resource Assessment is chemical geothermometry. The latter is the application of geochemistry to infer reservoir temperatures from the compositions of geothermal fluids that are found at the surface of the earth. The objectives of this research project were to: characterize the geothermal fluids that were present and their suitability for electricity production and other non-electrical uses, determine the existence of a geothermal resource, estimate the reservoir temperatures, and assess the suitability of the area for further exploration by deep drilling. Samples were collected from fumaroles at badlands, Elementaita and analyzed for gases that are associated with a major geothermal activity (carbon dioxide and hydrogen sulphide gases). The data obtained was used to infer reservoir temperatures, which were found to range from 234-353°C. Soil gas distribution for carbon dioxide and radon was suggested a high geothermal potential with enhanced permeability. Potential feasible uses of the Badlands prospect included electricity generation, horticulture, aquaculture and thermal resorts. It was recommended that further geochemical work be done to establish additional geothermal potential in that area.

**S2012-37: Geochemistry, Geothermal Exploration, Geothermal Resource Assessment:  
Multiple Production of 'Propolis' ...Apiculture...**

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**Abstract**

Apiculture, bee production is among the fast growing livestock sectors of the animal industry contributing greatly to economic stability in the developing countries. Bee production in Africa has been realized due to constant development of new apicultural technology. However, Propolis in particular, has not been given keen attention despite its key commercial uses. In Kenya for instance, a heavy drop from 6,000MT to 3,000MT of propolis has been realized over the last decade. This loss is greatly attributed to poor hive designs especially top bars for propolis deposition. Propolis is a sticky dark substance that bees collect from barks of the trees and uses to seal cracks on the hive. The bees deposit more propolis in the presence of an opening on the hive. An experiment conducted at St. Stephen's School Sisinga, Ugenya District in Siaya County during my first year 2011 field attachment clearly indicated that pitting top of the hive especially in Kenya Top Bar Hive would result into rapid deposition of propolis. The study aims at rapidly multiplying production of propolis using pitted tops of hives. Justifiably, the project is really necessary since; more propolis is demanded commercially, more propolis is needed for medicinal purpose, and constant deposition of propolis keeps the bees busy, a factor to prevent swarming. Hypothetically; worker bees collect propolis to seal the pitted top bars, translucent plate provides diffuse light –an indicator of an opening for further sealing, and the pitted top bar are constantly replaced to allow for continuous harvesting. The materials used mainly include; timber plate (1mx0.6mx0.05m), translucent plastic plate (1mx0.6mx0.05m), glue, nails, and handlers. Construction involves; framing, pitting, plating and handling. Propolis serves many uses e.g. treatment of inflammation, antifungal agent, dental filling of tooth, immune boosters, making vanish and ointments. Using pitted top bar design of bee hive constantly results into increased propolis production for weekly harvesting. The design is advantaged because; more propolis is harvested, propolis is easily separated from wax, bees are kept busy, high quality propolis is produced, raw bee propolis for commercial use and simplified harvesting of propolis is realized. On the other hand the project may

be limited due to; continuous handling of bee, propolis may mix with bee wax, excessive production of propolis may compromise on honey. When pitted tops are used; the bees collect and store more propolis, there is a rapid deposition of propolis on the pitted spaces and extra thick layer hence more propolis to harvest. It is therefore recommended that bee farmers adopt this design of top bar orientation.

Key words: *pitted top bar, bee hive, multiple propolis, apiculture production.*

### **S2012-38: Improvement of Pond Filtration ‘Charcoal Filter’ ...Aquaculture...**

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#### **Abstract**

Aquaculture, particularly modern, green and traditional fish pond farming has been highly of the rise as the core pillars to economic sustainability in developing nations. In Kenya for example, the rising growth in fish farming is due to the recent announcement by the government to construction of at least two fish ponds in every constituencies, adoption of fish eating habits and fish's nutritious and inexpensive animal protein. However, over the last quarter of the decade, there has been a decline in fish production accompanied a great loss to fish farmers. The loss is attributed to over siltation, logging, and eutrophication for lack of simple, inexpensive, but yet effective pond filter and filtration. Experienced study, the experimental idea is developed in Sagana Fish Farm; a Department in the Ministry of Fisheries and Development during an academic trip at second year in May -2012. Charcoal can effectively be used to develop simple, inexpensive and yet efficient pond filters. The basic requirements include; charcoal (10 g sized pieces), sac cloth (3mX2m), PVC polyethene (2mx1m), wire netting (2.8mx1.8m), metallic rod (3.5m) and pieces of strings (1m). The project is practicable as; charcoal is plenty available locally, the filter is simple to be managed by all farmers, and clean ponds increases fish production. Hypothetically; PVC funnel collects and directs water to charcoal core for filtration, charcoal soaks in water to filter out foreign particles and sac purely sieves out water from charcoal core. Construction of the filter involves; netting of wire, filling of charcoal, clothing of sac and funneling of PVC. When using the filter; the two ends of metallic rod are fixed to the sides of the pond, PVC funnel is fixed to inlet, the charcoal core should sink, but must not reach floor of the pond, and the rod is heavy to sink in charcoal core. Filtration of the pond using charcoal filter results into increased breeding. This filter is merited because of pure cleaning of ponds, filters of all foreign materials, used both manually and mechanically, requires little constructional skills, charcoal can easily be replaced, do not interfere with fish comfort, filter remain effective in all seasons and charcoal is not logged easily. The filter on the other hand is limited to areas with charcoal, maintenance cost to replaced charcoal and logging during floods. The study confirmed that the filter is efficient in cleaning and purification of ponds, a factor for rapid fish breeding. It is therefore recommended that fish farmers adopt charcoal filter.

Key words: *Charcoal filter, Pond filtration, Clean pure pond, Fish breeding, Aquaculture*

### **S2012-39: Modernized Battery Caging System: Rota-Circular Configuration ...Poultry...**

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## **Abstract**

Poultry farming, a sub-sector of animal industry of agriculture has been on the rise as one of the core pillars to economic sustainability in the developing nations. However, Layers production in Africa is particularly on the decline due to unsatisfactory rearing and caging systems. The loss is due to lack of simple, less expensive, but effective caging configuration of poultry structures. The study is developed during my second year, 2012 field attachment conducted at Veterinary Farm, a Department in the University of Nairobi. Rota-Circular system of Configuration and Battery caging can sufficiently be adopted to boost the entire egg production. Rota-Circular configuration is a battery caging system of rearing in poultry that involves using rotary cages laid in circular pattern and spreads in overlapping manner from top to bottom. The study aims at improving poultry production using a modernized battery caging system of configuration. The project is workable since; it can be practiced in small pieces of lands, uses locally acquired material and basic constructional skills. The main materials include; concrete stand (1x1x0.5 m), three concentric metallic frames of (1,2,3 m), central metal pole (3 m), cages (50x45x30) cm, hubs and ball bearings (20cm) diameter. Hypothetically, strong concrete stand and central metal bar provides frame work, Hubs and ball bearings on the central bar provide Rota-circular movement, and isolation of the cages prevents coccidiosis. Construction involves; fixation of the stand, fixation of hubs and ball bearings, fixation of concentric frames, caging and roofing. Other condition met by this system includes; raised floors for easy drainage of waste, isolated cages for disease control, rotary movement for bruise free birds, overlapped cages for lighting and raised roofing for proper ventilation. Using Rota-circular caging configuration in rearing layers results in an increased egg production, 50 eggs per bird per laying period is realized. This method is merited because of; high hygienic conditions, no bruises formation, coccidiosis is rare, efficient feed utilization, eggs are not broken, and ease handling of manure, high stocking densities, and easy egg collection, feeding and watering are eased. On the other hand, the system may be limited as it requires high initial cost and may not be used for broiler production. There is a constant increased egg production, hygienic condition and regulated levels of comfort resulting from Rota-circular housing configuration. It's therefore recommended that poultry farmers adopt this pattern of configuration.

*Key words; Rota-circular configuration, Battery caging system, Layers egg production, Poultry*

### SYMPOSIUM 3

#### **E2012-01: The Role of Exposure in Acquisition of Lexico-Semantic Competence By Hearing Impaired Learners**

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#### **Abstract**

This paper investigates the role of exposure in acquisition of lexico-semantic competence by normal hearing learners and hearing-impaired learners in standard six, seven and eight. The normal hearing learners were used as a comparison group. They have a longer exposure to English language than the hearing-impaired learners. The study compared the lexico-semantic errors of the hearing-impaired learners with those of the comparison group in order to determine if there was a significant difference that could be attributed to exposure. The lexico-semantic errors of the three classes were also compared to achieve the same objective. The study was guided by Selinker's Interlanguage theory and Corder's Error Analysis theory. Instruments for data elicitation were tests, which included a free composition, a picture story and a cloze passage. Data was collected at Ngala Special School for the deaf and St. Paul's primary school, where the comparison group was sampled. The population sample consisted of thirty hearing-impaired and thirty hearing pupils. The tests administered to the pupils were all written tasks from which lexico-semantic errors were extracted and categorized using the five steps of Error Analysis. Several T-tests were done to determine whether there was a significant difference between the lexico-semantic errors made by the hearing-impaired pupils and the comparison group. One-way analysis of variance was done to determine whether there was a significant difference between the lexico-semantic errors made by the three hearing-impaired pupils' classes. The findings of this study will not only add more knowledge to studies done in applied linguistics in Kenya but will also be of pedagogical value to educationists, teachers and the Ministry of Education in general.

Key words: *Exposure, Lexico-semantic errors, Competence and Acquisition.*

### **E2012-03: Participatory Approach to Community Development through Education for Sustainable Development**

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#### **Abstract**

The United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992 recognized education as an important tool for enhancing the attainment of sustainable development. Chapter 36 of Agenda 21 emphasized the role of education in supporting sound decision-making and hence the need to re-orient education and especially Higher Education towards sustainable development. Currently the world is facing increased consumption of resources which is causing climate change and other threats to the natural world and its global life-support systems. This is alongside overpopulation, overconsumption, increased global competition and interdependence, melting ice caps, financial meltdowns, and wars and other threats to security. One of education's chief roles is to prepare future workers and citizens to deal with the challenges of their times and hence the need for participatory approach to community development through Education for Sustainable development. ESD has emerged as a "new" way to know, a kind of broad, inclusive, holistic understanding. It is looked at as a logical way of knowing that is proper to the domains of information, teaching, and research and community engagement. Educational approaches now are to keep pace with the evolving challenges of sustainable development in the Kenyan communities. This paper aims at discussing participatory approach towards community development through Education for Sustainable Development. It will also look at the strategies of promoting and implementing ESD in order to realize Community development through higher institutions of learning.

### **E2012-04: Stereo-Typed Socialization and Inter-Ethnic Relations in Kenya: A Biblical Perspective**

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#### **Abstract**

Every community has a way of socialization for its members that ensures their world is redefined and events thereof interpreted in line with their social identities largely to define the in-group and the out-group differentiation. Hence, each community is socialized in ways that strengthens its social identification among its members and this is given impetus by stereo-typical socialization, indeed, indoctrination since childhood into adulthood. Thus ethnicity is largely socially created and perpetuated for the purpose of ethnic pride and identity although such in Kenya has been seen to fun negative civic engagement including conflict. In addition, oral literature including riddles,

songs, proverbs, saying and myths among others are told so as to transform the social world of the members to reflect their values, norms and beliefs. By doing this they create a shared collective memory that for the most part institutionalize the we versus them feeling within an ethnic group. With reference to examples drawn from ancient biblical communities found in the Holy Scriptures, this paper uses insights from social-psychological models and examines the link between socialization, stereotyping and inter-ethnic group relations in Kenya. It argues that ethnic relations are critically dependent on socialization that shape social identities in each ethnic group.

Keywords: *Ethnicity, conflict, Scripture, socialization, culture, stereotyping, community*

### **E2012-06: Evaluating Secondary School Examination Results: Application of Principal Component Analysis**

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#### **Abstract**

Results from Kenya National Examination Council (KNEC) indicate that there are schools that have had an upward trend in performance while others have continued to show a decline in performance. Different subjects contribute to the performance of individual schools. The research on which this paper was based sought to find out the principal component, in terms of subject, contributing to this performance. This was achieved by application of Principal Component Analysis (PCA), a data driven procedure, to assess the performance of the national examination at the Kenya Certificate of Secondary Examination (KCSE) level for the last five years. Cluster sampling method was used to obtain the required sample, from both the improved schools and from those that have dropped in performance in five randomly selected counties. Secondary data from KNEC was used and analyzed using Java Data Analysis method. The idea was then programmed using matlab software to confirm the results. A component Matrix and the corresponding component plot were obtained. The PCA brought out the correlation structure between the different subjects. As a result, two components were extracted and the first component provided evidence that all the subjects are highly correlated and the second component brought out clearly the subject groupings **vis** Languages, Applied subjects and Sciences. In all the schools considered, Languages and Mathematics were found to have the greatest effect on the performance of the schools. Performance in Languages affects all the other subjects and that of Mathematics affects mostly the Sciences. We would therefore recommend that: there be a re-evaluation of the curriculum to put more emphasis on Languages and Mathematics due to their contributions to the other subjects. Other inputs to promote these subjects such as improving the pupil-teacher ratio and motivating the teachers should be considered by the policy makers and the individual schools.

Key Words: *Correlations, performance, eigenvalues, components*

## **E2012-08: Task Based Learning as an Alternative Approach in the Teaching of Languages in Kenyan**

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### **Abstract**

Although language syllabuses in Kenyan primary and secondary schools encourage teachers to involve learners in their own learning, actual classroom practices reveal that this is not fully implemented for various reasons. Nevertheless, one of the approaches to the teaching of languages advocated for by language specialists is Task Based Learning (TBL), in which the central focus is completion of tasks that involve learners in language use in real life situations. In so doing, learners develop excellent communication and social interaction skills. The idea is for learners to learn the target language by being exposed to meaningful task-based activities. They perform tasks in pairs or in small groups after which they compile a report and present their findings to the class in written or spoken form. The research on which this paper is based investigated the use of TBL as an alternative to the teaching of Kiswahili and English in Kenyan secondary schools. Two schools (one in rural and one in urban setting) were purposively sampled. Learners in the experimental classes were taught using TBL while those in the control classes were taught using the regular approach. A pretest and a post test were administered before and after the teaching. Afterwards, the scores were tabulated and analyzed quantitatively and the emerging patterns discussed. The findings revealed that many benefits are derived from adoption of TBL in the language classrooms. Thus, we recommend that TBL be adopted in the teaching of languages in Kenyan schools and that language teachers be trained on this approach.

Key words: *Task based learning, language teaching, methodology, language activities*

## **E2012-09: Demystifying the Use of Information Communication and Technology in Teaching Language: A Case Study of Kenyatta University Language Programmes**

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### **Abstract**

Many people in Kenya use information and communication technologies in both public and private forums to communicate, gather information or for social interaction. Lecturers and students in Kenyan universities make up a significant percentage of these users. In Kenya, however, despite this prevalence in the use of ICTs for social interaction, the impact of the technological devices in the teaching of language is minimal. In-keeping with information, communication developments and in order to meet the needs of a diverse range of students, one of the modes of delivery at Kenyatta University is e-learning. In this mode, lecturers prepare modules for their courses and load them onto the University platform. Students access the materials and work on their own. The students also interact with their lecturers online. This paper presents the results of a survey that was carried out amongst the lecturers of three languages – English, Kiswahili and Chinese at Kenyatta University. Using questionnaire, data were collected among lecturers and language students of Kenyatta University and the responses analyzed qualitatively. The results indicate that it is possible to develop language friendly software that would enhance the teaching of language. With increased computer literacy skills amongst lecturers, it is possible to make the online lectures student-friendly

and more interactive. Our findings dispel the notion that some content cannot be delivered using technological devices. The use of ICTs in language teaching can be intensified. We conclude that use of ICTs in teaching language would increase access to quality education and modernize educational practices. This is the way to go in handling classes in diverse venues and in ensuring that our language students are at par with others from the developed world.

**E2012-10: Plan 'B': Deconstruction and Reconstruction of the Christianity-Islam Theologies to Enhance Global and Local Economic Integration**

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**Abstract**

Economic development may be said to be a function of human interactions and integration. The surging global economic trend stirred by the General Agreement on Trade and Services (GATS) has resulted in various corollary global human interactions that require adequate security and trust in fellow humans in order to get assurance of the vested goals and expectations of these integrations. The unfortunate reality is that certain of the religious philosophies and orientations of Christianity and Islam seem to interfere with global trust and its consequent free intercourse amongst some of their aficionados. Given the fact that the adherents of these major religions take a large segment of the global population, this article proposes that a paradigm shift in the theological viewpoint that bolster these philosophies is desired to assuage the tension that exists in our generation. The article briefly traces the history of these twin religions down to their periods of confrontation--a background that seems to breed the current rancour--and picks some of our contemporary case incidents of societal discord seemingly fanned by theological and philosophical conceptions of each camp. The article, therefore, recommends that since the propagation of the current acrimony is not far from the inspiration of the theological worldviews, a redefinition of the essence of the theologies is pertinent to the healing of the current inhibition to total global and local economic interaction and integration.

Key words: *Islam, Judaism, jihad, crusade, Christianity.*

**B2012-14: Social Dimensions of Marital Conflict in Kenya**

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**Abstract**

Data from FIDA (Kenya), Maendeleo ya Wanaume, Faith Based Organizations (FBO), Non Government Organizations (NGO) and media reports suggest that destructive marital conflict is on the increase in Kenya. This paper presents the findings of a study into marital conflict in Kenya using Anglican Diocese of Maseno North as a case study. Primary data for the study were collected through interviewing and a focus group discussion and this was analyzed using descriptive statistics. Destructive Marital conflict in the study area was perceived to be related to a wide array of factors which were grouped into five interrelated categories. These are: socio-economic factors,

socio-cultural factors, personal attribute of spouse, domestic family life factors and factors of structural inequality. Out of these groups the most important factors identified by respondents included the following: low income (money); disagreement over roles and responsibilities of spouses, irresponsible alcohol drinking, gambling and pilfering; maltreatment of children, step children and other relatives; interference from in-laws and other kin. The data indicated that psychological battering was common and employed by both spouses. About a third of females indicated they had been victims of physical abuse yet kept their abusive relationship because they were constrained by a network of social, cultural and economic barriers. Respondents' perception of gender relations in society informed their relationship to the opposite sex and this they carried over into marriage to influence the marital conflict behaviour of spouses.

**Keywords:** *Social Dimensions, Marital, Conflict*

## **Introduction**

Africa continues to be devoured by various types of conflicts (Adedeji, 1999). According to Deng, 20% of the sub-Saharan population lives in countries that are at war with themselves (Deng, 2005). The continent now accounts for more war-related deaths than the rest of the world combined as a result of poor leadership (Human Security Report, 2005). Leadership has challenged many people from virtually all walks of life and organizations including churches because of the complex nature of situations that leaders have to handle (White *et al*, 1964). This corroborates the findings which established that the amount of conflict and by implication peace in any organization is majorly determined by the influence of its leadership (Engle *et al*, 1986).

There has been a contention in the last three decades that families are in destructive conflict (UN, 1989). This has resulted in conflict management experts in family relationship meetings at the national and international levels (De graft Johnson, 1994). The nature of family conflict can be grouped into two fold (Parillo *et. al*, 1989). The first is the product of a shift from the trustee family in which absolute control resided in the patriarch, to the atomistic family in which emphasis is placed on the protection of the rights of family members; rights which are protected by the state apparatus and seen to take precedence over the maintenance of the family unit. The second source of alleged family conflict is the loss of family functions which have been taken over by other alternative institutions and therefore no longer offers psychological advantages for its members (FIDA Kenya, 2011).

A number of issues have been raised in connection with marital conflict. The first concerns the state of relations in marriage (Greenstein, 1995). In particular, marital relations have been discussed in terms of stability, satisfaction and adjustment. Ingredients for stability and satisfaction have been identified as love, sexual fidelity and spousal communication (Benokraitis, 1996); age at

marriage, religious and cultural homogamy or heterogamy as well as premarital cohabitation (Wright et. al, 1994).

The latter also stress life cycle transitions, health changes, influence of children and other family members and alcohol use as impacting on marital relations. Marriage and family life are very important in the lives of all people. In Kenya, most individuals are expected to marry and procreate. Unions of all kinds between men and women are common for the purposes of founding families of procreation. These include; religious, cohabitation and customary. Whatever the nature of the union, spouses experience conflict from time to time (Ilumoka, 2010).

This article examines the nature and scope of marital conflict and the extent to which it has been influenced by societal perceptions of gender inequality in the Anglican Diocese of Maseno North.

### **Marital Conflict**

Marital adjustment connotes the submerging of spousal interests for the common good of the marriage. Spouses can manage conflict so that they feel satisfied with one another and with their marriage (Scanzoni & Scanzoni, 1988). Marital adjustment assumes that marital couples complement one another and ignores gender inequalities (Strong et. al, 1983).

A woman being employed is source of marital conflict. This is seen either to upset the traditional expectations in marriage while decreasing a husband's marital satisfaction. Economic conflict in the form of financial difficulties, unemployment, and poverty tend to increase marital instability (Greenstein, 1995).

Domestic violence in Kenya tends to increase in the months when children are going or joining schools, colleges and universities. Another cause of marital conflict has been the role of significant others more especially in-laws and other kin. Depending on the level of interference that a husband allows, it is noted that mother in-laws have the potential to make or break marriages (Machera, 2000).

The impacts of marital conflict are physical, psychological and social but more often effects come as a combination of the three. The physical abuse as those experienced by wives only and the effects are seen in the form of bruises, teeth bites, scars and swollen faces. Psychologically women worry over divorce and disappointment, they are bitter, helpless, frustrated as well devastated (Razavi, 2010). As a result of their experiences, such women feel alienated within their marriages. While women socially feel embarrassed and would want to sever social ties with both family and friends, husbands determine to establish their superiority sometimes by marrying another woman (Atinmo, 2000).

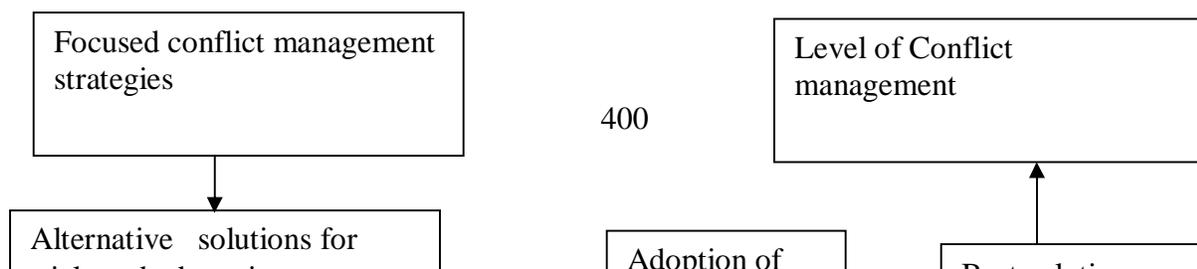
## Theoretical Framework

Conflicts are not only a major challenge but also a source of stress to the parties, groups or communities locked in the disagreement or conflict (Ross, 2007). On this basis, a theory widely used by American communities in search for solutions to a wide range of stressful community conflicts, problems or challenges will be adopted for this study. This theory was developed in America in 1966 by Lazarus and hence named as the “Lazarus stress theory.”

### Lazarus Stress Theory

Psychological stress defines an unfavorable person-environment relationship, its essence is process and change rather than structure. We alter our circumstances, or how they are interpreted, to make them appear more favorable an effort called coping (Lazarus 1966; Lazarus *et al*, 1974). Traditional approaches to coping had emphasized traits that is, stable properties of personality. But coping as *process is a* person’s ongoing efforts in thought and action to manage specific demands appraised as taxing or overwhelming (Lazarus, 1966 &1981; Folkman & Lazarus, 1988; Lazarus & Launier, 1978). Although stable coping styles do exist and are important, coping is highly *contextual*, since to be effective it must change over time and across different stressful conditions (Folkman & Lazarus, 1985). Coping affects subsequent stress reactions in that, if a person’s relationship with the environment is changed by coping actions the conditions of psychological stress may also be changed for the better. A number of replicable findings about coping can be deduced from the work of Lazarus, which was adopted in our work.

Coping is complex, and people use most of the basic strategies in coping in every stressful encounter; Coping depends on appraisal of whether anything can be done to change the situation. If appraisal says something can be done, problem-focused coping predominates; if appraisal says nothing can be done, emotion-focused coping predominates; Coping strategies change from one stage of a complex stressful encounter to another; The utility of any coping pattern varies with the type of stressful encounter, the type of personality stressed. Therefore, the operation of the Lazarus Stress Theory is such that a community faced with a particular challenge for example a conflict tries out or tests different alternative ways to solve or address it. From the many tried or tested alternatives, the community finally adapts and adopts the best alternative as the solution to the conflict, challenge or problem. This can be summarized diagrammatically as indicated below



**Figure 2:** Lazarus stress management theory (1966).

Based on Lazarus stress theory, conflict between the leadership and the congregation in the Anglican Diocese of Maseno North is the challenge whose cause was to be established. Since scholars are in agreement that there is no one particular leadership style that can be used in managing all types of conflict, Lazarus Theory (1966) was deemed appropriate because the conflicts had different causes in parishes and therefore, several different styles had to be tried to come out with the one yielding acceptable results. Therefore, this research sought to examine the nature of marital conflicts experienced among the Christians within Maseno North Diocese.

Social exchange, symbolic interaction and feminist are three theories that deal with marital relations and have an ultimate goal of examining the satisfaction of spouses as well as the stability of the marriage. Social exchange views the marital union as rewarding since its benefits outweigh any perceived costs. The most solid marriage is perceived to be one in which both spouses experience what has been termed maximum joint profit (Scanzoni and Scanzoni, 1988).

Symbolic Interaction explains marital interaction from the viewpoint of the actors involved. Spouses perceive events in marriage from two different and often contradictory realities, each spouse perceiving facts and situations according to his or her own needs, values, attitudes and beliefs (Glenn, 1987).

Feminist rethinking has concentrated on factors that generate conflicts and struggle within families (Scanzoni & Scanzoni, 1988). With differences in power and conflicting interests either between spouses or between spouses and children, gender and generational conflict arise (Glenn, 1987). Such power differences have been embedded in an ideology and system of patriarchy (Ferree, 1983) which determines through various institutions, women's role and subordinate position in society relative to men. Patriarchy is seen as a system of male domination or social stratification in which rewards and opportunities are handed out according to systematic structures and expectations which are designed to benefit men who hold power and who maintain the status quo. It is therefore a form of social exploitation. Patriarchy is also a form of social ideology of values and norms often embedded in law, religious beliefs, political and economic practices which support the perpetuation of gender discrimination against women.

## Research Design

This study utilized a case study research design. This design was appropriate for the study because it consisted of a detailed and intensive analysis of a single case, ACK Maseno North Diocese. This design was appropriate for the study because the nature of data required was supposed to be collected in only one round. A case study research design is appropriate for studies where the nature of data required does not require time series over several rounds of data collection (Kothari, 2007; Casely and Kumar, 1988). A case study research design is applicable where and when a researcher uses different categories of personnel at ago Kasomo (2007). This is applicable in this study because it covered married men and women at different levels or hierarchical positions within the Anglican Diocese of Maseno North.

## Location of the Study Area

The study was undertaken in Anglican Diocese of Maseno North which is one of the largest Anglican dioceses in Western Kenya. Administratively, it cuts across Six Counties namely; Kisumu, Siaya, Vihiga, Kakamega, Bungoma and Uasin Gishu (Constitution of Kenya, 2010). The inhabitants are agro-pastoralists and the crops they grow include; kale, maize, cassava, tea, coffee, and sugarcane (Kenya Census 2009, <http://www.cbs.go.ke>) and the livestock are cattle, goats and sheep (Sinaiko, 1995).

## Sampling

A multi-stage sampling technique was employed to obtain the sample of respondents. The study area was clustered into thirteen zones out of which eight were randomly selected. Fifteen respondents were purposefully selected from each of the eight zones to give a total sample size of 120. Respondents were purposefully picked from occupational groups common to the study area. These are farmers, housewife, professionals, self employed, clerical and administrative groups. Out of the 120 targeted, 107 or 90% were interviewed. The findings are in Table 1.

**Table 1: Respondents by Occupation and Gender.**

Occupation	Female	Male	TOTAL
Farmers	13	05	18
Housewife	09	00	09
Professional	13	15	28
Self employed	22	07	29
Clerical	03	07	10

Administrative	05	08	13
TOTAL	65	42	107

## **Data Collection Instruments**

### **Primary Data**

The research used both quantitative and qualitative research methods and because of the nature of the research topic, structured questionnaires and *in-depth interview guide* developed by the researcher was used to collect primary data.

### **Focus Group Discussion**

One focus group discussion was held. It consisted of ten (15) persons (9 females and 6 men) who were identified either as victims or aggressors. They were contacted through respondents to the questionnaire. The group shared personal experiences, and was probed for the underlying cause of conflict and battery in marriage.

### **Questionnaires**

Questionnaires as tools of research are widely used to get information about current conditions and practices to make inquiries concerning attitudes, behaviors and opinion (Lovell & Schmidt, 1988). Married men and women were administered with questionnaires with closed ended questions to obtain both personal and specific information (Philip, 2003). The structured questionnaires are suitable because, they are easier to administer because each question item is followed by alternative response for choice. They are also economical in terms of time and money and are in a form that is easily analyzable (Mugenda and Mugenda, 2002).

The questionnaire consisted of four sections. Section one solicited information on the background of the respondents. This involved their age, sex, marital status, ethnic background, religion, highest level of formal education attained and occupation. Section two elicited information on marital conflict sources as well as the incidence and prevalence of battery. It also covered aspects of respondent's culture that were either assumed to promote marital success or encourage discord and battery. In Section three, respondents were asked for their perceptions of gender relations in society and factors that engender those perceptions. Section four sought information on the role of spouses and society in minimizing marital conflict.

## **In-Depth Interview Guide**

Interview method is often superior compared to other research tools, certain confidential information can be divulged that would otherwise have escaped the researcher and a follow up can be traced on un-clear issues (Koul, 1993). The in-depth interview guide was meant to collect data from married men and women about causes of marital conflict. The five groups were sampled and each allotted with one in-depth interview guides. In-depth interview guides, are designed to discover underlying motives, feelings and desires of the subjects. The guide is useful because it explores the needs, desire and feelings of the respondents (Kothari, 2004). In addition, it is used to supplement the questionnaires used in the study (Fraenkel & Wallen, 2010). Ten people were purposefully selected for the in-depth interviews. These were two male and four female Anglican priests, two professional marriage counselor and two elders. These respondents were tasked to explain some of the responses collected from the field.

## **Secondary Data**

The research was formed through the analysis of secondary data such as books, journals, news papers, Conference proceedings, Government/corporate reports, theses, dissertations, Internet and magazines were critically analyzed. Secondary analysis is analysis of data by researchers who will probably not have been involved in the collection of data (Bryman, 2004).

It is concerned with analyzing already collected data within another study (Sarantakos, 2005). Secondary analysis allows for the examination of existing data yet can produce new and more detailed information, including the emergence of conclusions that differ to those in the original report (*Ibid*, 297). The advantages of secondary analysis is that it is of high quality data, an additional strength of secondary analysis is quick and easy to access materials such as documentary research is largely free of the restrictions (Bryman, 2001). Difficulties faced in primary data research, the researchers do not encounter rejection, non-response, bias, or any other respondent-based problems (Sarantakos, 2005). The data collected was in relation to objective of the research.

## **Demographic Characteristics of Respondents**

The respondents comprised 65 females and 42 males with a mean age of 41 years and the modal age falling within the 40-49 age group. Ninety five respondents (88.8%) were married, 7 (6.5%) were single and 5 (4.7%) separated. Respondents from the study area were mainly Luyha ethnic tribe represented 79% of the sample. The sample was predominantly Christian (97%). In terms of education, 38% had form four certificate; 45% had obtained the middle college certificate and 17% attained university education.

## Results

Data were analyzed based on gender and respondents' perspectives of sources of conflict in marriage, attitude towards spouse battering, constraints to leaving abusive relationships and perceptions of gender relations. Respondents were asked whether they approved the use of physical violence by either spouse in an effort to resolve conflict in marriages. Their responses showed no significant differences which implied that the spouses respondents disapproved the use of force. Again they were asked to check from a list of conflict sources. The responses showed there existed significant differences in the sources of marital conflict reported by male and female respondents. This means that male and female respondents prioritized conflict sources differently such that what is regarded as a conflict source for one is not regarded as such for the other.

Respondents were also asked whether they knew some abused wives who still kept their marriages and reasons for their continued stay in the abusive relationships. They enumerated a number of constraints such abused women face which made it impossible for them to leave. A test of significance revealed that there was no significant difference existing in the responses given implying that the spouses perceived the same set of constraints to prevent women in abusive marriages from leaving. Finally, there was no significant difference in how spouses' respondents perceived gender relations in the society.

### Causes of Marital Conflict

A total of 89% of respondents were aware of marriages which had conflicts. About 81% of these respondents claimed they knew spouses who still stayed within abusive marriages. Five main categories of marital conflict sources were identified. These were conflict based on personal attributes of spouses, domestic family life, socio-cultural practices, socio-economic and structural factors. The last category of factors was believed by respondents to influence how people relate to the opposite sex and this attitude is carried over into marriage. Tables 2,3,4,5, and 6 present the respondents reported causes of marital conflict. Male respondents mostly cited personal attributes of spouses as the main source of conflict in marriage, and female respondents cited issues in domestic family life and socio-cultural factors. The causes of conflict in marriage according to the respondents in descending order are:

**Table 2: Spouses Characteristic as Conflict Source by Gender**

Individual Characteristics	Female	% of female	Male	% of male respondent	Total

		respondent n = 65		n = 42	
<a href="#">Adultery</a>	21	32	27	64	48
Annoying Characteristics of Spouses- lack of personal hygiene, stealing, gambling drunkenness	45	69	31	74	76
Wrong acquaintances	19	29	14	33	33
Living beyond means of spouse	09	14	15	36	24

Annoying Characteristics of Spouses scored 76(89%) by all respondents and was the highest source of conflict in the family. Seventy four 31(74%) of male and 45(69%) of female respondents confirmed this. In this category, respondents cited behaviour such as lack of personal hygiene, stealing, gambling and drunkenness. Respondents' concurred that women by their socialization were not to engage in most of the habits numerated above. Respondents observed that some of these behaviours dissipated scarce family resources.

**Table 3: Socio-cultural Source of Conflict by Gender**

Socio-cultural Conflict Source	Female	% of female respondent n = 65	Male	% of male respondent n = 42	Total
Conflict by in-laws and other relatives	53	82	21	50	74
Co-wife rivalry	27	42	09	21	36
Cultural heterogamy of spouses	26	40	07	17	33
High education of female spouse	07	11	03	07	10
Religious fundamentalism	00	14	04	10	13

Conflict caused by in-laws, other relatives and the extended family was blamed by 74 (69%) respondents for causing discord between spouses. 53 (82 %) female respondents than 21 (50 %) male respondents affirmed this. According to respondents, in-laws from the man's side tend to interfere with decision making and dictate how households should be run, the number of children spouses should have and what property should or should not be acquired. When a man of means does not share his wealth with family members, they may interfere in his marriage and blame their daughter-in-law for their son or brother irresponsibility. This is so because within the Luyha community, better off members are expected to share the benefits of their education by taking care of economically disadvantaged relatives; it is argued that the successes of any family member have been made possible through the investment of other family members.

**Table 4: Domestic Family Life as Conflict Source by Gender**

Indicators of unstable family	Female	% of female respondent n = 65	Male	% of male respondent n = 42	Total
Spouses roles in marriage	23	35	14	33	35
Inadequate house budget	40	62	24	57	64
Treatment of nuclear and extended family members	49	75	20	48	69
Sex and reproduction	26	40	19	45	45
Decision making on marital issues	17	26	12	29	29

Uncivilized treatment of nuclear and extended family members was cited by 69(64%) of respondents. More females 49(75%) than male respondents 20(48%) identified this as a problem within marriage. Respondents observed that spouses may object to their children being disciplined by their partners. In the case of step children, the source of conflict was identified to center on the kind of disciplinary action a step parent takes against them. It was evident that stepchildren embark on petty rivalries with their stepparents on behalf of their own biological parents. Wives complained bitterly about husbands' comparative goodwill shown towards their relations and children.

Inadequate house budget was cited by 64 respondents. Sixty two per cent 40(62%) of female versus 24(57%) of male respondents identified this as a source of conflict. Wives desire to live beyond their means and attributed their demand on the high cost of living while husbands blamed their inability to give more on the low income and commitments such as remittances to extended family members.

Conflict over discharging Spouses roles in marriage cited by 35(33%) of respondents. This comprised 23(35%) of female and 14(33%) of male subjects. Comparatively, there was not much difference in the proportions of males and females who identified this variable as a source of conflict in marriage. Traditional norm of men as providers and women as home care takers are deeply rooted in the social consciousness. Hence respondents observed that traditionally husbands are expected to provide adequate house budget for basic needs. Respondents observed that while there is expectation by husbands for support from income earning wives, on the other hand, wives also expect husbands to be involved in household activities. These expectations are seen by respondents to challenge traditional beliefs about responsibility for family and housework and certainly contribute to marital conflict.

[Adultery](#) on the part of either spouse was identified by 48(45%) respondents to cause marital conflict. According to respondents, [adultery](#) results into mistrust which leads to most marriages being incompatible. Respondents were in agreement that [adultery](#) was one of the ways in which family limited resources are wasted. Husbands got by their wives in extramarital affairs, verbally and physically assaulted their wives. But when it was the wives were found to have extramarital sexual relations, they would be physically assaulted and at times be chased from the matrimonial home. Comparatively, more male respondents 27(64%) than female respondents 21(32%) viewed [adultery](#) as a source of conflict within marriage. It is plausible that most female have accepted the cultural dictates of polygyny and thus do not out rightly condemn it.

## Forms of Marital Violence

37% female respondents reported themselves as victims of marital violence. No male respondent owned up as a victim although respondents generally agreed that male victims also existed (FIDA Kenya, 2011). There was consensus that acts such as slapping, kicking and hitting of a spouse constituted violence. There was however doubts as to whether forced marital sex which some claimed to be husband’s right in marriage, constituted sexual violence. 93% of respondents indicated that they had revenged against acts of their partners to ‘discipline’ them, but failed to see these disciplinary acts as forms of psychological punishment in marriage. These include such acts as locking them out, communication breakdown, secretly monitoring the movement of the other spouse, withdrawing essential services like cooking, laundry and sexual relations.

Acts of violence in conflict situations revealed that they are sometimes triggered by wives in order to claim compensation during customary arbitration and they were also triggered to demonstrate to society a wife is loved by her husband. Whatever the source of conflict, 87 per cent of respondents disapproved the use of destructive conflict and abuse in marriage. Of the 9 per cent who approve of the use of violence in relationships, high sentiments were displayed on the issue with respondents citing factors such as laziness, late serving of meals and dissatisfaction with sex as some of the grounds for beating ones wife.

**Table 5: Socioeconomic Factors as a Conflict Source by Gender**

Socioeconomic conflict source	Female	% of female respondent n = 65	Male	% of male respondent n = 42	Total
Unemployment of male spouse	17	26	09	21	26
Unemployment of female spouse	07	11	03	07	10
High income status of female spouse	06	09	02	05	08

Socio-economic implication of marital violence is the fact that socio -cultural definitions tend to distort the levels of marital violence in this study. It is very probable that a number of

respondents did not concede to being victims or aggressors since for such people certain acts of violence are to be expected in marriage and therefore normal.

One of the findings is that victims of abuse within marriages appeared trapped and therefore could not escape for various reasons. Such reasons include; children in marriage. The primary concern of disenchanted wives is that as soon as they leave the relationship, one of two things could happen. Either child maintenance would be stopped if they leave with their children, or a new wife would treat them badly if they are left behind. Second, there is the fear of a remarriage; or if the present marriage is not the first attempt, there is the desire to see it work at whatever cost. Other reasons cited have been a lack of desire to break marriage vows, economic dependency on husbands, acquisition of joint property and extended family intervention.

**Table 6: Sources of Marital Conflict by Respondents**

<b>SOURCES OF CONFLICT</b>	<b>FEMALE</b>	<b>MALE</b>
Personal Attributes of Spouse	98	83
Domestic Family Life	103	75
Socio-cultural Practices	87	24
Socio-economic Factors	31	16

### **Gender-relations and Marriage**

The analysis of respondents’ perception of gender relations in society revealed interplay of two issues. The first relates to respondents’ perception of the daily occurrences in their lives and the second deals with their perceptions of what ought to be practiced as culturally defined. Arguments on perceptions of gender equality centered mainly on Christian religious teachings as well as daily observances.

These two factors, together with aspects of Kenyan culture, the nature of the educational system and religious teachings were also given as accounting for unequal gender relations in society.

Respondents reported their experiences of having been socialized as children to accept the headship and control of the man of the household. They were either given preferential treatment as males or discriminated against as female in the areas of housework and education. Female respondents indicated that as children they were socialized in family matters, how to be of service to the family and not to count the cost. The male dominated nature of the Luyha culture was also cited. References were made to the fact that folktales, folksongs, traditional or highlife music, proverbs values and practices either tend to belittle, devalue or marginalize females while holding

males in high esteem. Finally, the nature of the educational system before the current reforms was blamed for doing a lot of disservice to females as education tended to entrench gender discrimination through reading material and choice of subjects.

Together, these were seen to have helped to instill feelings of superiority and inferiority in males and females respectively, feelings which have been carried over into marriage. Husbands for instance are seen to invoke tradition or religion to justify their expectation of and demands for subservient or obedient behaviour from wives, while wives insist that times have changed to the extent that the modern wife should not be expected to play second fiddle to their partners.

### **Discussion of study findings**

Marital conflict is an issue confronting spouses in the Anglican Diocese of Maseno North. There is a clear indication that spouses failed to subsume their rights and interests for the common good of the marital relationship. Spouses employed both physical and psychological forms of violence to resolve problems. Whilst husbands used physical violence as a show of their masculinity and power, wives mainly engaged in psychological abuse.

Traditional stereotypes of men as providers and women as primary care givers are deeply rooted in the social consciousness. Hence expectations of husbands to be the sole sponsors of household expenditure have been used by wives as a yardstick to measure the performance of husbands. This supports Glenn's (1987) position that marital discord grows out of differences in socialization of spouses. Besides, the fact that wives expect husbands to help with childcare and domestic chores because they now find themselves in paid employment raises questions about responsibility for family and housework. These are expectations that challenge traditional role expectations and greatly have contributed to conflict in marriages (Scanzoni, 1987).

Gender relationships; instill feelings of superiority and inferiority in marriage to create discord and conflict. Thus husbands can take unilateral decisions on behalf of their families and physically 'punish' their wives if the latter complain. Gender ideologies and relations may well be seen as the foundation upon which social relations and by extension marital relations are constructed (FIDA Kenya, 2011).

### **Conclusion**

Traditional values and cultural practices have a great impact on marital discord within the study area. Perceptions of gender inequality in social life generally have been carried over into marriage such that husbands assume more power over wives in almost every aspect of marriage. Almost all spouses irrespective of gender go through some form of psychological abuse but it is

only wives who are physically abused in conflict situations. Finally, spouses find it difficult to quit their conflict riddled marriages because there are concrete reasons that prevent them from leaving.

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## **E2012-12: An Examination of Factors Determining Access to Free Primary Education in Mitaboni Zone, Kathiani Division, Machakos District, Kenya**

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### **Abstract**

With the re-introduction of the Free Primary Education (FPE) by the Kenyan Government in January 2003, it was expected that all children of Primary school going age would be enrolled in school. But, after the re-introduction of FPE there are still an estimated 2 million children and youth who remain out of school. This raises concern. The purpose of the study was to examine the factors determining access to FPE in Mitaboni zone, Kathiani division, Machakos district, Kenya. The objectives of the study were to: find out the factors determining access to FPE; investigate on the effect of factors on FPE and to establish the cause of action to be taken. The study adopted a descriptive survey design. The Production Function Theory was used in the study. The units of analysis were the Primary schools. Data was analyzed using descriptive techniques and zero order correlation analysis. The findings of the study showed that the factors determining access in FPE in Mitaboni zone were: school financial obligations, poverty and malnutrition, cultural factors overcrowded classes, pregnancies, early marriages and child labour demands. It was discovered that the multiple correlation, between the independent variables and the FPE was 0.999 and the coefficient of multiple determination,  $R^2$ , was 0.997. Conclusions drawn from the study showed that FPE in Mitaboni zone is yet to be realized. It was recommended that the Government should provide relevant curriculum, physical facilities and bear all the costs of Primary education, double streaming of schools and punishing of Parents who do not take their children to school. There is a corresponding need for more research in this area in other zones and similar comparative study between urban and rural zones.

**Key Words:**-Access, Completion, Dropout, Enrolment, Free Primary Education, and Retention.

## **INTRODUCTION**

### **1.0 Background of the Study**

The Government of Kenya re-introduced Free Primary Education (FPE) in January 2003 with the commitment of realizing UPE by 2005, ahead of the stipulated time frame for achieving the EFA goals and MDGs (Republic of Kenya, 2005). Under the policy of FPE, all fees and other levies for Primary education, that have for decades kept a large number of children and youth out of school, were abolished. Although primary school enrolment has grown through the years; 891,533 by 1963; 4,728,201 by 1983; 7.2 million by 2003, and the number of Public Primary Schools increased from 6,058 in 1963 to 17,600 in 2003, there has also been an increasing number of school-going age children who have been out of school in the last decade. However, this situation has changed with the re-introduction of FPE. Despite the upsurge in Primary level enrolment, an estimated 2 million children and youth still remain out of the school system (ibid.). This raises concern because it is assumed that FPE will be virtually UPE, having a net enrolment ratio (NER) of 95% and above,

where NER excludes children who are younger or older than a country's official school-age group (6-13 years for primary school in Kenya), since lack of fees is the principal reason for the shortfall in school enrolments (Republic of Kenya, 1964). In 2004, the Minister for Education explained that the government had made major strides in the provision of FPE and it expected more children to join Primary schools. He further noted that unfortunately, the FPE had not taken root in some areas and he singled out parents from ASALS as notorious in failing to send their children to attend school. This negates the aim of the FPE programme; to provide more school opportunities, especially to the poor communities. The argument was that the payment of school fees tended to prevent a large portion of school children from attending school.

It was estimated that more than 35% of the school-age population were not getting any Primary education. In 1974, enrolment in standard 1 to 4 rose by 1 million- from 1.8 million in 1973 to nearly 2.8 million in 1974. Despite this rise, it was estimated that another 1 to 2 million children of primary school going age were still not attending school in 1974, especially in ASAL districts where enrolments still remained low (Psacharopoulos & Woodhall, 1985; Sifuna, 1990). In Africa, enrolment at the primary school level stood at 72% by 2002 (UNESCO, 2002). This implies that despite the efforts being made for realization of UPE by various nations, there still exist various hindrances to access at this level of education.

A study by Levin and Lockheed (1989) noted that schools in developing countries faced problems of relatively low school participation, in terms of enrolment of eligible age groups; low levels of school completion; low levels of achievement. Kenya is also faced with several problems in education primarily related to decline in enrolment, completion rates, financial levies which are of critical concern (Republic of Kenya, 1998). The UNESCO (2002) noted that, while significant progress has been made in providing EFA, gender disparities continue to persist in enrolment, literacy, access and quality of education.

A study by Kerre and Obura (1992) concurred with this view by indicating that, despite laudable efforts by the government in striving to provide EFA in Kenya, there are still pockets of non-schooled children- who become non-schooled and illiterate adults. Children who are in this category who are out of school are mostly from the disadvantaged groups; street children; child labourers; abandoned, neglected and battered children, juvenile drug users and traffickers; children infected and affected by HIV/AIDS; adolescent mothers; children living in remote and hard to reach areas; children subjected to harmful cultural practices; children of refugees and children in commercial sex exploitation (Republic of Kenya, 2003). This places a heavy constraint on

development efforts when sizeable proportions of the population are not able to benefit from modern progress and when development itself is held back through the inevitably less than full participation of illiterate citizens in the nation.

### **1.1 Statement of the Problem**

The fact that there are children, of primary school going age, who are not enrolled in school even after the re-introduction of FPE in Kenya, draws a lot of concern. This is because of the importance attached to Primary education; it is the one that is generally relied upon to prepare the youth for literacy and acts as a basis for future training to enable the recipients participate in nation building. It is with this background that a need arose to examine the factors determining access to FPE in Mitaboni zone of Kathiani division, Machakos district, Kenya. The study therefore intends to find out whether FPE has led to UPE, and, if not, establish the factors that could be hindering the universalisation of primary education.

### **1.2 Purpose of the Study**

The Study was guided by the following specific objectives:

- (i) Determine the factors influencing access in primary education
- (ii) Establish the effect of factors determining access in Primary education on FPE
- (iii) Find out the action being taken to attain full participation of pupils of School going age in FPE

### **1.3 Research Questions**

The following research questions guided the study:

- (i) What are the factors determining access to FPE in Mitaboni zone?
- (ii) What is the effect of factors determining access in primary education on FPE?
- (iii) What action is being taken to attain full participation of pupils of school going age?

### **1.4 Significance of the study**

The study was significant in the following respects:

- (i) Primary education policy makers and planners may identify the constraints facing access to FPE, factors hindering provision of primary education and those leading to non-enrolment in and dropping out of Primary education for corrective action

- (ii) Primary education planners may maximize enrolment at this level through the suggestions that will be gathered on the steps that could be taken to ensure full enrolment
- (iii) May stimulate similar studies in other parts of the country and on other aspects of primary education such as relevance, equity and quality.

**1.5 Scope and Limitations of the Study**

**1.5.1 Scope of the Study**

The study covered only primary Schools in Mitaboni zone, Kathiani division, Machakos district, Kenya.

**1.5.2 Limitations of the Study**

The study was limited in the following ways:

- (i) It covered only a single zone, hence its findings may be generalized only to the zone
- (ii) The study only looked at the access of FPE while leaving out other aspects such as quality, relevance and equity;
- (iii) The study was limited to only seven independent variables of the study

**1.6 Theoretical Framework of the study**

The Theoretical Framework of the study was the Production Function Theory. It looks at how one can combine a given set of inputs to produce outputs. In the case of this study, the factors determining access to FPE are inputs while FPE is output. Psacharopoulos (1985) points out that the relationship between inputs and outputs of education is highly complex since many factors determine educational outcomes. He derives a simple production function for education as:

$$A=f(T, B, E-)\dots\dots\dots (i)$$

Where A is Achievement, T is teacher-pupils ratio, B is Books and other materials, E is Equipment. Experience shows, however, that the production function is far more complex than this and includes many more variables.

In determining the optimal level of utilization of educational resources in Primary education, it is vital to first establish the long run cost curve. Suppose the total input in any school unit i.e. the number of pupils in school in a given year is given by;

$$Q=f(m_1, m_2)\dots\dots\dots(ii)$$

Where,

Q<sub>1</sub>=total output

$M_1$ =total number of pupils in school in a specific year

$M_2$ =the accessibility factors, which are the quality index of the Primary schools

The study, however, examined the factors determining access to FPE and rewriting equation (ii) in regression model, the following equation is formed:

$$F = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + \dots + b_nX_n \dots \dots \dots (iii)$$

Where;

F, is the dependent variable, FPE

a is the constant, y- intercept

$b_1$  to  $b_n$  are the partial regression co-efficients.

$X_1$  to  $x_n$  are the independent factors, factors determining access in FPE namely:

$X_1$ -School financial obligation

$X_2$ - Poverty and malnutrition

$X_3$ -Cultural factors affecting girls more than boys

$X_4$ -Overcrowded classes

$X_5$ - Pregnancies

$X_6$ -Early marriages

$X_7$ . Child labour demands

$X_n$ -Undefined factors which determine FPE.

### 1.6 Assumptions of the Study

The study was carried out on the basis of the following assumptions:

- (i) The official age of primary school going children is between 6 and 13 years
- (ii) All children of school going age are enrolled in school
- (iii) The government has put everything in place to ensure that all children of primary school going age are enrolled in school
- (iv) Male and female children have equal access to Primary education

### 1.7 Definition of Key Terms

**Access** refers to the ability of primary school going age pupils fully participating in the learning process

**Completion** refers to the successful passage through a level of education in which one is enrolled

**Dropout** refers to leaving school before the completion of a given stage of education.

**Enrolment** refers to the number of pupils registered in school for the purpose of learning

**Free Primary Education** refers to the first level of formal education ranging from classes one to eight believed to be fully financially sponsored by the Government

**Retention** refers to the ability of a given level of education to have all students enrolled at the beginning of the education cycle to stay in school until completion of the cycle.

## 2.0 Research Design

The study adopted a descriptive survey design. The design was chosen because it enabled a research to gather evidence relating to the current status of access FPE.

### 2.1 Area of Study

The study covered Mitaboni zone of Kathiani Division, Machakos District, Kenya. It is located to the East of Machakos town 27 kilometers from Machakos and is located north east of Nairobi, 65 kilometers away. The zone has a total area of 15.8 km<sup>2</sup> and is surrounded by Kathiani, Kaewa and Iveti zones. It has a total population of 9129 people per km<sup>2</sup> with 4331 males and 4798 females (Kathiani Division office,). The zone has got 30 secondary schools with a total population of 2150 students, 2 youth polytechnics. There are 1560 boys and 2285 girls and 18 Primary schools in the zone. The total number of K.C.P.E candidates in the year 2011 was 654 in these Primary schools and a total of 168 teachers. The topography of the zone is mostly dissected by ridges, hills and a rolling topography and lies between 800-1100m above sea level.

### 2.2 Study Population

According to Kathiani Division office, the zone had a total of 18 primary schools with a total of 654 pupils in class eight and 192 class teachers. Therefore, the study population constituted 18 head teachers 654 pupils in class eight and 4 sub-chiefs in the zone.

**Table 1:**

**List Of Primary Schools In Mitaboni Zone And Enrolment Of Class Eight Pupils.**

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Schs.	Zonal enrolment	Class eight Enrl.	Sample
1. Mitaboni	213	42	14
2. King'ong'oi	167	33	11

3. Kwamunda	181	46	6
4. Ngiini	305	39	13
5. Muonyweni	177	48	16
6. Mwang'a	190	24	8
7. Kalambya	166	36	12
8. Kalikya	201	30	10
9. Kitulu	199	38	13
10. Komarock	237	28	10
11. Manzoni	149	44	14
12. Muumbuni	287	20	7
13. Kasovya	194	25	9
14. Thinu	171	50	17
15. Kavete	286	32	11
16. Mathunya	241	39	13
17. Kwale	254	33	11
18. Kisekini	227	47	16
<b>Grand total</b>	<b>3845</b>	<b>654</b>	<b>211</b>

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**Source: Mitaboni Education Zone 2011.**

### **2.3 Sample and sampling techniques**

Saturated, stratified random and purposeful samplings were used to pick out a sample of the study. Since there were 18 primary schools, 18 head teachers were by extension chosen into the sample of study hence saturated sampling was used. Stratified random sampling was used to select 211 pupils of class eight and purposeful sampling was used to select 2 sub-chiefs into the sample.

### **2.4 Methods of data collection**

Different questionnaires were used to elicit information from the respondents of the Study: Questionnaire for Head Teachers (QHS), Questionnaire for Sub-chiefs (QSC) and Questionnaire For Pupils (QP). The items which appeared in the questionnaires were: Government policy, Gender factors, Geographical factors, socio-cultural factors and costs of education which sought to examine the factors determining access on FPE on in Mitaboni zone, Kathiani division, Machakos

district, Kenya. The questionnaires also sought for the way forward in case of inaccessibility on FPE .

### **2.5 Development of research instruments**

The questionnaires for the study were prepared and evaluated on their suitability in collecting data. Piloting was also done in 3 schools outside the zone to identify any shortcomings or ambiguous items in the questionnaires. They were then revised and were ready for use.

### **2.6 Validity and Reliability of the instruments**

Having developed the Questionnaires and having done the pilot study ensured that the validity and reliability of the research instruments were addressed.

### **3.0 Methods of data analysis**

The data collected using the filled in questionnaires was thoroughly inspected and coded manually to allow the use of descriptive statistics. The data obtained by the use of the head teachers questionnaire was employed for most of the analysis while that of the sub-chiefs and pupils was used to confirm the data given by head teachers. The data was initially organized into percentages and averages obtained for interpretation purposes.

The methods of data analysis employed in the study were:

- a) Pearson's product moment method
- b) Stepwise linear multiple regression method

The above methods were found worth using because the study involved cause-effect relationships between the dependent and independent variables of the study. Since the study involved many variables and sought to analyze the data quantitatively, the Statistical Packages For Social Sciences (SPSS 12.0 version) was used to calculate the sample statistics.

## **4.0 Results and discussion**

### **4.1.1 Data from head teachers' responses on the questionnaire.**

Questionnaires were administered to all head teachers of the sampled schools and collected by the researcher on the same day of the visit or on dates agreed upon between the head teacher and the researcher. All 18 questionnaires were collected and analyzed. It was revealed that 55.56% of the head teachers had been head teachers of the schools under study between 1-5 years; 27.77% between 6-10 years while 16.60% over a period of 10 years as shown in the table below.

**Table 2: Period Head Teacher Had Served Schools****N=18**

<b>School under study</b>			<b>other schools</b>	
Period	No. of responses	%	No. of responses	%
1-5 years	10	55.56	3	16.66
6-10 years	5	27.77	8	44.44
Over 10 years	3	16.66	7	38.88

**Source: Responses From Sample.**

The researcher sought this information to establish whether head teachers had experience to make them competent enough to handle the questions. Since many teachers had served in the current stations at least 5 years. It was probably evident enough of acquiring the necessary experience to interpret the school data base needed by the researcher.

Asked about commenting on the general enrollment in the school, the head teachers revealed the following:

**Table 3: Head Teachers Comments on the General Enrolment in School****N=18**

<b>Comment</b>	<b>Number of respondents</b>	<b>% of respondents</b>
Enrolment is increasing in Every class	4	22.22
Enrolment is decreasing in every Class	0	0
Enrolment is increasing in some Classes	14	77.77
Enrolment is decreasing in some Classes	0	0
Enrolment is static	0	0

**Source: Responses From Sample**

It was clear that the enrolment was increasing in some classes as evidenced by 77.77%. An indication that despite the FPE, many students were still at home and therefore in some schools the enrolment had an upward trend. About the questions of gender parity in enrolment, many head teachers reported that the girls enrolment was more than the boys enrolment (68%) while 32% indicated that the boys were more than girls. The issue of gender parity has to be addressed to meet the MDG. The head teachers were asked to give the costs incurred by parents/guardians in meeting the incurred by parents /guardians in meeting the costs of educating their children. Their responses are recorded in table four below:

**Table 4: Primary Education Financial Costs Incurred By Parents/Guardians In Meeting The Costs Of Educating Their Children In 2009**

N-18

<b>Financial costs</b>	<b>No. of response</b>	<b>% of responses</b>
Development fund	18	100.00
Stationery	18	100.00
Purchase of tables	9	50.00
Purchase of school uniforms	18	100.00
Enrolments for non-TSC teachers	13	72.22
Internal examinations costs	18	100.00
Costs for extra curricular activities	18	100.00

**Source : Responses From Sample**

It was evident that Primary education was still characterized by a variety of costs, Development Fund, stationery, school uniforms, internal examinations, costs for extra-curricular activities as shown by 100% response from head teachers, emoluments of non-TSC teachers and purchase of textbooks as evidenced by 72% and 50% responses. When asked to provide reasons why students drop out of school despite the FPE, the head teachers gave the following responses.

**Table 5: Reasons for Dropping Out Of School despite FPE**

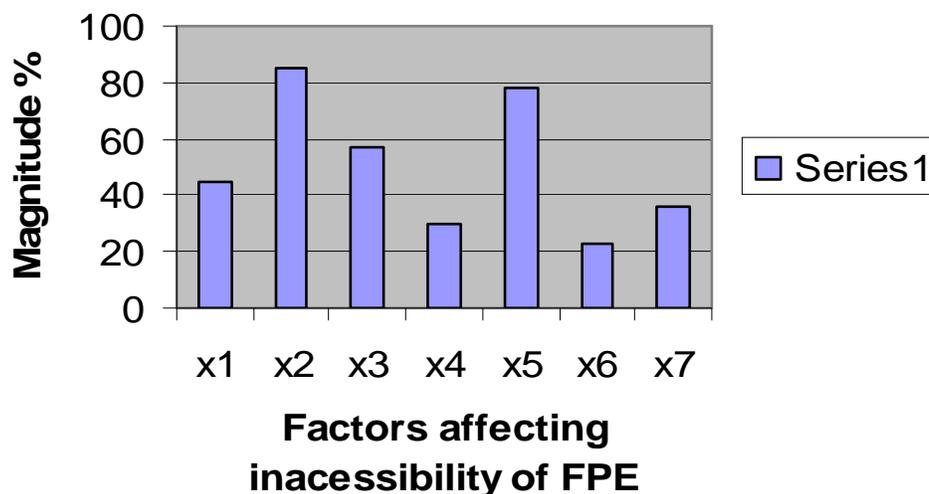
N-18

Reasons for	No. of respondents	% of respondents
<b>Drop-out of schools</b>		
Unable to meet school financial Obligations	9	50.00
Poverty and malnutrition	16	88.88
Cultural factors which affect girls Than boys	10	55.55
Overcrowded classes	5	27.77
Pregnancies	13	72.22
Early marriages	4	22.22
Child labour demands	6	33.33

**Source: Responses from Sample**

The head teachers indicated that 50% of the students dropped out because of being unable to meet school financial obligations, 88.88% due to poverty and malnutrition, 55.55% due to cultural factors which affect girls more than boys, 27.77% due to overcrowded classes, 72.22% due to pregnancy, 22.22% drop-out as a result of early marriages and 33.33% due to child labour demands. The above factors were displayed in a form of histogram as shown below:

**Histogram Showing Magnitude of % On Access In FPE In Mitaboni Zone**



**Fig.1 Histogram showing magnitude of factors affecting inaccessibility of FPE in Mitaboni zone.**

**Source: Constructed From Head Teacher Responses.**

**Legend:**

- X<sub>1</sub>-School Financial Obligations
- X<sub>2</sub>-Poverty and Malnutrition
- X<sub>3</sub>-Cultural Factors Affecting Girls More Than Boys
- X<sub>4</sub>-Overcrowded Classes
- X<sub>5</sub>-Pregnancies
- X<sub>6</sub>-Early Marriages
- X<sub>7</sub>-Child Labour Demands

It can be realized at this level that primary education was never “Free” in Mitaboni zone due to these varying factors. To find out the contribution of each of these factors (reasons) to inaccessibility of FPE in Mitaboni zone, correlation analysis was done on these variables as shown below:

**Table 6: Stepwise linear multiple regression analysis of factors determining accessibility of FPE in Mitaboni zone.**

**N-18**

Multiple	0.999		
R.square (R <sub>2</sub> )	0.997		
Standard error			
Of the estimates	0.0055		
Analysis of variance			
	DF	Sum of squares	mean squares
Regression	7	1.1680	0.1950
Residual	14	0.0035	3.031E-05
F	6425.513		
Sig F	0.000		
Variables in equation			
Coefficients			

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	B	Std error	BETA	T	Sig T
Constant	1.568E-03	0.001		1.673	0.097
SCH .Financial obligation(X <sub>1</sub> )	0.992	0.012	0.471	83.115	0.000
Poverty and Malnutrition (X <sub>2</sub> )	1.017	0.076	0.076	13.371	0.000
Cultural Factors(X <sub>3</sub> )	0.987	0.015	0.342	63.895	0.000
Overcrowded class(X <sub>4</sub> )	0.990	0.032	0.0197	31.148	0.000
Pregnancies(x <sub>5</sub> )	1.007	0.029	0.190	34.655	0.000
Early Marriages (X <sub>6</sub> )	0.980	0.019	0.318	51.698	0.000
Child labour demands (x <sub>7</sub> )	0.771	0.042	0.036	47.08	0.000

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**Source: worked out from head teachers data**

The table shows that the multiple R was 0.999, implying that the correlation between FPE and the seven factors determining FPE was very high. The co-efficient of multiple determination, the multiple R<sup>2</sup> was 0.997.

Therefore, the independent variables in the study accounted for 99.7% of the variability in FPE amongst pupils in Mitaboni zone. The unexplained variations, 0.3% could be due to other causal factors not included in the analysis and /or errors incurred in data collection. The Beta column indicated the values of the unstandardized regression co-efficients. The Beta value of school financial obligations (x<sub>1</sub>) was 0.992. This meant that a difference of one standard deviation in school financial obligations was predicted to cause a difference of 0.992 standard deviation on FPE. Since the regression co-efficient was positive, it was concluded that primary schools with high demands for school financial obligations led to more inaccessibility in FPE. It could be concluded that 1% decrease in school financial obligations would increase accessibility in FPE in the zone by 0.992%. The same is true for the independent valuables x<sub>2</sub>, x<sub>3</sub>, x<sub>4</sub>,x<sub>5</sub>,x<sub>6</sub>. From the stepwise linear regression analysis results, the study equation would be written mathematically as:
$$F=0.002+0.992x_1+0.017x_2+0.987x_3+0.990x_4+1.007x_5+0.980x_6+0.771x_7\dots\dots\dots(i)$$

Asked about the action they recommended to arrest the cases of pupils' non-attendance of schools, the head teachers gave the following responses:

**Table 7: Action Recommended Arresting The Cases Of Pupils Non-Attendance Of School**

**N=18**

<b>Action</b>	<b>No. of respondents</b>	<b>% of respondents</b>
Provide relevant curriculum	15	83.33
Government to provide physical facilities	18	100.00
Government to bear the costs of primary education	18	100.00
Parents/guardian who do not take their children to school	12	66.66
Deal with sex pests more harshly	5	27.77
Address issue of girl female role model	9	50.00
Double streaming of schools and consolidation of schools	8	44.44

**Source: Responses from Sample**

It is evident that to do away with non-attendance of pupils in Mitaboni zone, the Government should provide physical facilities & bear costs of Primary education as shown by 100% response for head teachers, provide curriculum which is relevant (83.33%), punish parents/ guardians who do not take their children to school (66.66%), deal with sex pests more harshly 27.77%; address girl female role model issue and double streaming and consolidation of schools as shown by 50% 44.44% respectively.

**4.1.2 Data From The Sub-Chiefs Responses On Questionnaires**

Asked about how long they have been sub-chiefs in their various sub-locations, the two sub-chiefs indicated that they had served over 7 years an indication that they were better places to provide reliable responses. When the sub-chiefs were asked to provide reasons for the non-attendance of pupils at school, they gave the responses tabled below:

**Table 8; Reasons of Non-attendance at School As Given By Sub-Chiefs**

**n=2**

<b>Responses</b>	<b>no.of respondents</b>	<b>% of respondents</b>
Lack of adequate school places	2	100.00
Lack of demand for education	2	100.00
Irrelevant curriculum	2	100.00
Inavailability of schools	2	100.00
Ignorance of parents on importance of educating their children	1	50.00
Suspensions and expulsions from school	1	50.00
child labour	2	100.00

**Source: Response From Sample.**

Lack of adequate school places and demand for education, irrelevant curriculum and unavailability of schools, child labour demands were reasons for non-attendance of pupils at schools as given by the sub-chiefs with 100% response.

Ignorance of parents on importance of educating their children, and suspension and expulsion from school as evidenced by 50% of the responses respectively.

Probed about the measures the sub-chiefs had put in place to contain the problem of non-attendance of pupils in their areas of jurisdiction, the sub-chiefs revealed that they force parents/guardians through their “Barazas”( 60%) even force some parents or guardians to do hard labour/public labour (90%).

#### **4.1.3 Data From The Pupils Response On Questionnaires.**

The pupils were asked to provide the number of students who had joined their respective classes since they joined class one. The table below shows their responses:

**Table 9. Pupils Responses On Number Of Students Who Had Joined Them Since Class One.**

<b>n=211</b>		
<b>Statement</b>	<b>No. of respondents</b>	<b>% of responses</b>
More than 5	211	100.00
Less than 5	125	59.24
Not applicable	67	31.75

**Source: Responses From Sample**

The pupils showed that more than 5 pupils had joined them since class one as evidenced by 100% responses, some pupils indicated less than 5 pupils had joined them as evidenced by 59.24% while 31.75% Of the pupils did not respond to the statement.

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Asked about reasons behind drop-out of their colleagues from school, the pupils gave the following responses:

**Table 10. Pupils Reasons for Dropping Out Of Their Colleagues from School.**

n=211

<b>Reasons</b>	<b>no. of respondents</b>	<b>% of responses</b>
Early marriages	211	100.00
Canning	50	23.70
Pregnancies	183	86.73
Child labour demands	107	50.71
Difficult concepts taught	148	70.14
Transfer to other schools	78	36.97
Costs of primary education	100	47.39

**Source: Responses from Sample**

All students in the sampled schools (100%) indicated that early marriages is the major reasons determining access to FPE, 23.70% indicated canning as the least reason for the inaccessibility of pupils in FPE. Other reasons advanced by pupils were pregnancies. 86.73%, child labour demands 50.71%, difficult concepts taught 70.14%, transfer to other schools, 36.97% and costs associated with primary education 47.39%.

**SUMMARY, CONCLUSIONS AND RECOMMENDATIONS**

**5.1 Summary**

The purpose of the study was to examine the factors determining access on FPE in Mitaboni zone, Kathiani division of Machakos district, Kenya. Yet three questions needed to be explained as the core of the study: what were the factors determining access to FPE in Mitaboni zone? What was

the effect of these factors on access to Free Primary Education? What actions need to be taken to attain full participation of pupils of school- going age in primary education?

The research found out the following factors as being the main determinants in access to FPE in Mitaboni zone:

- (i) Financial levies
- (ii) Poverty and malnutrition
- (iii) Cultural factors which affect girls more than boys
- (iv) Overcrowded classes
- (v) Pregnancies
- (vi) Early marriages
- (vii) Child labour demands
- (viii) Irrelevant curriculum
- (ix) Lack of demand for education
- (x) Ignorance of parents on importance of educating their children
- (xi) Suspension and expulsions from school
- (xii) Canning
- (xiii) Difficult concepts taught

From the stepwise multiple regression analysis it was discovered that the correlation, R, between the independent Variables of the study and access to FPE to be 0.999. The co-efficient of multiple determination R<sup>2</sup>, was 0.997.

This meant that the factors in the study accounted for 99.7% variability in accessibility in FPE in Mitaboni zone. The unexplained variations, 0.3% could have been due to other causal factors not included in the analysis and/or errors incurred in data collection.

The Beta for school financial obligations was 0.992%. This meant that 1% increase in financial demands of a school could lead to 0.992% inaccessibility in FPE. The Beta value for poverty and malnutrition, cultural factors affecting girls more than boys; overcrowded classes, pregnancies, early marriages, Child labour demands were 0.17%, 0.987%, 0.990%, 1.007% and 0.771% respectively.

The multiple regression equation for the research could be written as:

$$F=0.002 +0.992X_1 +0.017X_2 +0.987X_3+0.990X_4+1.007X_5+0.980X_6+0.771X_7.$$

## **5.2 Recommendations**

It was recommended that the action needed to deal with the inaccessibility of FPE were:

- (i) Provide relevant curriculum
- (ii) Government to provide physical facilities
- (iii) Government to bear all the costs of primary education
- (iv) Punish parents who do not take their children to school
- (v) Deal with sex pests more harshly
- (vi) Address issue of girl female role model
- (vii) Double streaming and consolidation of schools.

## **5.3 Conclusion**

Based on the findings of the research study, it was concluded that FPE in Mitaboni zone is yet to be realized. There are quite a number of pupils of school going age who have dropped out of school. Educational stake holders should do their part with a bid of promoting the realization of full participation in FPE. On one hand, the government ought to make primary education really “Free” in the strict sense of the word, on the other hand, parents/guardians should not sit on the fence but play their positive roles in enhancing the government’s efforts of moving toward providing of a really FPE.

## **5.4 Suggestions for further research**

Based on the findings of the study, the following issues were deemed necessary for further research:

- (a) There is a corresponding need for more research in this area in other zones where no such studies have been done.
- (b) There is need to do a similar comparative study between urban and rural zones.

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## **E2012-14: Existential Fulfillment, Work Engagement and Job Burnout**

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### **Abstract**

Existentially inclined researchers define burnout as a form of existential vacuum that is characterized by apathy, boredom and lack of interest in relationships. Recent studies have witnessed a shift towards positive perspective that rephrases job burnout as the erosion of work engagement. It conceptualizes the way people relate psychologically with their jobs as a continuum between the negative experience of burnout and the positive one of engagement and fulfillment. Engagement predicts workers' outcomes, organizational success, and financial performance. The changing psychological contract at the work place has majority of employees either not fully engaged or disengaged leading to an engagement gap that is a recipe for burnout. In research, burnout has been related to many person-specific variables. Two of these, existential fulfillment and work engagement have received little attention in research. This paper explores the relationships between existential fulfillment, engagement and burnout, as well as the contribution of the first two concepts to burnout. In a cross-sectional survey a random sample was drawn (n = 106) from a population of high school teachers. They were given a questionnaire that included demographic, existential fulfillment, burnout and engagement items. 89 respondents (which constituted a response rate of 84%) filled the questionnaire. The average age was 34 years and 60 percent of respondents were female. Participants had been in their current station for an average of four years and had on average 12 years of work experience. Existential fulfillment was positively correlated with engagement and both variables negatively correlated to burnout. These findings have significant implications for positive organizational behaviour and human resource development. It also demonstrates the importance of work engagement and existential fulfillment for the prevalence and prevention of burnout.

**Key words:** *Existential fulfillment, Engagement, Burnout*

### **Introduction**

Besides environmental variables that predict burnout phenomena, for example workload, social support and organizational administration, personality factors have also been identified as significant in the research on burnout. These include personality traits (Cano-garcia, Padilla-Munoz, & Carraso Ortiz, 2005), perceived self-efficacy (Evers, Brouwers, & Tomic, 2002), existential fulfillment (Tomic, Evers, & Brouwers, 2004), constructive thinking (Evers, Tomic, & Brouwers2005), and work engagement (Hakanen, Baker, & Schaufeli, 2006).

A lot of psychological research has focused on unhealthiness and being indisposed (Schaufeli & Bakker, 2001). However, this century has witnessed a paradigm shift in studies on psychological wellness and researchers have shown an increasing interest in positive aspects of personal functioning in organizations (Schaufeli & Bakker, 2007). This has been attributed to the new

movement called positive psychology, which Duckworth *et al.* (2005) describes as the scientific study of positive experiences and positive individual traits, as well as the institutions that facilitate their development.

The interest in the relationship between existential fulfillment and work engagement ensues from the view of healthy psychological functioning that has been developed by existential and humanistic psychology. Since self-transcendence is considered to be the core of existential fulfillment (Frankl, 2004), it is not surprising that some research has been done to understand the relationships between self-transcendence and well-being among workers. Kilpatrick (2002) found positive correlations between self-transcendence, spiritual perspective and wellbeing. Tomic and Tomic (2011) suggest that self-transcendence may increase with development.

In their research on the relationship between self-transcendence and burnout (the opposite of work engagement) Hunnibell (2006) and Hunnibell *et al.* (2008) found a significant negative correlation between self-transcendence and all three dimensions of burnout. Research conducted by Palmer *et al.* (2010) showed that the higher the workers' scores are on existential fulfillment the more energy they have towards their work and the higher their scores on work engagement dimensions are, i.e. dedication and absorption. This shows that existential fulfillment which helps workers derive positive meaning from their job experiences fosters work engagement. Therefore it can be envisaged that as existential fulfillment increases, engagement is predicted to increase and burnout symptoms decrease. Existential fulfillment and work engagement may therefore be considered as a resource for workers and may insulate them against job burnout.

Unfortunately, much of what has been written about employee engagement comes from the practitioner literature and consulting firms. There is a surprising dearth of research on employee engagement in the academic literature (Robinson, *et al.*, 2004). For the purpose of prevention and intervention, a large body of burnout and engagement studies has focused on identifying their antecedents, including both environmental and individual ones (Langelaan, Bakker, Van Doornen, & Schaufeli, 2006). Burnout has been referred to as an erosion of engagement (Maslach *et al.*, 2001). In particular, vigor and dedication are directly opposite to exhaustion and cynicism, spanning two underlying core dimensions (named activation and identification), whereas absorption has been found in research to be a unique component of engagement (Schaufeli & Bakker, 2004).

As for efficacy measured by MBI without reversely recoding, several studies have suggested it to be an extended engagement factor, leaving exhaustion and cynicism as “a core of burnout” (Schaufeli *et al.*, 2002b).

### **Existential fulfillment**

Existential fulfillment refers to a way of life that is full of meaning and purpose and reveals an existential psychological approach to life (La'ngle *et al.*, 2003). The three notions related to existential fulfillment are self-acceptance, self-actualization and self-transcendence (Loonstra *et al.*, 2007). Characteristic of existential psychology is the attention paid to the boundary experiences of human beings as determinants of human existence (Yalom, 1980). Human existence is confronted by with several existential boundaries. According to Tomic and Tomic (2011), humans must overcome the psychological conflicts evoked by these boundaries in order to obtain a fulfilled existence. Those who accept the self accept their potentialities and intrinsic limitations. When they actualize the self they explore and develop their possibilities and potentialities for the sake of personal growth in understanding and abilities. Those who transcends the self recognize the otherness of the reality beyond the self, search for respectful relationships with this reality, derive life-meaning from these relationships, feel responsible for them, feel part of a larger whole, distinguish interests that surpass self-interests, and are able to see the self in perspective of the outer reality (Loonstra *et al.*, 2007; Tomic and Tomic, 2008). In fulfilling these existential tasks, people find life-meaning and a fulfilled existence. Self-transcendence is considered by Frankl (2004) to be the essence of human existence. This is the spiritual ability that enables the individual to make intentional contacts with the world beyond the self, which provides ultimate meaning to life.

The notions of self-acceptance, self-actualization and self-transcendence can be interpreted as basic attitudes in pursuing existential fulfillment and overcoming the psychological conflicts caused by human limitedness. The inability to achieve existential goals may lead to burnout (Pines & Aronson, 1988), whereas the achievement of these goals may result in work engagement (Schaufeli & Bakker, 2001).

### **Work Engagement**

Work engagement has been given many definitions by many researchers. Schaufeli *et al.*, (2002) look at it as the positive, fulfilling, work-related state of mind characterized by vigor, dedication,

and absorption. To burnout researchers it is the opposite or positive antithesis of burnout characterized by energy, involvement, and efficacy, the direct opposite of the three burnout dimensions of exhaustion, cynicism, and inefficacy (Maslach *et al.*, 2001). Kahn (1990, 1992), defines employee engagement as the harnessing of employees' selves to their work roles; in engagement, people employ and express themselves physically, cognitively, and emotionally during role performances. Other researchers have defined it as emotional and intellectual commitment to the organization (Baumruk, 2004; Richman, 2006; Shaw, 2005) or the amount of discretionary effort exhibited by employees in their jobs (Frank *et al.*, 2004). Therefore, engagement implies being psychologically present when occupying and performing an organizational role. Rothbard (2001) expands this definition by adding that it involves two critical components: attention and absorption. Attention refers to the cognitive availability and the amount of time one spends thinking about a job role while absorption means being engrossed in a role and refers to the intensity of one's focus on a their role.

In the context of positive psychology, which focuses on health and well-being, the concept of work engagement is considered to be one of the positive dimensions (Tomic & Tomic, 2011). According to Schaufeli and Bakker (2001), it refers to a positive, affective-cognitive state of supreme satisfaction. The concept has three components. The first, vigor, is characterized by high levels of energy and mental flexibility while working, the willingness to invest effort in one's work, and perseverance in the face of difficulties. The second component, dedication, refers to a commitment to work and is characterized by a sense of significance. Dedication is a useful and meaningful experience, inspiring and challenging; it evokes feelings of pride and enthusiasm. Absorption, the final dimension of engagement, refers to the full concentration on and deep engrossment in one's work. It has been established that vigor and dedication are the main characteristics of engaged behavior (Llorens *et al.*, 2007). Engagement is not a momentary and specific state, but rather, it is a more persistent and pervasive affective-cognitive state that is not focused on any particular object, event, individual, or behavior (Schaufeli *et al.*, 2002). Research on burnout and engagement has found that the core dimensions of burnout (exhaustion and cynicism) and engagement (vigor and dedication) are opposites of each other (Gonzalez-Roma *et al.*, 2006).

The recent years have witnessed a great deal of interest in employee engagement and personal fulfillment at the workplace. Research has established that engagement predicts employee

outcomes, organizational success, and financial performance such as total shareholder return (Bates, 2004; Baumruk, 2004; Harter *et al.*, 2002; Richman, 2006). At the same time, it has been reported that employee engagement is on the decline and there is a deepening disengagement among employees today (Bates, 2004; Richman, 2006). Majority of workers today focus on the pecuniary benefits of their jobs and are either not fully engaged or they are disengaged leading to an engagement gap that costs businesses and organisations much in lost productivity (Bates, 2004; Johnson, 2004; Kowalski, 2003).

Schaufeli and Bakker (2007) observe that employees who display a high level of engagement work particularly hard and diligently because they enjoy their work, and not because of a strong, compelling inner motivation alone. When they experience fatigue, such individuals describe the feeling as quite pleasant because of its association with positive achievements rather than failures (Schaufeli & Salanova, 2008). The outcomes of work engagement primarily include positive attitudes towards work and the organization, such as job satisfaction, commitment to the organization and a lack of desire to turnover (Demerouti *et al.*, 2001; Schaufeli & Bakker, 2004). Likewise, engagement leads to positive organizational behavior, such as displaying personal initiative, a strong motivation to learn (Sonnentag, 2003) and proactive conduct (Salanova *et al.*, 2003).

When employees are engaged with their work, there is congruence between the employees' priorities and the organizations' goals. There are indications that the degree of work engagement is positively correlated with job performance (Schaufeli & Bakker, 2007). Schaufeli and Salanova (2007) conclude that engaged individuals have a well-developed ability to adequately respond to change, quickly adapt to a new environment and easily switch from one activity to another. Engaged employees continue to seek new challenges in their work and perform at a high-quality level, resulting in positive feedback from both managers and clients. Work engagement is contagious and thus is transferable from one person to another (Schaufeli & Salanova, 2007). Finally, there are indications that work engagement is positively related to health. Demerouti *et al.* (2001) and Schaufeli *et al.* (2004) observed fewer depressed, stress-related and psychosomatic symptoms among workers who scored highly on the engagement scale.

There are indications that work engagement has many advantages for both employees and employers (Tomic & Tomic, 2011). However, the level of work engagement varies for each profession. Schaufeli and Bakker, (2004) and Simpson, (2009) have formed the basis for theories about the relationships between the dimensions of existential fulfillment work engagement and burnout.

### **Job Burnout**

Burnout is a psychological syndrome of emotional exhaustion, depersonalization and a sense of diminished self-efficacy that can occur among individuals who work with other people in some capacity (Maslach, Jackson, & Leiter, 1996). Job burnout is an important index of psychological well-being among working people (Maslach, Schaufeli, & Leiter, 2001). It is associated with decreased job performance (Brouwers & Tomic, 2000), reduced job engagement and predicts low existential fulfillment (Lemkau, Rafferty, & Gordon, 1994), and stress related problems (Maslach, Schaufeli, & Leiter, 2001). Cherniss (1980) identified that, in the process of burnout, both attitudes and behaviors change in an unconstructive manner in response to work stress. Cedoline (1982) depicted the physical and behavioral symptoms of burnout as the reluctance to go to work, disappointment with performance, an extension of work problems into the person's home life, and an ultimate feeling of worthlessness.

Pines (1993) reported that burnout systems include, but are not limited to, fatigue, poor self-esteem, inability to concentrate on a subject, and a tendency to blame others. Maslach *et al.* (1996) further asserts that individuals suffering from burnout experience a depletion of physical and emotional resources, develop cynical attitudes, and feel a loss of professional self-efficacy. Dunham and Varma (1998) stated that the most pervasive symptoms of burnout are a noticeable lowering level of job commitment, a loss of enthusiasm and interest, and feelings of disaffection and alienation. In addition to negative effects of burnout on individuals, organizations also face significant implications and costs associated with burnout (Shirom, 2003). Among these negative impacts, organizations experience lower individual work performance, high rates of turnover, lower levels of organizational commitment, lower reported job satisfaction, high health care costs, and decreases in creativity, problem solving and innovation (Halbesleben & Buckley, 2004).

### **Methodology**

## Measures

**Existential fulfillment.** Existential fulfillment, composed of the three dimensions self-acceptance, self-actualization, and self transcendence, was made operational by means of the Existential Fulfillment Scale (EFS) (Loonstra *et al.*, 2007). The EFS consists of 15 items, 5 items for each dimension, measured on a 5-point Likert scale, running from 0 (*'not at all' relevant to me*) to 4 (*'fully' relevant to me*). The five items on self-acceptance refer to the urge to prove oneself to others, rejection of the self, inner uncertainty and psychological reliance (e.g., *'Often I do things more because I have to than because I want to'*). The self-actualization items deal with intrinsic motivation, the passion of one's own ideals, and feeling free to calmly pursue one's goals (e.g., *'I remain motivated to go on, even when things are going against me'*). The self-transcendence items focus on feeling part of a larger, meaningful totality, conceiving a sense of life that transcends personal interests and being convinced that life is good for something. The maximum score per dimension is 20. The internal consistency coefficients for the existential fulfillment scale were 0.79, 0.76 and 0.82, for self-acceptance, self-actualization, and self transcendence respectively.

**Work engagement.** Work Engagement was assessed with the Utrecht Work Engagement Scale (UWES; Schaufeli *et al.*, 2002). The UWES has been found to be a reliable and valid self-report questionnaire (Schaufeli *et al.*, 2006). The factorial validity of the UWES has been demonstrated in previous research (Hakanen, 2002). In addition, previous studies carried out in other countries have shown that the UWES has satisfactory psychometric properties (Schaufeli *et al.*, 2002). There are three subscales with five items each: vigour, dedication and absorption. Participants responded on a seven-point Likert scale, ranging from 0 (never) to 6 (always, daily), with a maximum score per subscale of 30. Examples of items are: *'At work I bubble over with energy'* (vigour), *'Work inspires me'* (dedication) and *'I am totally absorbed in my work'* (absorption). High scores on these scales indicate greater work engagement (vigour, dedication and absorption). The reliability of the data was found to be high with an overall  $\alpha = 0.91$ . Cronbach's alpha was 0.76 for vigor, and 0.83 for dedication and 0.79 for absorption subscales respectively.

**Job Burnout.** Burnout was measured with the Maslach Burnout Inventory–General Scale (MBI–GS; Schaufeli, Leiter, Maslach, & Jackson, 1996). The MBI (20 items) consists of 3 sub-scales: emotional exhaustion (8 items), e.g. *"Working with people all day is really a strain for me"*; depersonalization (5 items), e.g. *"I don't really care what happens to some of the young residents"*;

and self efficacy (7 items), e.g. *“I have accomplished many worthwhile things in this job”*. Teachers responded on a 7-point scale, from “never” to “always”. MBI reliability tests (Schaufeli, 1990) showed that the emotional exhaustion sub-scale is the most reliable of the three; Cronbach’s alphas vary between .80 and .90. The other two sub-scales appeared to have Cronbach’s alphas of between .70 and .80, which may be regarded as sufficient for research purposes according to Nunnally and Bernstein (1994). This study yielded an internal consistency of 0.85 for emotional exhaustion, 0.78 for cynicism and 0.73 for efficacy. These fall above the acceptable threshold for testing of reliability. The three-factor structure of the MBI has been investigated with confirmatory factor analysis (Green & Walkey, 1988). The factorial validity of the MBI–GS has been confirmed across occupational groups and across nations (Schutte, Toppinen, Kalimo, & Schaufeli, 2000).

### **Population**

In a cross-sectional survey a random sample was drawn (n = 106) from a population of high school employees. The respondents completed a questionnaire that included demographic, existential fulfillment (EFS), burnout (MBI) and engagement (UWES) items. The questionnaires that were properly filled were 89, which constituted a response rate of 84%.

### **Procedure of Data Collection**

All respondents were directly contacted by the researcher. A self-administered questionnaire was used as an instrument to collect data. Participation of the respondents was voluntary.

### **Results**

Descriptive analysis revealed that 4% of the respondents were younger than 25 years old, 30% were between 26 and 35 years, 25% between 36 and 45 years, 27% between 46 and 55 years, and 14% were over 55 years of age. The mean job tenure as a teacher was 12 years (S.D. = 10.1). With respect to job seniority, 18.7% have held their jobs for 1 - 5 years, 27.9% for 6 - 10 years, 27.9% for 11 - 15 years and 25.5% for over 15 years. Regarding job position, the great majority of the respondents (69.8%) are classroom teachers, followed by heads of departments (15.1%) and deputy principals (15.1%). Most participants were female (60%).

### **Table 1.**

A Survey of Mean Scores, Standard Deviations and Correlations between Burnout Dimensions and Independent Variables (N = 89)

	Mean	SD	1	2	3	4	5	6
1. Emotional Exhaustion	12.65	6.24	-.04					
2. Depersonalization	3.31	2.61	.03	.42**				
3. Self Efficacy	32.28	4.56	-.07	-.29**	-.30**			
4. Self-Acceptance	37.41	4.82	.08	-.37**	-.34**	.37**		
5. Self-Transcendence	73.34	5.08	.11	-.33**	-.45**	.40**	.53**	
6. Self-Actualisation	52.29	5.78	.01	-.34**	-.39**	.43**	.55**	.66**

\* p < .05, \*\* p < .01

Table 1 presents the mean scores, standard deviations and correlations between the three existential fulfillment subscales and three burnout dimensions. The results show that self-acceptance, self-transcendence and self actualization are negatively correlated to both emotional exhaustion and depersonalization: the less the scores on the existential fulfillment subscales, the higher the scores on the two burnout dimensions. However, the fulfillment subscales positively correlated to professional efficacy: the higher the scores on the existential fulfillment scale, the higher the self efficacy scores. Correlation coefficients were significant at p<0.01.

**Table 2**

Means, standard deviations, correlations, and internal consistencies of the burnout (EX, CY, reduced EF) and engagement (VI, DE, AB) scales (N = 89)

	Mean	SD	F	EX	CY	rEF	VI	DE	AB
<b>EX</b>	2.24	1.23	227.52	0.85	0.59***	0.21***	-0.34***	-0.30***	-0.16*
<b>CY</b>	1.87	1.21	48.50	0.46***	0.84	0.41***	-0.47***	-0.55***	-0.39***
<b>rEF</b>	1.65	0.86	29.22	0.21***	0.38***	0.73	-0.60***	-0.55***	0.44***
<b>VI</b>	3.82	0.86	55.89	-0.20***	-0.27***	-0.64***	0.79	0.69***	0.69***
<b>DE</b>	3.74	1.29	60.70	-0.14*	-0.51***	-0.68***	0.60***	0.89	0.72***
<b>AB</b>	3.53	1.00	4.51	-0.12*	-0.22***	-0.60***	0.74***	0.56***	0.72

\* p < .05, \*\* p < .01, \*\*\* p < .001

Table 2 indicates that as expected, all burnout and engagement scales are negatively related, whereas interrelations of the burnout and engagement scales are all positive.

The correlations between the dimensions of existential fulfillment and work engagement were also investigated. There appeared to be a significant positive correlation between self-actualisation and the three dimensions of work engagement: vigour ( $r = 0.42, p < 0.01$ ), dedication ( $r = 0.30, p < 0.01$ ) and absorption ( $r = 0.43, p < 0.01$ ). The explained variance was 10%, 8% and 13%, respectively. The higher the score on self-actualization, the higher the scores obtained on work engagement. Self-transcendence correlated significantly but negatively with one dimension of work engagement, namely vigour ( $r = -0.16, p < 0.05$ ), and explained 2% of the variance. The higher the score on transcendence, the lower the score on vigour. These results demonstrate that self-actualization had a positive and significant correlation with all dimensions of work engagement. Self-transcendence, however, was significantly negatively associated with one dimension of work engagement, i.e. vigour. There was no correlation between self-acceptance and the dimensions of work engagement.

Multifactor Multivariate Analysis Of variance (MANOVA) revealed that there were no significant main effects found in the data. There was no significant differences in work engagement between male and female respondents ( $F(57,152) = 0.176, p > 0.05$ ). The participants' age did not have significant effects on subjects work engagement ( $F(177,139) = 0.983, p > 0.05$ ). Education background had also no significant effects on subjects work engagement ( $F(57,149) = 0.131, p > 0.05$ ). This means that the respondents with or without advanced levels of education engage equally with their job. Teaching experiences had no significant effects on the subjects work engagement ( $F(116,150) = 0.305, p > 0.05$ ). There were no significant differences in work engagement between respondents of different status ( $F(116,149) = 0.613, p > 0.05$ ).

## 5. Discussion

The purpose of the current study was to examine the relationships between existential fulfillment, work engagement and job burnout. In addition, the extent to which the first two independent variables influence job burnout was investigated. To the best of my knowledge, there is no published empirical data on the relationships between these concepts in Kenyan setting. Therefore, a comparison with results of previously conducted studies is hardly feasible. In the Loonstra, *et al.* (2009) study, similar concepts were examined, i.e. the relationship between existential fulfillment and burnout (the opposite of work engagement) among secondary education teachers.

A positive relationship between existential fulfillment and work engagement was confirmed for the dimension of self-actualization. The results show that self-actualization explained a substantial percentage of variance in all three dimensions of work engagement. On the other hand, self-acceptance and self-transcendence hardly explained variance in work engagement dimensions. With regard to self-transcendence, this is consistent with the results reported by Loonstra, *et al.* (2009).

Job burnout explained a substantial proportion of variance in vigour and dedication. A higher burnout level experienced by teachers resulted in lower scores on vigour and dedication on one hand and self-transcendence and self-actualization on the others hand. This finding is consistent with Van Rhenen's (2008) study, in which he advises that people concentrate on work pleasure because enthusiastic staff members are a positive contribution to an organization. A higher degree of perceived job burnout may result in decreased vigour and energy, including mental resilience and perseverance. Dedication, a particularly strong work involvement, diminishes, and the question is to what extent respondents experienced their work as meaningful and inspiring. It is likely that teachers with a higher perceived burnout will not be fully concentrated and deeply engrossed in their work (absorption).

The results of this study have several implications for research. First, it was revealed that the teachers had an average score on the emotional exhaustion subscale, high degree of depersonalization, and low degree of personal accomplishment. According to Budinick (2005), higher scores on emotional exhaustion and depersonalization subscales indicate higher levels of burnout. Personal accomplishment subscale is scored in the opposite direction; where lower scores on personal accomplishment indicate higher burnout. The overall results of this study describe the teachers to be on the borderline of burnout showing signs of moving toward a high degree of burnout.

Differences between female and male teachers' burnout levels provided an interesting comparison. Although no statistical significant was found, female teachers were found to have scored higher on all three burnout dimensions over their male counterpart. These results point to a significant need for further research related to gender and burnout in high school teachers.

This research established that existential fulfillment is positively correlated to work engagement and negatively correlated to job burnout. Existential fulfillment and work engagement are mutually reinforcing and developing ways of boosting them at the work place can be a powerful tool not only for combating but also for insulating workers from burnout.

Several limitations may have influenced the results of the current study. Firstly, this study was limited by its cross-sectional design. Some reservations must be expressed in terms of the direction of causation. The relationships shown do not reveal the causal direction. The results indicate that self-actualization influences work engagement, but one can also imagine influences moving in the opposite direction: a low level of work engagement leads to diminished self-actualization. When teachers are subjected to strict demands from their superiors and the work environment does not offer opportunities for personal development and growth, self-actualization, absorption and dedication may be diminished. Secondly, the direction of causation requires further investigation. Future longitudinal studies are needed to evaluate the possibility of causal relationships between existential fulfillment, work engagement and job burnout.

Thirdly, the measurements in our study were based on self-reports. Consequently, we do not know the extent to which these self-reports accurately reflect existential fulfillment, work engagement and perceived job burnout. Naturally, the results of the present study for the association between existential fulfillment, work engagement and burnout should be interpreted with caution, but there are no indications that these findings solely reflect biased respondent reporting. Combining self-report data with data obtained in a more objective manner is recommended for further research so that powerful statistical techniques can be applied for hypothesis testing. The findings of the present survey could be used to generate hypotheses for future research. Fourthly, since this study did not take into account geographical spread or the various working environments of teachers, generalizing the results to all teachers in the county should be done with caution.

Despite the limitations, the current study contributed to the knowledge of the teaching profession with regard to existential fulfillment and work engagement in relation to job burnout. Because the aim of the present study was to generate empirical knowledge about positive behaviours in organizations, it may be concluded that this study fits into the research context of positive psychology. Existential fulfillment, in part, and work engagement appear to be determinants of job

burnout. In order to maintain and promote work engagement and the high performance of employees, organizations should provide sufficient challenging work (Bakker, 2009). According to Laschinger, *et al.*, (2006), engaged professional teachers are critical to preserving the quality of education.

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**E2012-15: Influence of HIV/AIDS Counselling Services on the Quality of Life of People in Selected Churches in Nakuru County, Kenya**

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**E2012-16: Effects of School Fees on Equity Provision of Education in Public Secondary Schools in Nairobi Province, Kenya**

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**Abstract**

The main objective of this research was to find out the effects of school fees on equity provision of education in public secondary schools in Kenya. The ministry of education fee guidelines allows schools to charge fee according to the category of schools and schools are allowed to alter the fee guidelines to cater for parents to finance school projects( MoEST 2008).As a result there exists different fee structures in public secondary schools whose effects on equity provision of education is not clear. The researcher used cross-sectional survey research design. The independent variables were: fees charged in various categories of secondary schools, parents' economic background, government policy on fees, while the dependent variables were equity provision of learning resources, provision of teachers, student retention in schools, student educational and career aspirations. Target population comprised of secondary school head teachers, teachers, students and parents. The sample comprised of: twenty three head teachers, two hundred forty seven teachers, three thousand two hundred and ninety one students, and forty six parents. The research instruments used were: Interview for head teachers and parents, questionnaires for teachers and students and observation check list for school facilities. Reliability of the instruments was established through a pilot study. A test- retest technique was used to correlate the result of the pilot study. The pilot study results indicated that instruments yielded consistent results each time they were administered to the respondents. Experts established content validity of the instrument by reading thoroughly to ascertain their focus in responding to research questions. Data obtained were analyzed using descriptive statistics such as frequencies, percentages, and means by statistical Package For Social Sciences.(SPSS) and presented using tables, graphs, and charts. Discussion and interpretation of the findings, established that the higher the school fees charged, the better the provision of education to students, the lower the school fees charged the poorer the provision of education to students. Students from low economic backgrounds are highly disadvantaged in equity provision of

education. In conclusion, categorization of school fees in Kenyan secondary school is an hindrance to equity provision of secondary school to learners from poor economic backgrounds .To the ministry of education, the researcher, recommended a revision of school fees policy guidelines to guard against unrealistic fee increments, allocate funds for free secondary school according to the needs of the schools but not per student. Employ enough teachers for all public secondary schools to enhance equity provision of education. To the head teachers, the study recommended that they should explore avenues of soliciting for funds from non-governmental organizations, well wishers, income generating projects and CDF to assist in funding the school projects. To the parents the study recommended that, they should work in collaboration with the head teachers to be educated on economic empowerment through seminars and workshops. The researcher recommended further research on adequacy of school facilities to establish which school needs more funding for facilities and learning resources to enhance equity provision of education.

### **1:1 INTRODUCTION**

Internationally, education is recognised as a basic human right, this is stipulated in Article 26 of the Universal declaration of human rights as spelt out in the Charter of the United Nations, adapted in the General Assembly on 10<sup>th</sup> December 1948 (Kiruthu, Kapiyo, and Maina; 2003). The charter reaffirms: the fundamental human rights, worth, dignity, and the equality of all men and women.

Declaration of Human Rights states that, “everyone has a right to education”. This education should be ideally free at least at primary school level. The technical and professional education should be made generally available while higher education should be equally accessible to all on the basis of merit. Guaranteed right to education means enhanced people’s access to and enjoyment of other rights (UNESCO, 2002).Lack of access to education limits to human development (Allen, Thoman 2000).

In Newzealand, government provides free and compulsory education both in primary and secondary levels between age Six to Sixteen. (Encyclopaedia 2000).

In America, education is one of the components of equal opportunity. America judges her education through ‘Equality and Equity’ assessment of education system to its intended beneficiaries and when the governments assumed a larger role in financing public education, equality and equity in education improved significantly (Crampton and Thomson 2001).

The British government channels her funds through the local authorities and they in turn allocate funds to schools and colleges within their Administrative boundaries and this has increased equity in student participation a great deal. (Pedron and Bruce 2009).

Immediately on gaining Kenya’s independence, the government with supplements from local people build equipped and maintained secondary schools (Bogonko, 1992). In 1968 the government admitted that the harambee schools constituted 70% of all unaided schools (Sifuna 1990).The

government paid teachers' remunerations, and purchased teaching and learning resources which constrained the government budget (Republic of Kenya 1972).

The World Bank's and International Monetary Fund's (IMF) Structural Adjustment Programmes (SAPS) compelled the Kenyan Government to reduce spending on education. Cost sharing in all sectors of education by Kamunge report 1988 which led to high dropout rates. By an act of parliament in 1994 bursary fund (SEBF) was introduced to address the escalating cost of education. Njeru and Orodho (2003), point out that the bursary scheme has not been very effective due to the fact that apart from political favouritism, the funds allocated fall short below the schooling needs.

In January 2008, the coalition government of Kenya introduced tuition waiver policy in Public Secondary Schools in which the government pays Kshs. 10,265.00 per student per year, pays the remunerations for the teaching and Non-Teaching Staff (NTS) and as well meets students' activity fees while the parents in boarding schools pay 18,627.00 per student per year summing up to Ksh. 28,892.00. per student per year. Parents also meet other obligations such as school uniforms, lunch and transport and the development of physical facilities. (MoE;2008).

However, there exists differences in the amount of fees charged in public boarding and day schools in Kenya. National schools an average of Ksh. 62,000.00, provincial boarding pays Ksh. 40,000.00, Day schools pays approximately Ksh.12,000. per year exclusive of the government (Source: Ministry of Education 12th February 2010 Approved fee structures).

The cost of education at secondary school level is often high and unsustainable and solutions should be provided if participation is to be increased argues (Lewin 2004). Secondary schools charge different schools, bursary fund is inadequate, students learn common curriculum, do common national examinations and Kenya signed the universal declaration of human rights to ensure equity in education participation. It is against this background that the researcher sought to answer this question: What are the effects of school fees on equity participation of student in public secondary school education in Nairobi province; Kenya?

### **1:2 Statement of the Problem**

Studies have been done generally on the factors affecting student participation in education provision of physical and learning resources, student retention in school, gender disparity and examination performance, student educational and career aspirations but no conclusive and systematic study has been done on the effects of school fees on various categories of public

secondary school on equity participation of student in secondary school education in Kenya. Kivuva, 2006; Chepkenei, 2004; Bironga, 2002; Lekaligatile, 2003, Eshiwani, 2001; Orengo 2007, Bennaars, 1995).

The cost of education at secondary school level is often high and unsustainable and solutions should be provided if participation is to be increased argues (Lewin 2004). Public secondary schools charge different school fees whose effects on equity of student participation in education have not been researched so far in Kenya? In order to bridge this gap, this study sought to answer this question: What are the effects of school fees on student participation in public secondary education in Nairobi province?

### **1:3 Research Questions: The study sought to provide answers to the following research questions:**

What are the effects of school fees charged by various categories of public secondary schools equity participation of students in learning of various subjects?

2. What are the effects of school fees charged by the various categories of public secondary schools on the equity retention of students in the school

3. What are the effects of school fees charged in various categories of public secondary on the provision of teachers

4. What are the effects of the school fees charged by various categories of public secondary schools on the equity students' educational and career aspirations?

### **1:4 Significance of the Study**

The study provided new knowledge on the effects different school fees charged by the various categories of public secondary schools have on equity student participation in education and suggestions on how the situation can be remedied.

The findings and the suggestions of the study are useful to the school administrators, policy makers especially in the area of school fees policies, school resource and finance management.

The findings and suggestions of the study are useful to the parents for their children will participate in education on equal bases regardless of parents economic backgrounds.

The findings of the study and suggestions of are useful to the students as equality of education participation would be availed to all regardless of social-economic status and the category of school.

## **1:5 Theoretical Frameworks**

This study is based on the theoretical model of learning put forward by Chinapah (1984) which emphasises equal rights and equity to education participation irrespective of age, sex, ethnicity, social-economic backgrounds and regional origins.

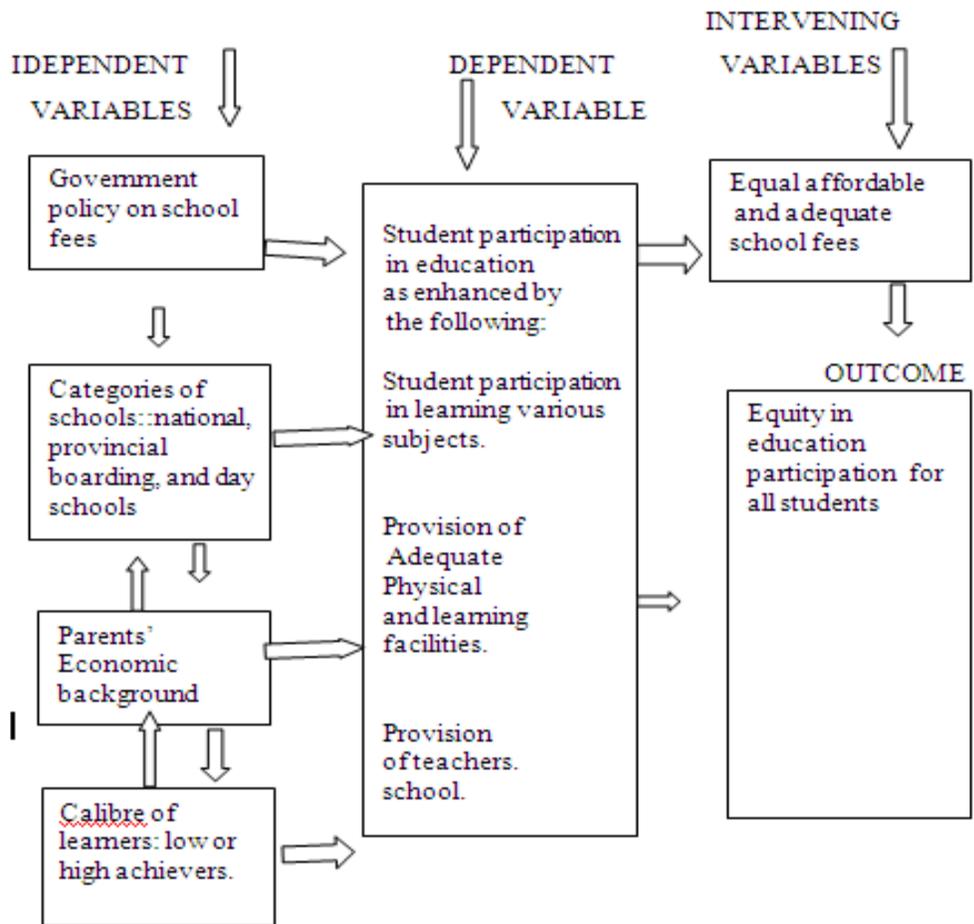
The model further notes that home characteristics such as social-economic status and home possessions directly influence parent support for their children's education in terms of paying fees, buying books and so forth.

This theory therefore concurs with the classical liberal theory on the equality of education provision to every learner without any form of discrimination. Furthermore, (UNESCO 1949) argue that education should be universal as per as the constitution of UNESCO (1949) which embraces equity of educational opportunity without regard to race, sex or any other distinctions.

Economic or social inequality to education is a drawback to agreed policy and also contravenes the convention of the elimination of all forms of discrimination on education participation

## **1:6 Conceptual Frame Work**

Figure 1.1: Conceptual framework.



**1:7 Knowledge Gaps  
Ministry of Education Fee Guidelines**

A study carried out by Obulemilit (2006) in Kenya on the financial management in 34 secondary schools found that the management of school resources is the responsibility of the head teacher of that institution. Parents’ Teachers’ Association (PTA) and Board of Governors (BoG) and teachers may render their support.

That institutions determine their own expenditure priorities which involve parents, District Education Board (DEB) and Provincial Director of Education’s approval. It is clear from Obulemilit study that public secondary schools charge different school fees but the effects of different school fees on equity participation of students in education were not established.

World Bank (1984) Observe that for quite a number of years, African governments financed the cost of education to the maximum.

Towards the end of 1980s, the governments did not have the capacity to fully finance education. The World Bank therefore recommended that the burden of financing education be passed to parents and community through cost sharing. However effects of cost sharing on equity of student participation in education were not discussed in this survey.

### **Student participation in education and provision of physical, human and learning resources**

The literature review shows that school fees are the main source of public secondary school finances in Kenya. In Siaya District for example parents provided textbooks and school uniforms but found these unaffordable (Okeke 1986). In Eldoret Municipality, parents provided laboratory apparatus and teaching aids (Matiasi1986).In Kisumu Municipality Parent provided text books, constructed classrooms and home science rooms but were unable to provide enough facilities (Obongo1987). In Imenti Division Meru District most schools lacked essential facilities to cope with increased enrolment due to inability of the parents to finance them (Kiugu1990). (Irungu1992).

In addition, (Matiasi,1986; Bironga, 2002; Aluoch, 2002; Lekalgitele, 2003; Murumba, 2004) in their studies on cost of education found out that lack of school fees and inadequate provision qualified teachers, learning and physical facilities affected student participation in secondary education.

### **Student retention in school**

Several researchers such as Efumbi, 2003; Orenge, 2007; Njagi, 2008 just to mention but a few, found out that lack of school fees led to absenteeism from school. Schools in Eastlands in Nairobi City registered high dropout rates and poor examination performance due to inability of the parents to pay levies and provide essential learning facilities. The pertinent question one may ask at this point is: how and to what extent do the varied secondary school fees affect the equity of students' retention in public secondary schools in Kenya?

### **Participation in various subjects, educational and career aspirations**

On the subjects' participation and career aspirations, studies conducted by (Kinyanjui, 1990; Kibera, 1993; Obonyo, 1994; Ehiwani, 2001; Munguti, 2004; Mauga, 2007) agree that the type of school and the availability of facilities influence the educational and career aspirations of the students.

Ogeto (2008) conducted a study at Nairobi University on the factors influencing female students in the choice of science-based courses and found out that schools lack of adequate

facilities, such as well equipped science laboratories and textbooks. The study was conducted at a University level. A study on the extent to which facilities influence student choice of subjects at secondary school level is crucial for equality of student participation

### **1:8 Methodologies**

The components of research methodology used in this study includes description of research design and sampling procedure, description of the research instruments, validity and reliability of the instruments, description of the data collection procedures and finally description of the data analysis.

#### **Research Design**

Cross-sectional survey design was used in this study which allowed the researcher to study the effects of fees on equity participation of student in education across various categories of public schools in Kenya and gather information at one point in time. It also allowed the researcher to carry out the study in a natural setting and a real-life situation using profanity samples to enhance external validity.

#### **Target Population and Sampling procedures**

This study targeted included head teachers, teachers, students and parents in Public Secondary Schools in Nairobi Province.

Stratified random sampling techniques were used in which the researcher established strata according to the major and minor categories of school. The researcher then proceeded to sample 10% of the schools from each category and the 10% of the respondents respective

Out of the total of sixty five (65) secondary schools in the province, twenty schools (23) schools were selected using stratified random sampling technique. The total number of students in all categories of the schools was 32,928.

Twenty three (23) schools were sampled for the study and the 10% of the total students in the sampled schools made a total of 3291 students as respondents to the study and 46 parents were PTA members.

#### **Research Instruments and data collection procedure, and Ethics**

In these study questionnaires, structured and semi-structured interviews and observation check lists were used to collect data. Observation check list were used to collect data on physical facilitates such as classrooms, laboratories, home science rooms, libraries, teacher preparation rooms (staffrooms) computer rooms, dormitories, play grounds, water systems, lighting systems

and income generating projects. Self administration of the instrument was used to correct data and informed, voluntary consent, and confidentiality of respondents was sought for through writing.

### **Validity of the Research Instruments**

In this study content validity and triangulation were used to establish instrument validity. Content validity was established by three experts on curriculum studies who determined that the set of items accurately represented and measured the concept of study. methodological triangulation was utilized in which the researcher used Questionnaires, interviews and observation check lists with similar items to collect data to ascertain similar results.

### **Reliability of the Instruments:**

Was established through pilot study in three secondary schools in Kiambu District on three head teachers, forty students, three parents and ten teachers. Observation checklist was also piloted in the three schools. Cronbach’s alpha was used to calculate alpha coefficient and it established that the correlation between the two tests was 0.7 which was above 0.5 reliability index recommended in social sciences.

### **Data Analysis Procedures**

Descriptive statistics were used to summarize the data in frequencies, percentages, mean scores and standard deviations using statistical Packages for Social Sciences (SPSS) A T-Test analysis was carried out at a significant level of 0.05 to find out the level of significant of the effects of school fees on student participation in education in various categories of schools. The qualitative data was analysed thematically.

### **1:9 Study findings**

Table 4.1: Response rates (expected, actual and percentage) of the study participants.

Participants	Expected Response	Actual Response	%
Students	3291	3204	93.4%
H/teachers	23	23	100%
Teachers	247	200	81%
Parents	46	42	93.9%
<b>Totals</b>	<b>3607</b>	<b>3469</b>	<b>93.9%</b>

A percentage response rate of 93.9% was indicated which shows that the sample was representative of the target population, hence reliable

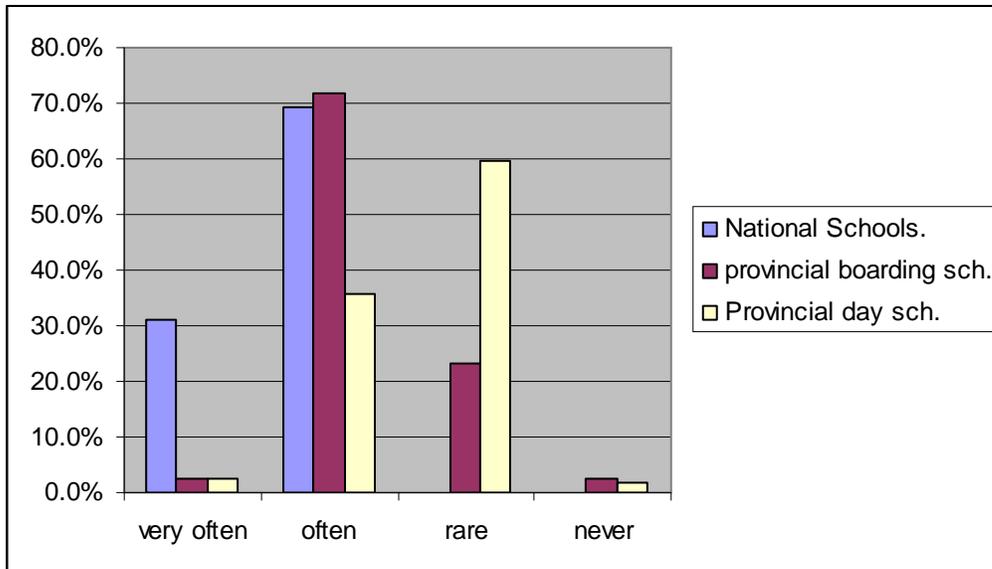
**Research Question One: Effects of school fees charged by various categories of public secondary schools equity participation of students in learning of various subjects?**

**Table 4.2 Effects of school fees equity participation of student in science and technical subjects by school category.**

<i>School category</i>	<i>Very often</i>		<i>Often</i>		<i>Rare</i>		<i>Never</i>	
	f	%	f	%	f	%	f	%
National	42	30.9%	94	69.2%	0	0%	0	0%
Provincial boarding	9	2.38%	272	71.7%	88	23.22%	10	2.64%
Day sch.	11	2.28%	152	35.5%	254	59.77%	8	1.88%
<b>Totals</b>	<b>62</b>	<b>6.6%</b>	<b>518</b>	<b>55.1%</b>	<b>342</b>	<b>36.4%</b>	<b>18</b>	<b>1.19%</b>

Student participation in practical was highest in national schools at 30.9% very oftenly done and 69.2 often done while in provincial boarding and day schools only 2.38% and 2.28% respectively very often were practical done. This due to availability of laboratories, science rooms and equipments as the checklist for facilities indicated. (Musoga, 2005; Nyongesa, 2008) found that most schools lacked teaching –learning facilities such as laboratories, workshops and libraries as a result of lack of finances to provide these facilities.

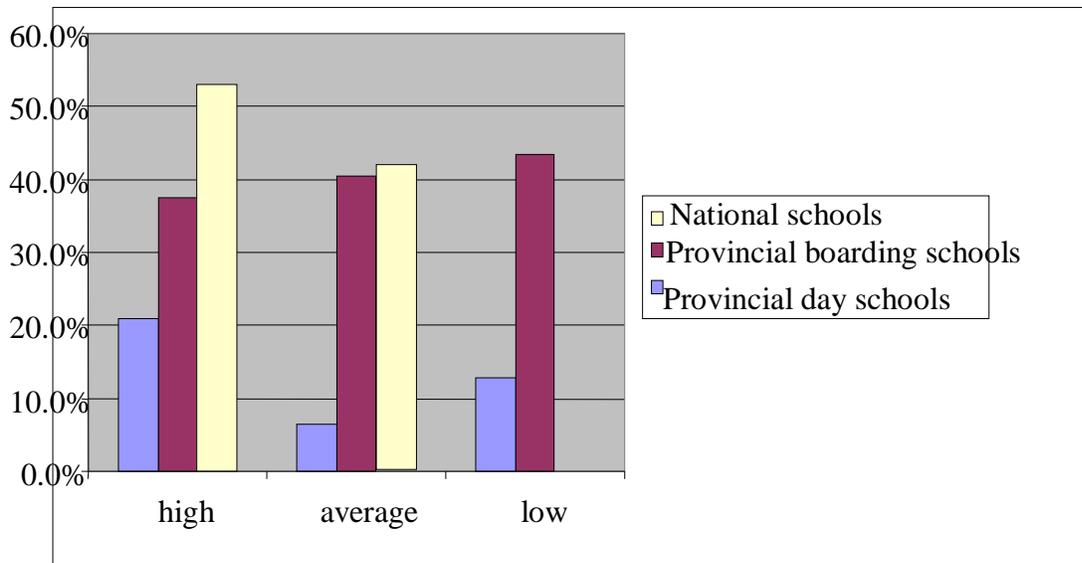
**Figure 4.3 Comparison of student level of participation in various subjects per school category by consultations, writing notes, group discussions, field trips, asking questions.**



In national schools students' participation in learning various subjects is very high (69% and 30%) respectively for very often and often as compared to the provincial boarding(4% and 72%) respectively for often and very often and day school (4% and 36%) respectively for very often and often. This is a very high disparity in equity participation in education. On this Amanjo (1997) argues that unequal participation in education at long run worsens the status of the poor or vulnerable groups. Betts (1999) observe that lack of adequate facilities in schools compromises quality education.

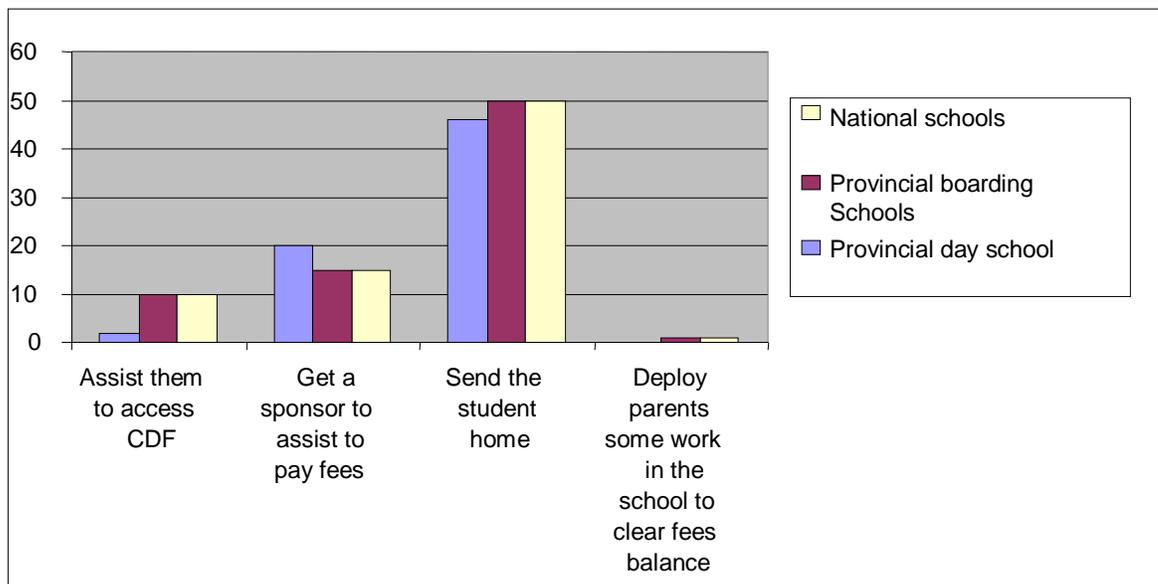
**Research Question Two: Effects of school fees on equity retention of students in various categories of secondary schools**

Figure 4.5: Rate of student Retention in various categories of categories of schools.



National schools have the highest retention rate as indicated on figure 4.4 with a percentage of 42% followed by provincial boarding schools with a percentage rate of 38% . Day schools have a very low retention rate as indicated by the 21%percentage.

**Figure 4.6: Head teachers’ reaction on the students who are unable to pay school fees.**



10% students get bursary in both national and provincial boarding schools while only 2% get bursary in day schools. This could be explained by the fact that the criteria for the poor criteria for bursary award as observed by (Njeru and Orodho2003)

On sponsorship day schools indicated the highest percentage of 20% while the provincial boarding and national schools indicate 10%.

Most common reaction of the head teachers on students who are unable to pay school fees on all categories of schools is to send student home: in national school of 50%, provincial boarding 50% and 48% in day schools. Betts (2002) argues that schools could reduce rates of dropouts by using savings to pay for textbooks and to reduce the fixed costs of sending children to school.

On deploying parents in school work to assist in clearing fees all categories of schools registered a minimal percentage

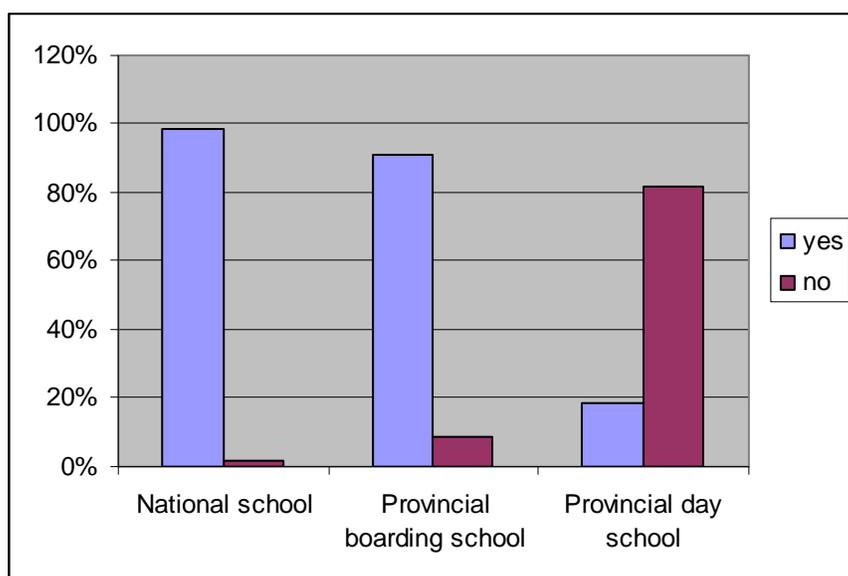
Table 43: Inability to pay fees and student transfers

<i>School category</i>	<i>Frequency</i>	<i>Percentage</i>
National schools	20	12.98%
Provincial boarding schools	100	64.94%
Provincial day schools	34	22.08%
<b>Total</b>	<b>154</b>	<b>100.00%</b>

In national schools parents inability to pay school fees indicate 12.98% , provincial boarding 64.94%, day schools 22.08%.

**Research Question Three: Effects of School Fees on equity provision of Teachers’ Staffing in Public Secondary Schools.**

Figure 4.7: Effects of school fees on the provision of teachers in various categories of school



National Schools have 99.8% percent capability of proving teachers through school fees, provincial boarding indicates 87% and day schools only 19%. Chabira (2005) observe that understaffing contribute to low student participation rates in education.

**Research Question Four: Effects of School Fees on equity on student subject choice, educational and career aspirations.**

**Table 4.16 Student educational and career aspirations by school category**

97.8% Students in national schools aspire for university education high careers and only 2.2% in

<i>School category</i>	<i>University</i>		<i>Tertiary colleges</i>	
	<i>f</i>	<i>%</i>	<i>f</i>	<i>%</i>
National sch	133	97.8%	3	2.2%
Provincial boarding sch	213	67.7%	16	33.3%
Day schools	65	7.2%	128	92.8%
<b>Totals</b>	<b>411</b>	<b>73.3%</b>	<b>147</b>	<b>26.3%</b>

tertiary colleges while provincial indicated 67.77% and 33.3% aspirations for university and tertiary colleges respectively. In public day secondary schools, the educational and career are very low (7.2%) students aspiring for education to university level and 92.8% aspire for tertiary colleges. Gary and John (2001) argue that if cost differences among schools are substantial, then imposing state wide student performance without simultaneously reforming the way financial resources are described among schools will result in a situation where the schools with inadequate finances will not have enough resources to educate their students to meet the new standards. Julie and Suzanne (2001) observe that the problem of educational inequalities in financing education could be solved by centralization of education finance at the state level.

**1:10 Conclusions.**

The government provision of tuition fund for Ksh.10,265.00 per student per year is hardly enough to cater for textbooks and development of physical facilities in day schools. Study findings established that the government tuition fund has enabled the economically disadvantaged students to access education in day schools but participation is not effective due lack of physical facilities such as laboratories, libraries, workshops and computers and computer rooms. Technical subjects

such as home science, power mechanics and computer studies are mainly offered in national schools and a few provincial boarding schools which can afford to finance them. There is great disparity in equity participation of students in education as a result of different school fees paid in various categories of secondary schools in Kenya.

### **1:11 Recommendations**

#### **Recommendation to the ministry of Education**

That school fees be equalised for all categories of secondary schools and be made affordable. That the government take the role of financing infrastructure development in secondary schools and parents pay tuition.

That the ministry of education move speedily to solve the understaffing of teachers in secondary schools.

That the allocation of free secondary education fund be based on the school needs for infrastructure and learning facilities development and not on student enrolment.

That all the funds for financing secondary school education be consolidated and be planned by the ministry of education for effective accountability. These funds include: Free Secondary Education Fund, Secondary School Bursary Fund, allocation from the constituency development fund and the Local Authority Transfer Fund.

That the ministry of education should issue a policy on the most necessary facilities for secondary schools for effective learning.

#### **Recommendations to head teachers**

Solicit for funds from well wishers, non-governmental organisations for school infrastructure development.

The school head teachers organise for parents, seminars in schools preferably on Saturdays to educate both students and parents on how to access the CDF fund to facilitate payment of school fees.

Explore the possibility of sharing the facilities with the nearby needy schools such as laboratories, workshops, computers, playgrounds, school bus and so forth for equality of student participation in education.

The school head teachers should employ some of the parents in school as watchmen, cooks, messengers, casual workers, drivers, artisans and so forth to empower them to meet fees obligations.

Allow those parents who are able to make supplies in schools such as maize, beans, firewood, milk and so forth should be asked to participate called upon and be educated by the school management on allow to participate in tendering so as to supply their goods in school to meet fees obligations of their children.

### **Recommendations to the parents and students**

Parents should explore various methods of economic empowerment so as to be able to finance the education of their children to the highest levels. For example parents can get small loans from the banks and associations and invest in business, be deployed some work in school.

Parents should find out the procedures followed to acquire bursary fund for their children, from constituency development fund. Parents should consult the location chief for guidance on how to get bursary funds for the education of their children in case of need. This is because the chief is one of the committee members for bursary awards

Students could also be involved in income generating projects to in schools through c organisations such as cubs to subsidise school fees. For example student can be involved in poultry and pig keeping raising money. Students can also raise money for infrastructure construction through” school facility walks”.

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## **E2012-17: Education as a Tool for Enhancing Social Adjustment for Students with Mental Retardation**

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### **Abstract**

Mental retardation is a condition characterized by a combination of deficits in both cognitive functioning and adaptive behavior. The severity of mental retardation is determined by the discrepancy between the individual's capabilities in learning and the expectations of the social environment. While the term mental retardation is widely used in special education, many advocacy groups feel that this label has a negative connotation. The newer label of intellectual disability is becoming more accepted and prevalent within the field of Special education. Special education for learners with mental retardation is an educational program designed to meet the unique needs of students with intellectual disabilities. Traditionally there has been an overemphasis in providing support for learners with mental retardation at the expense of providing individualized instruction to help the students access a challenging and interesting general curriculum. Holding students with disabilities, including those with Mental retardation to the same high expectations as all students, leads to an improvement in the learning and educational outcomes of these students (McGrew & Evans, 2004). This study was designed to investigate how the educational needs for students with mental retardation were met at the Meru school for the Mentally challenged and in particular paid attention to factors other than direct instruction that influenced the education of learners with Mental retardation, teacher's role as a promoter of advocacy and the instructional resources available in the school. The study used a descriptive survey design. Data was collected from 17 teachers and 20 parents were interviewed over the telephone. 80% of the teachers reported that there is a tendency to emphasize traditional instruction and cited challenges such as lack of instructional materials and the severity of mental retardation as the major contributors. The findings may be useful to the planners, policy makers and teacher educators of learners with mental retardation. The study recommends a paradigm shift from education for support to education for development and social adjustment. Exposure to a challenging curriculum will lead to improved learning and educational outcomes for these learners.

### **Introduction**

Mental retardation is a condition of substantial limitations in intellectual functioning that impact on performance in school and daily life. Learners with mental retardation vary depending on the degree of limitations and also on the services and support received. Most people with mental retardation are capable of achieving self sufficiency with proper instruction. Initially, learners with mental retardation suffered greatly prior to the introduction of special education. In the 1800s to the 1960s there was widespread building of institutions to house individuals with mental retardation. During this period individuals with low intelligence were sterilized under the assumption that the population would be improved (Luckasson, 1992). When education for all the handicapped children

act was passed by 1975, and special education was required some students with mild mental retardation attended school. Those with severe mental retardation remained at home. The numbers of students with mental retardation however declined substantially because of the stigma in the label mental retardation. The primary goal of education for this group is to increase self sufficiency by teaching functional academics and other skills needed in everyday life in the community ,workplace and in leisure.

Although the label mental retardation brings services, it also brings stigma and low expectations. This was evidenced by a reduction in students labeled as mentally retarded with a corresponding increase in those with learning disabilities from the 1970s to the 1990s(Kirk,2003).Special Needs Education advocates for learning in the least restrictive environment with appropriate services and support. Educators need to understand better how to teach these students and equip them for transition to adult life.

## **PROBLEM STATEMENT**

Special education for learners with mental retardation is an educational programme designed to meet the unique needs of learners with intellectual disabilities. Traditionally however there has been an overemphasis in providing support for learners with mental retardation at the expense of providing individualized instruction to help the students access a challenging and interesting general curriculum which may lead to an improvement in their learning and educational outcomes .The study was therefore carried out to investigate how the educational needs of these students were met.

### **Purpose of the study**

The purpose of the study was to investigate how the educational needs for students with mental retardation are met. It was aimed at establishing factors other than direct instruction that influenced the education of learners with mental retardation, the role of the teacher and the instructional resources available.

### **Objectives of the study**

1. To determine other factors other than direct instruction that influence education for learners with mental retardation
2. To establish the role of the teacher as a promoter of advocacy for learners with mental retardation
3. To find out the instructional resources available for learners with mental retardation.
4. To recommend teaching strategies for learners with mental retardation

### **Methodology**

The study used a descriptive survey method. Notably surveys are the most common forms of research involving asking large numbers of people questions about particular issues; and are useful in describing exactly what the situation is (parkash, 2009).

The survey design was preferred for this study as it enabled the researcher to reach all the teachers within a very short time using the same questionnaire. Telephone interview was used for the parents since it was the most convenient way that enabled the researcher to get important information. The target population was all the mentally retarded learners in Meru School for the mentally challenged.

### **Data collection instruments**

Questionnaires are the heart of survey researches (orodho, 2005).a researcher designed questionnaire was used to collect information from the respondents. The questionnaire consisted of two sections A and B sections elicited background information while section B of the questionnaire mainly focused on questions that elicited information on factors other than direct instruction such as memory,generalization,interpersonal skills, personal life skills, sexuality among others that affected learning, availability of instructional resources like assistive technology and the role of the teacher in promoting advocacy and establishment of a positive and productive learning environment.

**Procedure for data collection and analysis**

The questionnaires were distributed to the teachers and seventeen (17) teachers responded. Learners could not participate in the study due to such problems as incoherent speech among others. The parents who were purposively sampled were interviewed over the telephone.

Descriptive statistics was used to analyze the data. Frequency counts and a percentage were used and the results of the findings discussed.

**RESULTS AND DISCUSSIONS**

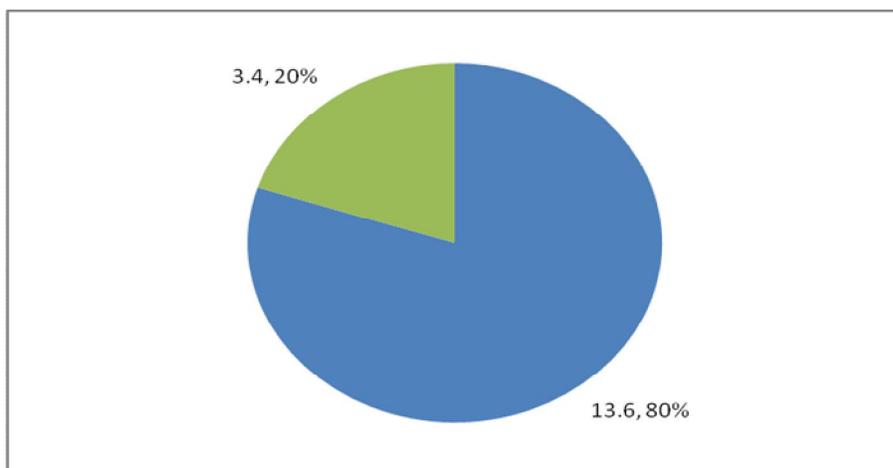
The following table shows the level of qualification of the teachers handling learners with mental retardation in the school.

**Table 1: Level of qualification of the teachers**

<b>LEVEL OF TRAINING</b>	<b>FREQUENCY</b>	<b>PERCENTAGE</b>
<b>Diploma in SNE</b>	17	100
<b>Total</b>	<b>17</b>	<b>100</b>

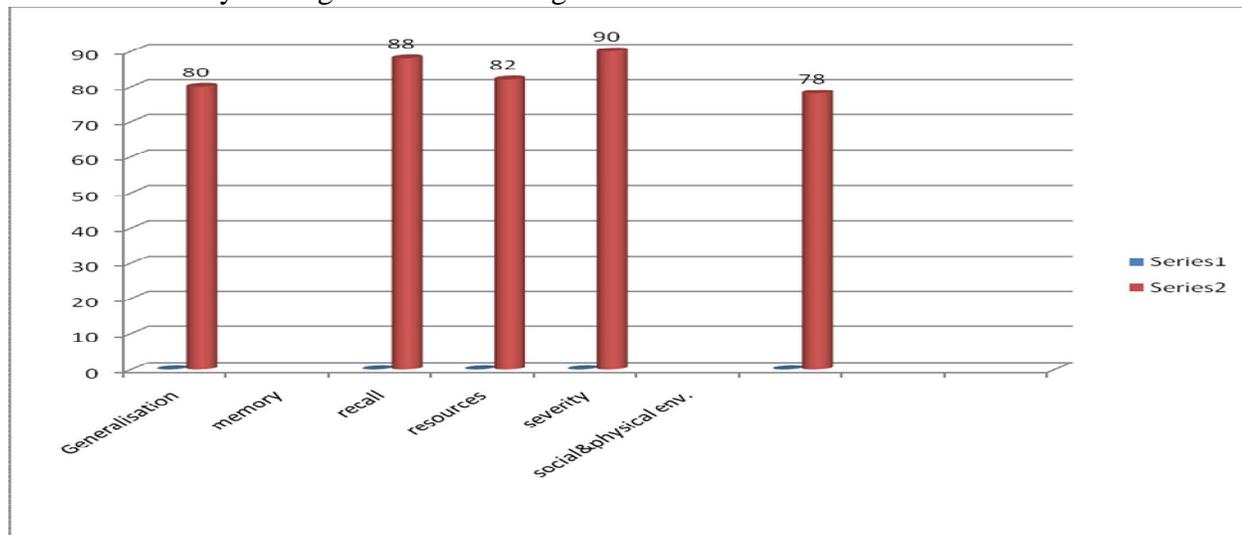
Study findings revealed that all the teachers (100%) had training in Special Needs Education. The teachers had the skills and knowledge on how to teach these learners and equip them with skills for social adjustment in order to be useful members of the society.

Regarding education for support and education for social adjustment and development the teachers gave the following responses. Figure 1 shows the teachers’ responses.



**Figure 1: Teachers’ response on education for support or education for development**

80% of the teachers reported that education for learners with mental retardation is mainly for support while 20% reported that education was for social adjustment and development. According to the teachers, learning for children with mental retardation is hampered by other factors other than direct instruction .the study sought to find out how the teachers rated these factors that hamper instruction. Study findings are shown on figure 2.



**Figure2: Factors other than direct instruction affecting learning for the MR**

Figure 2 shows the rating of the teachers of the other factors affecting the education for learners with mental retardation.90% Of the teachers said that the severity of the mental retardation greatly affected the rate at which the learner learnt. Individuals with mental retardation differed in the range of severity of the mental handicap. The educable mentally retarded have an ability to master numeracy and literacy skills as well as adjust well to the community setting and become economically useful. The moderately mentally retarded have the ability to acquire some literacy and numeracy skills as well as adjust to the home. They can also muster some economic usefulness. However the severely mentally retarded are only able to master activities of daily living like eating, toileting and dressing. In cases where the mental retardation is so severe, the child requires twenty-four hour surveillance as they may not be able to master activities of daily living.

88% of the teachers reported that most of the learners had problems with memory while 82% reported that the learners had problems with recalling. Recall is when a learner is required to reproduce material learnt earlier. Learners with mental retardation are unable to reproduce learnt material even with external cues. According to Thungu(2008) Memory is the mental capacity to store and later recall or recognize events that were earlier experienced. Teachers reported that learners had problems remembering earlier events.

82% of the teachers reported that learning resources were available and that they were mostly provided through donations. These included toys, balloons to enhance speech, blocks for pre-number activities, beads to make necklace for eye-hand coordination, skipping ropes for eye-hand coordination and books .play is very important for this category of learners. The study established that there were swings, slides and balances to stimulate physical growth. The study further established that there were chairs for toilet training provided in the classrooms.

78% of the teachers reported that the physical and social environment was conducive for the learners. There was in place a perimeter wall and security in and out of school was tight with a

watchman at the gate throughout. There were cleaners to keep the environment clean and in the classes to support learners who had not mastered toileting.

### **Role of the teachers in advocacy**

Teachers promoted advocacy by offering guidance and counseling to parents in order to empower them to become advocates for their children. Counseling was done both for adjustment and for information. Adjustment counseling helped the parents to accept the child with the mental retardation while information counseling helped the parents to access any information that could be helpful to their children. Teachers also promoted advocacy through advocating for the children's families and for educational change. Teachers responded promptly in cases of neglect, physical and or sexual abuse. Although the school environment was safe, teachers reported that some children were sexually or physically abused during school holidays in which case they called parents and talked to them.

### **Recommendations**

Arising from the discussions above, this study recommends a shift from the traditional education for the mentally retarded for support to education for social adjustment and development by ensuring the following:

Learners with disabilities have a variety of different needs. The instructions of children with mental retardation require certain enhancement strategies. The severity of the mental retardation, and the individual personality traits come into play when discovering the best way to teach a child.

Learners with mental retardation need content that is broken down into simple and easier to manage steps. This serves to keep the frustration levels down as well as enabling learning to take place. Providing concrete learning experiences for these learners helps them to understand new ideas in a physical hands-on approach. The hands-on experience may include such aspects like providing manipulative when teaching maths, taking field trips for instance to the grocery store or to the post office for a meaningful experience for the mentally retarded learners. Immediate and positive feedback encourages the learner to keep on trying. Teachers need to constantly reward or applaud a learner immediately if he/she masters a concept or meets a goal.

Music for learners with mental retardation is a wonderful motivator. Teaching a simple catchy song to go along with a concept is a fun way to engage the learners and to help them remember the information.

### **Conclusions**

Education for learners with special needs is an important programme that ensures children with special needs exploit their potential to the fullest. Every possible mechanism should be put in place to ensure that these learners are not just kept in schools for support services but rather adaptations should be put in place to ensure that they learn and become useful members of the society.

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### **E2012-18: Cross-Border Cooperation in East Africa: Building Capacity among University Academic Staff**

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#### **Abstract**

Cross-border cooperation in East Africa dates back during colonial time and soon after member countries attain its independence in 1960's, new Permanent Tripartite Commission formed in 1967 but collapsed in 1977, due to political differences, consequently, East Africa Community (EAC) revived in 1999, currently, with five member states and possibility of new members to come on board, despite the bloc's members educational opportunities, intra-regional staff/research exchange in East Africa still reflects a dominant North-South global staff/research exchange. The creation of EAC renewed interest and possibility of regional capacity building cooperation, as a tool to its economic development. This paper investigates on how EAC's universities can utilize training and research opportunities available within the region to build their universities academic staff capacities. Enhanced academic staff capacity will provide the region and universities in particular with a pool of well trained experts for effective participation in teaching, research and community services which will enable universities to meaningfully achieve its core functions and regional economic development as a whole. This study recommends creation of centres of excellence within the region to enable academic staff and students to share research findings and best practices in different academic disciplines.

Key words: *Cross border, higher education, academic staff, universities, capacity building*

### **E2012-19: Barriers to Sexual and Reproductive Health Education on Students Sexual Behaviour in Secondary Schools in Lugari District Kenya**

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## **Abstract**

Over the recent years, health systems in many countries have recognized the importance of providing students with reproductive health services and education. This has been attributed to early initiation of students into sexual activities, which have resulted in unwanted pregnancy, early marriages, abortion, and sexual transmitted infections. Reproductive health education aimed at changing the sexual behavior of the students. This study seeks to establish barriers to sexual and reproductive health education on students' sexual behaviour in secondary schools in Likuyani division of Lugari district, Kenya. The study utilized a Descriptive survey research design and targeted Form Two students in six selected schools in the study area. Primary data was collected using two questionnaires, one for students and another for teachers from a random sample of 241 students and 30 teachers. Secondary data was collected from documented information on adolescent reproductive health education. Data collected was analyzed using both Descriptive and inferential statistics with the aid of computer statistical package for social science (SPSS) version 17. The study findings confirm that policy and programmatic gaps exist in addressing the RHE needs of students. This is attributed to, lack of clear guidelines on how to address the RHE of students, challenges of dealing with students RHE in general as well as cultural constraints. The study therefore recommended the need for, clear guidelines on dealing with RHE of students in schools; demystify the cultural beliefs and attitude towards sex and reproductive education that hinder its implementation and providing training and reorientation of RHE providers. The findings of the study will assist all stakeholders, who include Ministry of education, health and the general public in appreciating the value of reproductive health education, in changing student's sexual behavior.

## **Barriers to Reproductive Education and Services**

Students reproductive needs are many, but so are the obstacles they face in trying to maintain good reproductive health. The public negative attitude towards reproductive health education constrains open discussion about it and therefore creates barriers that may inhibit or prevent students from receiving accurate, unbiased and complete information. (Schueller & Barnet 2000). Moreover, for those who are young and are sexually active, negative social norms and attitudes concerning what age one should access the services hinders access to the services, thereby increasing the risk of unwanted pregnancy and infection including HIV/AIDs. In many countries, Kenya included, services and information to students is very sensitive. Anytime efforts are made by the government to introduce it in schools, is always met with a lot of resistance and protest from the public.

Deeply held cultural and social beliefs by the public on reproductive health education, makes it hard for the providers to give information to students. Their needs have not received universal recognition and services that are designed to meet their needs lack adequate funding or technical makes support (Senderwitz, 2000). Being a special population, the group requires alternative mechanism of passing knowledge and information, for example separate hours, rooms or clinics

which are lacking. Putting them in the same rooms with adult members of society make them shy away from the services. (PATH, 1998).

Providers also create barrier due to their judgmental attitudes towards students' reproductive life. Providers have set standards of what they accept of the students. How and when they should behave in certain ways. All this create barriers to reproductive health and services. Open discussion on reproductive health education or sex remains a taboo in majority of societies.

On the part of female students, they are reluctant to discuss matters in the belief that their innocent should be protected. Male students on the other hand may remain ignorant and ill prepared because adults assume they already have information on reproductive issues (Youth Net, 1998). To add to these, dominant masculinity ideologies may prevent boys from asking about sex for of appearing ignorant and therefore unmanly. While ideologies on the feminity may make girls fear that their reputation may be at stake when they appear to know too much about their reproduction. This therefore makes them not seek information and services on reproductive health education (WHO, 2002)

Students are also greatly disturbed and affected by a feeling or suspicion that their sensitive and intimate issues will be shared with other persons. Unless they are sure that their right to privacy and confidentiality will be respected, most of them will not come forward. The service providers have to cultivate confidence with the students that no information coming to them in the course of their responsibility will be leaked to any person including the parents (MOH, 2004).

### **RATIONAL OF CURRENT STUDY**

Students in secondary school are in adolescent stage which is a time of transition from childhood to adulthood. It is a period in which significant physical and psychological changes take place, and a time when young people develop many of the habits, behaviours and relationships they carry into adult lives. While these changes occur at the level of each individual, students in secondary schools who are in adolescent make up a large proportion of Kenya's population. Currently, adolescents (10-19) comprise about one-quarter of the population. The government thus faces the crucial task of promoting healthy behaviour, preventing disease and enabling a healthy transition to adulthood for entire student population. This can be achieved through provision of reproductive health education. The government therefore has to deal with challenges that face its implementation, in order to realize its results.

### **Objectives of the current study**

**The following objectives guided the study**

- i. To determine the differences in the level of awareness of reproductive health education between boys and girls in secondary schools.
- ii. To establish factors that hinders the effectiveness of reproductive health education and services among secondary school students.

### **Research questions**

- i. Is there any difference in the level of awareness of reproductive health education between boys and girls?
- ii. What factors hinder the effectiveness of reproductive health education and services among secondary school students?

### **Hypothesis of the study**

Ho<sub>1</sub> There is no significant differences in the level of awareness of reproductive health education between boys and girls

### **Ethical Issues**

- (i) Completing the survey was voluntary and students were assured of confidentiality
- (ii) Students had an option of answering the questions or not
- (iii) The researcher obtained a letter from Egerton university, which was used to get research authorization and clearance from the district education office in Lugari District

### **Methodology**

#### **Study Design**

The study was cross-sectional descriptive survey that focused on barriers to reproductive health education in secondary schools in both private and public secondary schools in Likuyani Division.

#### **Study Location**

The study was carried out in Likuyani Division of Lugari district, Kenya. Lugari district has 30 secondary schools. Lukuyani Division has 13 secondary schools.

#### **Participants**

A total of 1312 form two students in 13 secondary schools in the division` formed the accessible population. Six sampled schools with a population of 650 took part in the study. Multi-stage,

proportionate to size, stratified and simple random sampling method was used to select the participating schools, students and teachers.

### Data Collection and Statistical Analysis

Two questionnaires, one for teachers and the students were used to collect data. Level of awareness on reproductive health education was measured by asking students on their knowledge on reproductive issues. Barriers to RHE was measured through asking students questions on challenges they encounter in accessing information and services on RHE

## RESULTS

### Gender Difference in the Level of Awareness of Reproduction Health Education

The first objective of the study sought to determine whether there is any gender difference in the level of awareness about reproductive health education in secondary schools in the study area. Accompanying this objective was the null hypothesis, which stated that there is no significant difference in the level of awareness of reproduction health education between boys and girl students. Two statistical analyses were used to test this hypothesis and included independent sample t-test and Chi square. Table 1 summarizes the output of the t-test.

Table 1: T-Test Analyses on the Level of Awareness of Boys and Girls

<i>Variable (gender)</i>	<i>N</i>	<i>Awareness</i>	<i>Mean</i>	<i>T</i>	<i>P value</i>
Boys	123	68.24	-0.55	-0.605	0.546
Girls	118	68.79			

Since  $p > 0.05$ , we do not reject the null hypothesis stated that there is no significant difference in the level of awareness of reproduction health education between boys and girls students. It can therefore be concluded that there is no significant difference in the level of awareness on reproductive health education between boys and girls in secondary schools. This suggests that both boys and girls are facing the same kind of schooling environment, adolescent stage and source of information about reproductive health issues.

The above results using independent sample T-test are also supported by chi square test using cross tabulation. Table 2 shows across tabulation of the level of awareness by gender of the students.

Table 2: Level of Awareness about Reproductive Health Education by Gender.

	<i>Gender</i>		<i>Total</i>
	Boys	Girls	

<i>Level of awareness</i>	Moderate	95 77.2%	86 72.9%	181 75.1%
	High	28 22.8%	32 27.1%	60 24.9%
Total		123	118	241

From table 2 it can be observed that there is almost same pattern of distribution of boys and girls in the two levels of awareness about reproductive health education with majority (77 and 73 percent, respectively) of them falling in the moderate awareness category in almost equal Proportions. These suggest that it is unlikely for there to be difference in the level of awareness about reproductive health education between boys and girls in a school. This is further supported by the chi-square value, which suggests that there is no significant difference in the level of awareness about reproductive health education between boys and girls in a school. This could be attributed to the same kind of schooling environment, adolescent stage and source of information about reproductive issues that both students are facing.

**Factors that Hinder Effective Reproductive Health Education and Services among students.**

Objectives two of these studies sought to establish the factors that hinder effective reproductive health education and services in secondary schools in Likuyani division. The student’s sample respondents cited a number of key factors that hinder them from accessing reproductive health education and services in secondary schools in the study area. Table 4 shows a summary of these factors.

**Table 3:** Factors That Hinder Effective Reproductive Health Education and Services.

Factors	Response (percent)	
	Yes	No
Fear of being seen in the clinic	54.4	45.6
Staff asking many questions	50.2	49.8
Time consuming	43.6	56.4
Lack of confidentiality	37.3	62.7
Services are far away	36.5	63.5
The services are expensive	36.1	63.1
Judgmental staff	33.6	66.4
Services meant for adult and married people only	33.2	66.8
Going for the services portray one as promiscuous	32.4	67.6

N=241

Data in Table 4 can be categorized as fear to be seen in the clinic, attitude of the staff, and accessibility. 54 percent of the respondents reported that they fear going to the clinic because the

services are meant for adult and married people only; might meet older people there, and it portrays one as promiscuous. This fear emanates from the cultural influence whereby adolescent have been made to believe that matters concerning with reproduction are a preserve of the adults and married people only. Society also has a belief that when adolescent are given reproductive health education they become promiscuous, (PATH, 2001). Various study done indicate that when students get accurate information on reproductive health education they can be able to make responsible decision on their sexuality. Information does not encourage sexual activities.

For those who have managed to go to the clinics, the attitude of the staff does not encourage one to freely and openly get the required services. The staffs are too inquisitive, unfriendly, and judgmental, and cannot be trusted with such sensitive information. The staffs also assume that no adolescent can just go to the clinic for advice only and therefore they do not really trust and serve them effectively.

Lastly, respondents reported that there is lack of accessibility (physically and financial) to these services. Some of the clinics are located far away from the schools or homes and one has to spend a lot of time in order to get there, for those clinics that can be easily located the services are not offered free. This is an expense that most adolescents are not ready and able to meet.

Teacher respondents, on the other hand, reiterated the same factors and enumerated a number of key challenges facing students in accessing reproductive health education and services in secondary schools in the study area. 20 summarize these challenges.

**Table 4:** Challenges in Accessing Reproductive Health Education and Services

Challenges	Frequency	Percent
Cultural factors	8	27.6
Lack of resource center and reference Materials	4	13.8
Peer pressure	7	24.1
Lack of role models	3	10.3
Limited time allocated for the services	4	13.8
Fear of victimization	3	10.3
Total	29	100.0

From table 4, the cultural background of both the teacher who is supposed to provide this knowledge and the student to receive it impedes free and open access to reproductive health education and services. Some of the teachers and students believe that matters relating to sex are sacred and not supposed to be spoken in the open, especially between people of different age groups. To be effective in communicating information teachers should reflect upon their attitude,

feelings, beliefs, experience and behaviour regarding reproductive health education (Barnnet & Schueller, 1997) peer pressure limits access to accurate information as one attempt to copy what his/her peers are doing and be part of them. Many peers lack factual knowledge and instead believe in actual experimentation as the best way to learn. Other students fear to openly and freely seek for this information thinking they will be victimized by the teachers (providers) as having loose morals and involved irresponsible sexual behaviour.

Most schools, the researcher visited lacked the necessary resource centre and reference materials that can assist students get in-depth understanding of issues surrounding their reproductive health. In other schools, the providers are not good role models or people of integrity to effectively disseminate this information. This includes those teachers who at times involve themselves in irresponsible sexual behaviour with students. Such teachers cannot therefore convince students on the importance of good sexual behaviour. There is also the problem of limited or lack of specific time allocation for the programme on school timetable and instead it is carried out as part of the normal school curriculum included in various subjects and topics for the sake of examinations. This denies the subject appropriate time and seriousness it deserves.

### **Conclusion**

A large proportion (78 percent) of the student respondents reported that they have never talked to someone about family planning issues. This could attribute to cultural factors and social beliefs that recognize students as still very young and are not supposed to engage in sexual activities

Over half of the respondents fear going to the health clinic because the services are assumed to be meant for adult and married people only, might meet older people there and it portrays one as promiscuous.

### **Recommendations.**

- (i) Open communication through mass media at a more personal level helps remove the taboo from discussing adolescent sexuality and also can provide information, redefine social norms, and change attitude and behaviour
- (ii) Accurate and understandable information can defuse conflict and mobilize support for programs by demonstrating the magnitude of students reproductive health problems.

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**E2012-20: A Study of the Effects of Home – Based Lunch Provision on Child Retention in Primary Schools in Mbita District, Kenya**

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**Abstract**

Child retention rates in the Public Primary Schools in Mbita District has dropped to 70%. The 30% attrition rate is quite a concern among the Education officials and the community in the district. The purpose of this study therefore is to establish the effects of Home – Based lunch provision on child retention in the public primary schools. To achieve this, the study is focused on determining the problems, effects and intervention measures to curb the declining child retention rates in the primary schools in Mbita District. The study adopts a descriptive technique and utilizes a combination of Stratified Random Sampling and Precision rate and Confidence level derivative  $n = z^2 \cdot P \cdot q / N / e^2 (N-1) + z^2 \cdot p \cdot q$  to define the study sample size of 42 schools from a target population of 98 public primary schools. The data is collected using closed ended questionnaires and interview schedules sent to Head Teachers, Class Teachers and Class Prefects to standard six class. Two post graduate research assistants have volunteered to assist in the distribution, interviewing, collection and editing of the responses. Data analysis involve descriptive statistics done using the Statistical Package for Social Sciences (SPSS) computer programme. The study findings will be presented using tables, frequencies, percentages and charts.

**E2012-22: The Plight of The Kenyan Male: Searching for a Pedagogy that is Relevant to the Nature of the African Male Child**

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**Abstract**

The plight of Kenyan men is a major social concern that needs urgent attention. This paper does not address deeper social issues with regard to the status of men in the Kenyan society, but rather attempts to describe what is happening to men in respect to their social roles and responsibilities, and how their female counterparts are reacting. In this paper the researcher diverts blame from the males, and puts responsibility on the education system which through its feminine characteristics has socialized the males into a state of role conflict and ambiguity. Attention is drawn to the contradictions between the nature of the males, the cultural expectations and the characteristics of the Kenyan education system- specifically the school setting, the curriculum, classroom environment, expectations in terms of behavior and rules. A new pedagogy, inclusion, which considers the nature of the male child, social-cultural expectations, and the changing roles of the male in the society, is proposed. This pedagogy embraces the concept of inclusion, critical and constructivist theories. Implications for curriculum planners, education policy makers, teachers and

social workers are also discussed. The paper stresses the importance of understanding the nature of the male child, societal expectations versus the globalizing culture in male socialization. In this context educators must particularly respond to the question “Why do the Kenyan males fail to take up their roles and responsibilities as expected?” This question is asked to challenge the role of the school as a social agent, and arouse educators to get on board with the researcher on a marathon search for a new pedagogy that will resolve the issues of the male child.

**Key words:** *Male-child, education, African men, socialization, culture, constructivism, critical-theory, pedagogy, inclusion.*

### **Introduction**

Over several decades gender activist have focused on women, particularly in Africa. In many minds today, the word gender is synonymous with female not the males. Most governments have declared affirmative actions in favor of women, with the assumption that the males are still in very dominant positions socially, economically and politically. Now that there are alarms about the men of the society failing to fend for their families, could it be that there has been an over emphasis on women empowerment and the pendulum have swung so hard against the man? Could we have feminized important institutions of socialization like the school such that the male child instead of repose is entangled in deep confusion? Could we also be oblivious of the waves of globalization contributing to the evolving gender roles? These questions are addressed in this paper. Particularly, educators are persuaded to address the Kenyan male problem by adopting the pedagogy of inclusion. Its merger with critical pedagogy and principles of constructivism makes it a most viable method in finding solutions for the problem of males in the 21<sup>st</sup> century African society.

### **What is happening to the Kenyan Men?**

As the year 2012 was ushered in, the pendulum had swung so hard against the Kenyan men, especially in the central province. One rhetoric question that hung in the country’s tropical air was “What is happening to the Kenyan men?” Through out the early months of the year up to June, media headlines flashed multiple incidences of wives battering their husbands for what they termed as “neglect of domestic roles and responsibilities”. The climax of this male crisis was heard from the voice of BBC’s Network Africa program on 20th February, 2012 when the leader of a Kenyan men’s lobby group called for a six-day food boycott to highlight what he said was increasing domestic violence against men. The organization termed as “Maendeleo ya Wanaume”- Kiswahili phrase translated as “development of men”, called upon men to refuse eating meals cooked at home by their wives and partners as a move to protest against the emotional abuse by women. The move

that was deemed as an opportunity to sensitize men, and have them share their experiences of emotional and physical abuse fueled more violence than was expected.

Three months later media floated satirical comments on men by women. A typical one was Genga's (2012) article in the Standard news paper entitled "Kenyan men and their annoying habits". In this article women criticize men for selective hearing and memory, being the villager and mamas' boy and co-dependence on the "Boyz"- hanging out with peers and relying on their opinions to make major decisions. The question is, why should the 21<sup>st</sup> century Kenyan male go through such humiliation?-the kind that has sent a wave of shock the world over. Say he deserves this because he has absconded from his responsibilities, but what has happened to the social institutions that are mandated with responsibility of ensuring proper socialization of individuals into their expected roles, especially the family and the school? In order to address this question there is need for a deeper understanding of the contradictions that seem to exist between the biological nature and the societal expectations of males in Kenya and Africa in general, and the feminine characteristics of the Kenyan Schools.

### **The Biological Nature and Societal Expectations of the African Males in Kenya**

Biologically men are physically stronger, and engage in more active roles than women. The African male child is, especially, expected to be active, brave, adventuresome, curious, dirty, robust, disheveled and rough. Under normal circumstances socialization into these characteristics begins at the cradle, and is evident in the way the mother handles the male child. It is common for her to let her baby boy cry a little longer, than she would do to her baby girl, before his needs are met so that he gets hardened. Unlike the girls young boys are let to engage in rough play so that they become tough and brave. As they get weaned from the mother's care, traditionally they are socialized by their fathers and peers into male roles and responsibilities. Beyond the African culture Kail and Cavanaugh (2009) observe that fathers are most likely than mothers to treat boys and girls differently. For example, they encourage gender related play and are more likely to urge a frightened son to jump off the diving board ("Be a man") p. 198, but not insist on the daughter to do so.

As mentioned by Tyrell and Jurgens (1983) the African boys learnt special skills from their "father's Knees". Peers also played an important role, in the book "Not Yet Uhuru", Jaramogi Oginga Odinga (1967) ( father of the prime minister of Kenya now) reminisces about the lessons he learnt from his peers in the boy's cottage (simba); lessons which groomed him into manhood. This

close nurturing by peers and fathers was to ensure that the young boy was properly initiated into his future roles which include providing for the family in terms of protection, food, shelter and other basic needs. In most cases learning by practical involvement reached a climax during initiation. There are various initiation rites by different African societies in Kenya. The Bantus mainly circumcise the males at adolescence. The Luo and Kalenjin remove the lower teeth (incisors), while other communities such as the Turkana tattoo their bodies. Tolerance of the pain experienced during initiation is used to gauge male attributes of endurance and valor. At the same time the initiates engaged in practical experiences like hunting to learn survival skills and prepare for various social institutions upon their graduation from the initiation schools (Ayisi, 1997).

As the boys get weaned from their mothers' laps and handed over to their fathers for masculine training, the girls continue to be nurtured and trained by their mothers, grandmothers and aunties. Feminine characteristics such as neatness, cleanliness, orderliness, quietness, obedience, gentility, humility and sensitivity are instilled. Traditionally, the girls engaged in learning pottery, basket weaving, firewood gathering, food preparation and child care. As long as this type of socialization was maintained in the African society, the social grid remained intact, with every member of the society fitting into their appropriate roles and reciprocating whenever possible. Unfortunately the social grid is now falling apart!

The phenomenon of globalization has caused cultural lag in family socialization, especially of the male child. The whole world has been invited into our homes through the internet and the TV screens, which are now replacing parents as socializing agents. What the African traditions portray as attributes of maleness is in sharp contrast with media portrayals of extreme femininity in terms of dress, grooming, and roles. Whenever masculinity is emphasized it carries with it chauvinistic overtones. Cases of homosexuality and unisex have also created a mix in understanding boundaries of socialization in terms of maleness. Another dimension of globalization that is affecting socialization of the male is new demands of the job market; parents work longer hours and are therefore absent from home. The fathers are particularly gone away from home for longer hours. In this case the boys stay longer with the mothers, if they happen to be home, and are bound to be more feminine if not totally confused (Kail & Cavanaugh, 2009).

### **The Feminine nature of the Kenyan Schools contradicts the Biological Nature and Societal Expectations of the Male Child**

In the book *Reading Rights for Boys* Austin, Clark and Fitchett (1971) warns about the feminine nature of the school system that contradicts the male nature. After working with hundreds of teachers the three researchers observe that the masculine virtues stand diametrically opposite those viewed as desirable in a typical school system. They argue that “standards of conduct, restricted environments for learning, staffing, academic and social expectations, and the physical setting for the school are all substantially feminine, with little regard to the male culture presented within the social structure outside of schools”(p. 1). Terms such as “quiet”, “orderly”, and obedience that are used to describe a well- functioning school system are directly in contrast to the societal expectations of the male child. The Western form of education- that gives a foundation to the modern Kenyan education stresses more on intellectual development as opposed to the needs, goals and expectations of the African society (Clarke, Bray & Stephens, 1986; Wane, 2009). Having been a colonial tool for imperialism this type of education is likely to be more enslaving than liberating (Bogonko, 1992).

The very pattern of uniform, dresses for girls and shorts/trousers for boys, at school reveal contradiction of conduct expected of the boys – why sit so quietly as though in a dress? The shorts/trousers spell more freedom to be active and be the boy that the society so desires; yet doing so defies the schools’ expectations. In addition, the masculine conversations that are used to socialize the boy from home and the exploration traits developed among boys outside school are inconsistent with the formal structure of the school learning environment (Austin, Clark and Fitchett, 1971). Kenya, like other countries in Africa is still influenced by the colonial models of the school and will by no means reinforce much of the traditional African views about expectations of the African male child. Bray, Clarke and Stephens (1986) in the book *Education and Society in Africa* gives a typical example of the impact of such schooling on the African male child outlook - when he quotes what Kofi Busia , the prime minister of Ghana between 1969-1972 , confessed about his experience in the following words;

At the end of my first year at the secondary school I went home to Wenchi for the Christmas vacation. I had not been home for four years, and on that visit, I became painfully aware of my isolation. I understood our community far less than boys my own age who had never been to school. I felt I did not belong to it as much as they did. It was a traumatic experience (p. 29).

This quotation reveals the divisible effects of the Western education that cuts deeper into the social fabric of the African male personality. As way back as two decades ago Bray, Clarke and Stephens had sensed that this divisible effect was not only going to be an educational problem, but an extended economic problem that would come with a whole set of contradictory values. The trio point out that traditional economy and modern economy have distinct opposite values, and since education has set preference for the modern economy, the educated “individuals sometimes consciously reject the values of society they hope to leave behind” p. 30. Implying that the educated African men are more likely to abandon their traditional role and identity expectations, and embrace the new values prescribed by the new economy. The contemporary term in Kenya “the Metro man” (one who over-grooms himself with cosmetics) is used to describe this ambiguity.

From African perspectives this is a case of social dislocation. “Social dislocation is particularly acute when individuals have not succeeded in crossing the bridge” (p. 30) from the traditional economy to the modern economy, and when they are unemployed (Bray, Clarke and Stephens, 1986). Recent research has not only indicated high rate of unemployment among Kenyans, but a failure of the educational system to create a bridge that should have enabled a smooth transitioning from the traditional economy, through industrial to post industrial economy (Amimo, 2012). As predicted by Bray, Clarke and Stephens I can see a situation where the majority of the Kenyan adult males seem to be confused about /or are abandoning the traditional values that expect them to be the providers and opting for the modern economy values that suggest equal participation with the female partners. Hence, a case of “social dislocation”, that is likely to result into “role conflict” and “role ambiguity” between couples.

According (Austin, Clark and Fitchett, 1971) the school has become the agent of social dislocation for the males, since its feminine set up distorts and contradicts the biological nature and societal and expectations on male behavior and roles. Once the males experience conflicting expectations they are more likely to experience role ambiguity, as they get confused about their duties and responsibilities in the family and society. No wonder the Kenyan males, especially from Central province, are allegedly accused of abandoning their responsibilities. Carloni, (1987) and Chesaina (2012) support this argument by a claim that Kenyan women who form slightly over half of the country’s 35 million people are the tillers of the land; food processing and marketing resource people; and the psychological and physical nurturers of families. In other words, when we talk about the position of Kenyan women in the global village, we are referring to the half of the population on whose shoulders the country stands. Who is to be blamed for this imbalance? Is it

the school? Unlike the indigenous education that focuses more on transmission of attitudes, values, skills, social understanding and customs of the society the modern Western education in Kenya is more intellectual, and pays little attention to the needs, goals, and expectations of the wider society.

Currently the whole schooling process and socialization in Kenya is emphasizing empowerment of the girl child, to the extent that the boy has been forgotten. Girls are promoted and admitted for further education with lower points, are given more scholarships and are generally treated with more understanding than boys. The outcome is empowered women citizen with equal job opportunities and status in society versus frustrated male citizens who are not yet able to comprehend what is happening to their long cherished dominant position in the society. With training emphasis shifted to the girl child how do we expect the boys whose cases are less emphasized to grow up into responsible adult males?

Referring to social rank theory Gilbert, El-Bassel, and Rajah (2001) in their study on intimate partner abuse on African American women- found out that violence is used by the dominant or at times the dominated partner as an acceptable means of bolstering social status. In view of this theory the women in Kenya, having been so sensitized about their abuse and the need to gain their rightful positions in the society seem to use violence on male partners to realize this dream. This notion is further endorsed by Gilbert, McEwan, Bellew, and Mills (2010) research on “the dark side of competition” which reveals that competitive behavior and striving to avoid inferiority can lead to depression, anxiety, stress and self-harm- this last element, harm, can be extended to the competitor. Gilbert (1992, 1993) concludes that primates would display a pattern of involuntary subordinate strategy to yield to competitive behavior. Such submissive behavior includes a crouched posture, screaming, crying, retreating or avoiding eye contact. Perhaps this explains the observed behavior of the man in the central Kenya province.

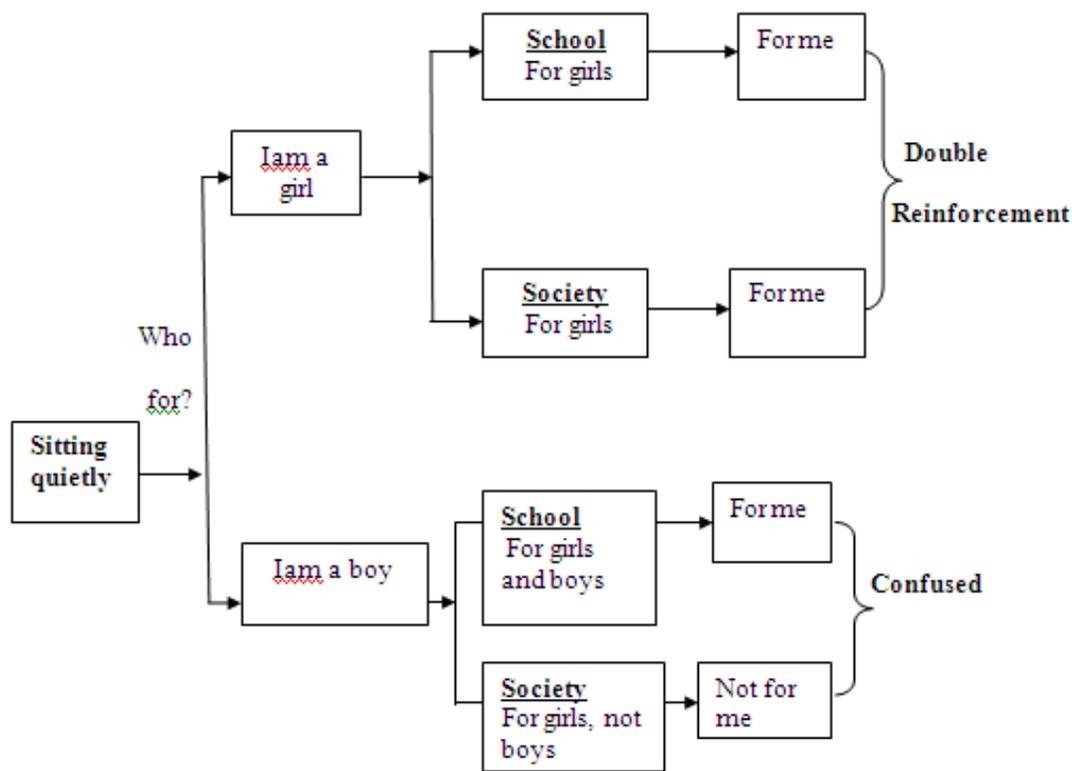
Speaking about education in the African society Bray, Clarke, and Stephens (1986) in the book *Education and Society in Africa*, indicate that the small number of stories in which females are the main character are balanced, with half stressing positive characteristics, and half stressing negative characteristics. But in the case of boys, positive characteristics are portrayed as negative, thus confusing the boy about right behavior. In another international study, the researchers observed that all secondary education is molded on the traditional image of women, thus fitting the female child directly to vocational experience, guidance and training that prepares her for her traditional role as mother, wife, or housewife. On the contrary, boys are prepared for more academic career

oriented education that gets them away from home responsibilities-thus disadvantaging his participation in family.

### **Evolution in Gender Roles**

We are informed by evolutionary developmental psychology that throughout history men and women have performed vastly different roles. While women are more invested in child rearing, men invest more in providing important resources such as food and protection for their offspring. In performing these roles men and women develop different traits and behaviors. For example men become more active and aggressive to ward off predators while women have a disposition for nurturing, sensitivity, care, and gentility (Kail & Cavanaugh, 2009). According to Kolberg (1966) children learn about gender roles after they have come into terms with gender constancy- the fact that gender is fixed across time and situation. In gender-schema theory, children will further decide if an object, activity, or behavior is associated with maleness or femaleness and whether they should learn more about the object, activity or behavior.

The whole process of adopting gender appropriate behavior depends on the socialization process, and this is where the society and school come in (Kail & Cavanaugh, 2009). If the society and school send conflicting messages to the boy (see figure 1), as is the case today, he is likely to be more confused about his roles in the society (even as a future husband and father). From this figure we can see that where as the girl gets a double reinforcement from both the society and the school that sitting quietly is good for the girl, the boy receives conflicting messages- while the schools affirms that sitting quietly is good for both girls and boys, the society says not for boys, thus the boy gets confused as shown in figure 1.



**Figure 1: A Schematic Processing Model depicting Conflicting Messages on Male roles as Portrayed by School and Society**

***Views on Evolving Gender Roles***

Men and women view gender roles differently. While men are satisfied with equitable division of labor based on the amount of time spent, women are often satisfied when men are willing to do women’s traditional chores (Saginak &Saginak, 2005). There are also ethnic differences regarding gender roles. For example, African American men and Latino men tend to spend more time in domestic chores, like washing dishes and cooking, than European American men. However, the participation is more in cases where the couple is in regular employment- even so women still perform the lion’s share of housework. Where as there is a growing change in gender roles in the 21<sup>st</sup> century in all cultures, it is more evident in the American society where some fathers stay home primarily as care givers of children while some mothers take up full time work to support the family.

A research carried out by Weisner and Wilson- Mitchell in 1990 (reported in Kail & Cavanaugh, 2009) indicated that American couples are more adaptive to opposite sex roles, and their own children have fewer sex-typed attitudes- as they tend to enjoy many sex-typed activities- “Boys and girls are equally using... a shovel, a hammer and nails and a needle and thread” p. 201. This is far from the experience of the typical African family, especially in rural Kenya. There are still taboos about women engaging in masculine activities like riding a bicycle (among Luhya and Nandi communities), constructing a house, cutting a tree, eating a hen’s gizzard (Luhya); A Luhya woman is not supposed to whistle, this is compared to having a hen crowing in stead of the cock. Subsequently, having men act as care givers to children or just being present in the kitchen is still an abomination in the African culture. By and large the majority of women globally still want husbands who are sole breadwinners (Hale, 2010).

With the wave of globalization sweeping across Africa, the membrane of the African culture protecting gender roles will not remain impermeable. In the words of Genga (2012);

We need to understand there has been a change in dynamics...a change in the norm of our society. For the longest time, this has been a society where the men were used to being the sole providers, treated like kings, well-educated and their word was the law. Times have changed and enter the breed of Kenyan women who have become well educated, well spoken, well paid and very competent leaders.

While women are struggling to assert their new found independence, men are struggling to understand what happened. According to Genga, the current situation calls for compromise, understanding and adjustment from both parties. Women need to understand that men’s habit of hanging out with the Boyz is a natural trait that begins in early child hood, in form of play, and is a constant throughout the life span (Moller, Hymel, & Rubin, 1992). Further, that their dominating habit is a response to the crucial need for procreation and getting access to resource for offspring- and should not be counteracted by women (Kail & Cavanaugh, 2007). The larger picture of this is accommodation, which spells out inclusion. As a social agent for change, the school needs to take up the challenge of embracing the pedagogy of inclusion to solve this looming crisis in Kenyan society.

## **Inclusion: Embracing a New Pedagogy that Reconciles the Nature of the African Male Child, the Traditional Expectations and the Modern Culture**

In the book *Education at Crossroads* Maritain (1978) long predicted that the most important yet most difficult task is to become a man (in plural) , and “the chief task of education is above all to shape man, or to guide the evolving dynamism through which man forms himself as man” p. 1. This implies that the school has a crucial function to help man deal with the dynamics of the socio-economic and political elements that shape his life. From the foregoing discussion, the looming crisis of the males in Kenyan, seem to be a function of combined socio-economic and political changes resulting from globalization.

The concept of globalization points to a universality of cultures, economies and politics (Roth, & Gur-Ze'ev, 2007); and is best discussed in educational sphere based on the pedagogy of inclusion- more so in this paper, as a way of reconciling the nature of the African male child, the traditional expectations and the modern culture. According to UNESCO (2005) report (Acedo, Ferrer, & Pamies, 2009) inclusion is;

a process of addressing and responding to the diversity of needs of all learners through increasing participation in learning, cultures and communities, and reducing exclusion within and from education. It involves changes and modifications in content, approaches, structures and strategies, with a common vision which covers all children of the appropriate age range and a conviction that it is the responsibility of the regular system to educate all children. Inclusion is concerned with providing appropriate responses to the broad spectrum of learning needs in formal and non-formal educational settings

The key elements of inclusion are the identification and removal of barriers to learning; having ALL students achieve results in attendance, participation, and quality learning; and emphasis of those groups of learners most at risk of exclusion and marginalization- in this case boys. Inclusion goes beyond a simple integration in mainstream education, by embracing concepts of transforming education systems and other learning environments to respond to the diversity of learners. It is a new paradigm that aims at changing the organizational structure of the school system, its culture and practices with a view of spreading its agenda to the entire society (Border, Barnet, & ,Baver, 2010). One major requirement of inclusive education is a broad spectrum pedagogy that is characterized by critical and constructivist models that integrates all students into

the school-not only girls. This type of training propels teachers to adopt a more holistic approach to their work as they work hand in hand with other professional educators such as educational and cognitive psychologists, counselors, school doctors, and social workers.

The ideological concepts of inclusion reside in the capacity for consensus among broad sectors of the population, including teachers, public authorities, families, private entities, socio-economic players such as employers and trade unions; all together involved in the education sector. For this particular case of the Kenyan men, inclusion implies encouraging schools to promote community dialogue that includes establishment of networks of mutual support among families, schools, and other members of the community. The school and social players should share inclusive values in a supportive and stimulating community setting in favor of both sexes (Acedo, Ferrer, & Pamies, 2009).

In particular the school setting, curriculum and pedagogy should embrace both the nature and societal expectations of both sexes. Instead of the dominant teacher centered curriculum characterized by stern and confining rules of quietness and passivity that contradicts the nature of the boys, a new pedagogy that encourage problem solving through critical thinking and construction of ideas should be encouraged to help male students to develop their natural potentials. According to Paulo Freires' "the pedagogy of the oppressed, critical examination of the real life as experienced by the oppressed followed by dialogue on the shortcomings and the expected, creates critical consciousness about the magnitude of the problem and prompts a search for a solution (Giroux, 2010). Using this pedagogy, the case at hand can be best presented in theatre performances and analyzed in debates organized by educational institutions for public deliberations and reflective solutions. Unfortunately, reflective thinking as an art of problem solving is currently very scarce in the Kenyan schools.

This mode of thinking works best when community members, especially families, collaborate and share responsibility with teachers by supporting education-related initiatives. Country wide campaigns should be carried out to find educational solutions, based on Kenyan male potentials—as opposed to their deficiencies. One such attempt was carried out by a Kenyan news reporter who visited Uhuru Park in Nairobi (the capital city) on Father's –day celebrations of 2012. He showed videos of fathers' participating in leisure activities with their families and commended this initiative. That day the FM radio stations in Kenya boomed with the song "dancing with my father again"- a reminiscent of good times one had with a father.

Further success of this new pedagogy will depend on positive depictions of family life in the text books. Specifically there is need for a masculine curriculum with male models, especially in lower primary school. This should include male teachers and aids, male counselors, and male resource visitors. The femininity of the current curriculum should be diluted by male curriculum elements such as activity centers (construction centers, art media centers, writing centers and library reading centers- of course with some adventurous stories); study trips that relate to both male and female functions in society- integrating the findings and experiences with male function and their biological nature (Austin, Clark & Fitchett, 1971).

The manner in which the teacher organizes the classroom should be inviting and not offensive to boys. In other words the organization should not be unnecessarily neat and too precise. While cleanliness is important to all children, precise order is not. Austin, Clark and Fitchett compare this nature of children, especially the boys, to the behavior of women at a store sale- that if items are dumped at a table the women are more attracted to it than when it is ordered; implying that teachers should give room for exploration and discovery in the process of learning.

All together this prescribed pedagogy will contribute to shaping desired male characteristics if parents and community members are fully involved. Social constructivist theory supports this model of learning that involves interaction with others in the society based on shared cultural objects, modeling and scaffolding. Its emphasis is situated learning, metacognition, higher order thinking, real world, learning process, the student, and intrinsic motivation (Cohen, Manion & Morrison, 2006). These are the methods that can be used to model important cultural ideals and expectations to the young male so that when they grow up they wouldn't depart from it.

### **Conclusion**

This paper has articulated circumstances surrounding the plight of the Kenyan male. The fact is, the magnitude of this problem can be greater than what is reported, as most men- because of shame, will not come out publicly to say they have been beaten by their wives. Gilbert (1997), says that victims of harassment usually feels inferior, loss of status, suffer rejection and exclusion- all these feelings result in great shame. Instead of burrowing our heads in a mirage of deception that it is still the woman who suffers more than the man, the society and the school should collaborate to avert the awaiting time bomb of male exclusion from the Kenyan society. In particular, inclusive education should be stressed in schools for it provides a chain of pedagogies (including- critical reflection, modeling, scaffolding, situated learning, metacognition, higher order thinking, real world

experiences, dialogue, and intrinsic motivation ) which correspond to formation of an inclusive democratic society that is based on a broader model of social equity. All factors constant, men have greater potential to contribute to the survival of the society, and must be equally empowered and esteemed!

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## **E2012-23: NEPAD e-School Project: The Kenyan Case**

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### **Abstract**

In July 2001, during the 37<sup>th</sup> summit of the Heads of States the African Union (AU) adopted an integrated social-economic development framework for African renewal called the New Partnership for African Development (NEPAD). The objectives of NEPAD were well linked to the millennium development goals but centered around eradicating poverty levels in Africa, accelerating sustainable development, and halting the marginalization of Africa from the globalization process. These objectives would be achieved through capacity building and improvement of infrastructure in ICT, education, energy, transport and health sectors.

An offshoot from NEPAD was a program known as the "NEPAD e-School Project" which was born and launched in Durban South Africa, at the African Summit of the World Economic Forum, in June 2003. The NEPAD e-school project aims at imparting ICT skills to primary and secondary schools, and harnessing ICT technologies to improve, enrich and expand access to education in Africa. Sixteen (16) countries acceded to the memorandum of understanding of NEPAD peer review mechanism and the pilot phase was launched in Algeria, Burkina Faso, Cameroon, Congo, Egypt, Gabon, Kenya, Lesotho, Mali, Mauritius, Mozambique, Niger, Rwanda, Senegal, South Africa and Uganda. In Kenya, the pilot phase was initiated in six (6) Kenyan secondary schools in the year 2004. During the pilot phase, the program has registered achievement and challenges that

this paper wishes to address. The paper explores and reviews the extent of use of ICT in the classroom, examines and provides data related to access of ICT equipment by students, analyses the competencies of the teaching staff in ICT integration, and describes the environmental acceptability of the NEPAD e-school initiative by the school community. The paper ends by giving its recommendations to individuals and institutions wishing to fund future ICT programs for schools in Kenya and in Africa.

## **BACKGROUND**

### **Introduction**

This study sought to obtain data on the success and challenges facing the NEPAD's e-School project in Mumbi Girls' secondary school in Murang'a District of Central Province, Kenya. The study explored the extent to which the e-learning facilities are being used to facilitate learning during science lessons. The study further sought to find out the extent of teacher preparedness in the use of the e-School facilities in Kenyan Secondary schools. ICT simply means information communication and technology. ICT can be seen to encompass a wide range of technologies including telephone, fax machines, televisions, video, compact disk (CD) players, compact disk read only memory (CDROMs) players, personal organizers, programmable-remote operated toys, as well as computers (Ohara 2004:ix). In the early years of its development, ICT was formally known as Information Technology (IT), and widely revolved around the computer itself. However today, computers form only a component of ICT. While the term ICT was used in this study, the term computer has frequently been used, without suggesting that the wider context of communication and other related equipment are being omitted or overlooked.

Though appearing as a new concept, ICT can be traced back into antiquity, about a hundred thousand (100,000) years ago, when **Homo sapiens** begun using intelligence to meet and further his goals. The first recorded ICT device is the abacus, believed to have been made in the oriental China, around 3,000 B.C. The abacus, a primitive calculating device, was a bead and frame device which was developed for adding large sets of numbers. Although the abacus is credited to the oriental China, the ancient Babylonians are known to have used series of lines on sand and stones on a wood platform to make calculations. The idea of the ancient Babylonians was harnessed by the Chinese to make the abacus, an amazing accurate ancient calculating device that is still popular today (William 1995: A1).

The abacus remained the primary calculating device through the early human history. Two thousand years (2,000) years later, water clocks were made in China, Egypt and Assyria. The records of the works of Plato reveal inclination of the human thought towards the mechanics of machines. At around 415 B.C., Plato founded an academy for the pursuit of science and philosophy, an institution which formed a fertile ground for the development of mathematical theory. The outcomes of the academy was solid geometry, concepts which resulted to production of more elaborate automata during the European renaissance (William 1995).

Since the time of Plato, the world of computing showed tremendous innovations leading to the development of new hardware, software and applications. Computers found specific applications in business, industry, government institutions and amongst wealthy individuals. This exciting technology has also descending onto our learning institutions, where it has found interesting application in school administration, delivery of classroom instructions and pedagogy, and has opened new frontiers of knowledge, such as computer science and computer electronics. More so the school children are today growing up in societies with widespread desire to use technological devices. This positive attitude can be harnessed for an educational advantage (Ohara 2004). With the increased craving for ICT in education, the New Partnership for African Development (NEPAD) vision for e-School was born. The NEPAD e-School initiative aims at imparting ICT skills to young African primary and secondary schools, and harnessing ICT technologies to improve, enrich and expand education in African countries. A body called “the Information Society Partnership for African Development” (ISPAD) was selected as the vehicle for the private sector involvement in the NEPAD e-School initiative. ISPAD would bring together fiscal, human resources, ICT infrastructure, curriculum material for the private sector partners and the civil society, so as to merge them to the Africa e-School initiative. The private partners identified by ISPAD have already initiated pilot projects in sixteen (16) countries that acceded to the memorandum of understanding of the NEPAD African peer review mechanism. ISPAD was mandated to organize and manage the project. The NEPAD e-School project set up its objectives. First, the e-School projects endeavored to provide a hardware infrastructure such as computers, radios, Television set, communication equipment, scanners and copy printers to African schools. For all the equipment, appropriate software was provided. Secondly, the e-School project aims at providing African schools with connectivity to the internet, while providing satellite networking of all schools in the continent. The project also aims at providing ICT training for teachers while

mobilizing the community to be involved and own the e-School ICT project. Lastly, the project focuses its efforts towards proving a health point within the school. The NEPAD e-School project was to be executed in a period of ten (10) years, with secondary schools being completed in the first five (5) years, which was to end in June 2008. Over six hundred thousand (600,000) schools in Africa were set to benefit.

In Kenya, the NEPAD e-School project was launched in the year 2004. The pilot phase is in progress in six (6) Kenyan secondary schools, namely Mumbi Girls in Murang'a District of Central Province, Isiolo Girls, Isiolo District of Eastern Province, Menengai High School in Nakuru District of the Rift valley province, Chavakali High school, Western Province, Wajir High School of the North Eastern province, and Malanda Secondary School in the Coast Province.

### **Statement of the problem**

The NEPAD e-School project is a welcome idea aimed at automating the schools' operation in line with the technological advances taking place globally. The program, which is at its fourth year of the pilot phase, has registered profound achievements. However the project faces challenges and obstacles that needed to be documented and addressed. More so, no study has been done to document the competence and willingness of teachers in utilizing the NEPAD e-School facilities.

### **Objectives of the study**

- a) To document the e-School hardware and software equipment at Mumbi Girls' secondary school, and relate them to access of the e-School technology to teachers and students
- b) To find out the extent to which the e-School facilities are being used for classroom instruction during science lessons
- c) To find out the extent to which the science teachers are trained to handle the e-School facilities

### **Delimitations of the study**

- a. Being a case study, the study was done in one NEPAD e-school only - Mumbi Girls secondary school. The sampling was done with regard to the limitation of time available for the research work and distance between the researcher and other NEPAD e-Schools, However, the findings of this study are expected to reveal the scenario being experienced in other NEPAD e-Schools which were not involved in the study.
- b. A larger sample size, which would be more representative, could not be obtained for the study. The sample size was by virtue limited to the number of science teachers that Mumbi Girls' secondary school has.

c. The study school was selected for the fact that it is under the NEPAD e-School program.

Other schools under different ICT programs were not involved in the study

## **REVIEW OF RELATED LITERATURE**

### **Theoretical framework**

The use of ICT in school teaching and learning process is based on the principle that linkage between content and methodology is crucial in determining the teaching-learning outcome (Tony 1992:1). What is being learned and how it is being delivered holds a special importance for the learner. The use of ICT resources allow the involvement of the self: - body, thought, feelings and action, not just the mind. Thus the learner and the teacher are engaged as a whole person. In the use of ICT resources, the learner is regarded as an active rather than passive participant. In this process, the focus of control is shifted away from the teacher in the direction of the learner. The teacher facilitates the active learning process, resulting to desirable learning outcome.

### **Conceptual framework**

The use of ICT resources to facilitate teaching and learning process is highly justifiable. ICT in the strict sense is a fairly recent innovation, so by and large, in the traditional classroom, teaching and learning was facilitated by other resources and not ICT. The outcome of the traditional classroom was pointed towards two expectations, desirable outcomes or undesirable outcomes. The extent to which desirable learning outcomes can be obtained is crucial in any teaching learning process. The use of ICT resources opens up new methodologies of instruction, which can make the learning of sciences more interesting and exciting. If the ICT resources are utilized effectively by the teacher and the learner, better indicators of the learning outcome would be obtained.

### **Argument for ICT resources in schools**

Since the emergence of microcomputers in the late 1970's, developed countries have embarked on ambitious projects to introduce the technology into schools. On 12<sup>th</sup> April 1989, UNESCO organized a congress in Paris, covering the application of computers in education. The aim of the congress was to recommend how computers can best be used in education. The congress observed that computers can be used "to develop ...the education system, educational progress, and the education process" (Njine G.C. 1989:5). According to the congress, the use of ICT in the teaching process would help the teachers and students to appreciate their capabilities and to demystify the mystery with which it is sometimes associated with. Jonathan (1986), Makau (1989) and Njine (1989), provide us with argument for the role of ICT resources in the school environment.

First, ICT can be used as a catalyst to initiate changes in teacher pedagogical perceptions and practices. The integration of ICT in school learning has been argued to be an ideal way of improving or even reforming the traditional curriculum process and pedagogy. On this issue, Makau (1989: X) suggested that

“The computer is capable of transforming the teaching-learning transaction from being dull teacher-dominated activity, geared to dishing factual knowledge, to an exciting learner centered process which nurtures confidence, initiative and mental skills”

Makau (Ibid) further amplifies the sentiments of (Njine1985) by saying that the multimedia capabilities of the new technologies open a new pedagogical paradigm

“ the irreversible move from teaching to learning (sometimes called the new paradigm) calls for production and distribution of educational (computer) packages which are multimedia, and more interactive about various subject matter, must replace the more traditional educational methods and render learning easier and more pleasant”

Secondly, the effective use of the ICT technologies offers new ways in which the quality, effectiveness and flexibility of education can be improved. On this vein, the new technologies in the secondary schools can have various impacts: ICT can be used as a tool that can enhance the teaching of school subjects, especially mathematics and sciences. ICT resources can be used in the teaching of informatics, popularly known as computer science at secondary schools. ICT can further be an effective mode of delivery of distant education through the e-learning concept. Again, ICT resources can help in the automation of the management and administrative processes such as timetabling, administration of exams, duty allocation to teaching staff and support personnel, and can provide a very effective tool for financial monitoring and control. Lastly, ICT can provide fast means of communication for staff and students, while providing effective tool for doing business with suppliers, examiners, career trainers, colleges and policy makers in the ministry headquarters (Jonathan: 1986). Thirdly, a very crucial role of ICT technologies is that it has opened some new bodies of knowledge. Of particular interest is in the area of informatics, otherwise known as computer science (Jonathan: 1986)

### **Integration of ICT in science learning**

ICT assumes deep and strong presence in nearly all daily human experiences. ICT contain the necessary ingredients to push the change that the society needs. The school provides a space where construction of knowledge and social improvements are operated (Gome 2005).

It is this scenery that technologies can be fitted to guarantee that the students takes the best out of the learning experience. To achieve this, the teacher and the student must orient their teaching and learning approach in order to answer the demands of the modern science classroom. This can be achieved by integrating ICT both in learning and teaching experience.

The concept of e-learning therefore emerges. E-learning is the integration of ICT in the learning teaching process, such that teachers and learners use the technology to meet their learning needs. ICT integration is key for countries of the world, and Africa in particular to achieve their set national goals and the millennium development goals (MDGs) (Republic of Kenya: 2006)

The efficient integration of ICT in daily classroom experience revolves around four (4) issues. The first has to do with access of the technology while the other three are outlined below as discussed by Gome (2005): Integration of curricular content, integration of pedagogical approaches and teacher formation with a view of meeting the demands of the new technology. This study will examine these tree issues and how they shape the integration of ICT in Kenyan secondary schools.

### **Teacher competence in the utilization of ICT resources**

This is the information age, and is technology driven, and therefore technology dependent. Any academic qualification devoid of basic ICT skills is perceived to be without a critical component. Universities and teacher training institutions need to take a leading role in promoting ICT education, preparing the student teacher to utilize ICT and in-service practicing teachers to orient their methodologies towards ICT adaptation. Teachers should be sensitized and equipped with skills in ICT so that they can promote and utilize the technology in schools.

In Kenya, literature does not reveal a projected demand for capacities by teachers training colleges and universities to provide teachers for teaching ICT. The Daily Nation observes "... a majority of our Kenyan two hundred and sixty thousand (260,000) teachers are not ICT capable, and there is no program to train them in the subject." (Aduda D. Daily Nation 21<sup>st</sup> February 2000, page 20 column

1&2). Republic of Kenya(1999), emphasized the observations made by Adam(1985) in its report on Totally Integrated Quality Education and Training by saying:

“Although the content of teacher education(in Kenya) is fairly adequate, it is deficient in a number of areas, and would need to be revised with the view of revamping it, and expand it to address recently emerging issues such as computer science, information technology and the recent developments in communication technology”

Agreeing on the importance of teacher’s competence in ICT, Adams (1985) argues that the ICT resources can perform “mundane instructional tasks, and can provide subject matter with a greater intellectual depth”. So without ICT skills, Adams observes that ‘...the teacher is excluded from many experiences and events.’ Commenting on the same, Makau (1988)

“... the computer is capable of transforming the teaching-learning process from being a dull teacher-dominated activity, geared to dishing factual knowledge, to an exciting learner centered process which nurtures confidence, initiative and mental skills. ... educational computer packages, which are multimedia and more interactive about various subject matter, must replace the more traditional education methods and render learning easier and more pleasant.

It is important to realize that in-depth knowledge of ICT and its operation is not necessarily a requisite for using the ICT resources in teaching and training. However a large scale of ICT equipment “require a trained staff to design and support systems while helping potential users who may not be skilled programmers’(Rushby 1984:9). This explains why training of science teachers in ICT utilization would not be an effort in futility. Consequently, this study will try to find out if there are existing programs to train teachers in ICT skills, and perhaps make recommendations based in the finding.

## **DATA ANALYSIS, PRESENTATION AND DISCUSSION**

### **Hardware and software equipment in relation to access**

The study documented the variety if hardware at the Nepad e-school. Table 1 represents the data obtained

**Table 1 A profile of hardware equipment at Mumbi Girls' ICT laboratory**

TYPE	BRAND	QUANTITY	WORKING CONDITION		
			Good	Fair	Salvage
DSTV DECODER	DSTV	1	√		
KEYBOARD, SYSTEM UNIT, MONITOR, MOUSE	MECER	21	√		
WHITE SCREEN	EPSON	1	√		
COMPUTER SERVER	MECER	1	√		
UNINTEUPRED POWER SUPPLY	MECER	1	√		
MODEM	DirecWay	1	√		
SATELITE DISH	AphSAT Kenya	1	√		
PRINTER	XEROX	5	3√		2√
EARPHONES	N/A	21	√		
TELEVISION SET – 29 INCH	SHARP	1	√		
VIDEO RECORS PLAYER	SONNY	1√	√		
COMPUTER PROJECTOR	EPSON	1	√		

All equipment was in good condition, except the copier printer which was grounded. The copier printer had stalled due to a technical fault, yet the ICT champion (the NEPAD e-School project manager in the school) was not mandated by the Xerox Company to carry out repair and maintenance of the printer.

**Table 2: Computer student ratio in Mumbi Girls Sec School**

CLASS	ENROLLMENT	COMPUTER:STUDENT RATIO
Whole school	520	1 : 25
Form 1	135	1 : 7.0
Form 2	135	1 : 7.0
Form 3	18	1.16 : 1
Form 4	15	1.4 : 1

The results in table 4.2 indicate a ratio of 1 computer for every twenty five (25) students in the school. This means that if all students were to access the computers at any one time, twenty five (25) students would be sharing one computer at such a time. These ratios are very high if compared with the international standards of two is to one (2:1) ([www.scott.k12.va.us](http://www.scott.k12.va.us))

This study therefore observes that the facilities are barely enough to provide sufficient access for e-learning resources during a normal science lesson. Secondly, the placement of the ICT resources in one laboratory is greatly limiting access.

**Software.** Software is always bubbled in hardware. Consequently the challenges that face science teachers and students when accessing hardware are by virtue, experienced when handling software. This study documented the following concerning software

**Table 3: Software in the ICT laboratory**

TYPE	BRAND	QUANTITY	VERSION		
			Recent	Fairly recent	Obsolete
aSc-Timetable	Hemmisoft Solutions	Enough		√ 2004	
Microsoft Office	Windows XP Professional	Enough		√ 2003	
Internet explorer	Microsoft	Enough		√ 2003	
Digital Library	Ms Encarta	Enough		√ 2003	
e-School	Oracle	Enough		√ 2002	
<b>Thinkpad.com</b>		enough			
Letts Revisions Series	GCSE mock papers (Physics /Biology)	Enough		√	

Two revelations from the table above are striking. First, there are no home made programs tailored to meet the objectives of the Kenyan secondary school science syllabus. The **Letts series** is a revision program for the General Certificate of Secondary Education, which is a British curriculum. The **Microsoft Encarta** is a digital library program containing topical content in almost all subjects. It is not systematically programmed for use by Kenyan Students. Though the science teachers and students can use these programs, they are faced by the never ending hassle of sieving the material over and over until the desired content is achieved.

Secondly the **HEMMISOST SOLUTIONS**, which has installed time table program- **aSc time table**-, raises a policy question:- within which policy framework do private software developers operate, and how do they infiltrate into the school ICT laboratories?

### Qualifications of the respondents

**Professional and academic qualifications.** The respondents were classified as follows based on their major teaching subject

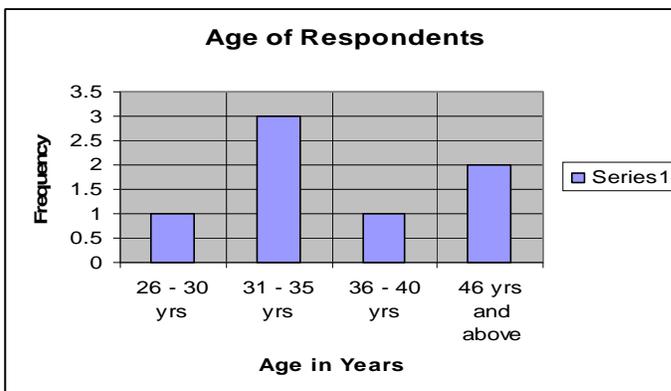
**Table 4 Number of respondents by their major teaching subject**

RESPONDENT	NO OF TEACHERS	PERCENTAGE	CUMMULATIVE
Biology teacher	2	28.6	28.6
Chemistry teacher	3	42.6	71.4
Mathematics	1	14.3	85.7
Computer	1	14.3	100
Total	7	100	

Form this table it is evident that Biology and chemistry was handled by teachers who were qualified to handle the subject. 71.4% of them being specialists in the listed subjects, the teachers were armed with sufficient subject matter during pre-service. The ongoing assumption is that the respondents would spend more of their free time experimenting with newer methodologies (such as ICT integration in the instruction of sciences) rather than acquainting themselves with subject matter.

### Age of respondents

The respondents were asked to indicate their age, highest academic and professional qualifications, and the institutions in which they attended their professional training. Upon data analysis, the information captured is represented below.



**Figure 2** Ages of the Respondents

The majority of the respondents (71.4%) are between age twenty six (26) and forty (40). This age bracket represents a group of individuals who must have attended their pre-service training after 1990, when ICT was taking root. These individuals, due to their orientation towards science would most likely be expected to have taken a keen interest in learning ICT. It is further expected that the same should show high degree of enthusiasm in the use of ICT resources to further their instructional objectives based on exposure to ICT at an earlier age. The respondent beyond the forty (40) year bracket is expected to display the normal resistance to change.

**Academic qualifications of respondents**

With regard to academic and professional qualifications, all the seven (7) (100%) respondents had either a college diploma or a university degree. A college diploma or a university degree is an indicator that the respondents possess highly developed cognitive structures. This information is represented in the table below.

**Table 5** Highest academic and professional qualifications of the respondents

		Number of teachers	Percent	Valid Percent	Cumulative Percent
Valid	College	4	57.1	57.1	57.1
	University	3	42.9	42.9	100.0
	Total	7	100.0	100.0	

The information regarding academic qualifications reveals that the respondents possess dispositions that confer them the flexibility to emerging issues, both in their formal life and in their professional practise. This argument is validated by Makau (1989) who observes

“...education disposes the beneficially to readily adopt to change... hence academic qualifications are a facilitating factors in the implementation” of any educational program”

The expectation is that the respondents would embrace the emerging pedagogical approaches readily.

**The qualifications of teachers in ICT.** The researcher, in finding out the qualifications of the science teachers, further compared the college which the respondents attended and the institution which offered the first training in ICT. The table 6 confirms that all the seven (7) received their pre-service training in respected public teacher training institutions.

**Table 6 Institution respondents received their professional training**

		<b>Number of teachers</b>	<b>Percent</b>	<b>Valid Percent</b>	<b>Cumulative Percent</b>
Valid	Egerton University	2	28.6	28.6	28.6
	Kenyatta University	1	14.3	14.3	42.9
	Laikipia University College	1	14.3	14.3	57.1
	Kenya Science Teachers College	2	28.6	28.6	85.7
	Kagumo Teachers College	1	14.3	14.3	100.0
	Total	7	100.0	100.0	

However, table 7 below exposes that five (5) 71.4% against two (2) (28.6) of the respondents received their first ICT exposure not at their teacher training institutions, but trained in other institutions.

**Table 7 Institution where respondents received their first training in ICT**

	<b>NUMBER OF TEACHERS</b>	<b>PERCENT</b>	<b>VALID PERCENT</b>	<b>CUMULATIVE PERCENT</b>
Mumbi Girls	4	57.1	57.1	57.1
Karatina Comm. Bureau	1	14.3	14.3	71.4
Egerton University	1	14.3	14.3	85.7
Kenya Science Teachers College	1	14.3	14.3	100.0
Total	7	100.0	100.0	

The implication is that the Teacher training programs are devoid of adequate training in ICT. Any training devoid without adequate exposure to ICT is lacking to a larger degree.

#### **Extent of use of ICT resources by science teachers**

The researcher asked the teachers to indicate the frequency with which they use the programs stated in the table to perform various tasks. These tasks were classified as follows: to support classroom use, personal use and for administration. The frequency of use was rated on a daily (D), weekly (W), monthly (M), termly (T) or never (N). Table 4.10 represents the data obtained for the never (N) and daily (D) frequencies and their percentages determined in relation to the totals.

**Table8 Areas of ICT for which the respondents use ICT**

	<b>CLASSROOM USE</b>		<b>PERSONAL USE</b>		<b>ADMINISTRATIVE</b>	
	<b>N</b>	<b>D</b>	<b>N</b>	<b>D</b>	<b>N</b>	<b>T</b>
INTERNET	71.4	28.6	57.1	14.3	100	0
W.W.W.	71.4	14.3	57.1	14.3	85.7	14.3
SATELLITE n. WORKING	85.7	0	71.4	0	100	0
Email	100	0	57.1	14.3	100	0
CDROM	71.4	14.3	85.7	14.3	100	0

FAX	100	0	85.7	0	100	0
E-LEARNING	57.1	0	42.9	0	100	0
WRD PROCESSOR	57.1	14.3	42.9	14.3	71.4	14.3
SPREADSHEET	57.1	14.3	57.1	14.3	71.4	14.3
DATABASE	71.4	14.3	71.4	14.3	85.7	14.3
DT PUBLISHING	85.7	14.3	71.4	14.3	71.4	14.3
ED. SOT WARE	71.4	14.3	71.4	14.3	85.7	14.3

The outcomes of the teachers' responses reveal inadequate use of ICT resources in almost all areas. First, though 100% of all the respondents have received training in the use of word processor, only one (1) 14.3% of the respondents use the program to further their classroom objectives. A similar percentage uses the word processor and spreadsheet software for personal and administrative purposes on a daily basis.

### Competence of teachers to handle the e-School facilities

The competence of the respondent would be probed further by asking the frequency with which each of the respondent used the knowledge gained during training for the instruction of science lessons. Table 9 below represents the data captured.

**Table9 Areas of ICT for which the respondents have received training**

Area of ICT training	n	Yes		No	
		No of teachers	Percent	No of teachers	Percent
Internet & World Wide Web	7	2	28.6	5	71.4
E-mail	7	3	42.9	4	57.1
E-learning	7	4	57.1	3	57.1
Networking	7	1	14.3	6	85.7
Word Processing	7	7	100.0	0	0
Database Management	7	3	42.9	4	57.1

Spreadsheet	7	5	71.4	1	14.3
Desktop publishing	7	2	28.6	5	71.4
Networking with other teachers	7	0	0	7	100
Faxing	7	1	14.3	6	85.7
Video conferencing	7			7	100
Digital Camera	7	1	14.3	6	85.7
Digital scanner	7	1	14.3	6	85.7
Educational software	7	0	0	7	100
Online information sourcing	7	1	14.3	6	85.7
Digital timetabling	7	3	42.9	4	57.1
Web design	7	1	14.3	6	85.7
		7	100.0		

The frequencies and percentages obtained in table 9 indicate alarming revelations. There are high proportions of respondents with inadequate know-how on the crucial computer programs. Imperatively only two (2) (28.6%) have received training on how to use the internet, one (1) (14.7%) can source information from a computer network, zero percent (0%) can exchange educational views on Video conferencing, Zero percent (0%) can share electronic experiences with other teachers from other schools in Kenya and Africa. None of the respondents (0%) have previous exposure to educational software of any kind. The fore-mentioned areas are the core programs for the most acclaimed e-learning and the e-School concept. This argument is supported by the electronic wikipedia dictionary which states

“ e-learning is a form of advanced learning technology, which deals with the computer as a tool and associated methodologies in learning using networked and multimedia technologies. The internet and multimedia technologies are the basic enablers of e-learning.”

### ICT Laboratory Timetable

The time table is in line with the school policy of 10 lessons per day. The above timetable shows that the ICT laboratory is fully engaged for computer studies classes, Physical Education and Agriculture. The time table does not provide us with any evidence for incorporation of the **e-learning concept** during the normal working hours. Only fifteen (15) slots out of the fifty (50) available can be utilized for e-learning. This represents a meager thirty percent (30%)

## **CONCLUSION, RECOMMENDATIONS AND SUGGESTION FOR FURTHER STUDIES**

### **Introduction**

This study documented the e-School hardware and software in relation to access, examined the teachers' competence in handling the facilities and explored the extent of use of the documented facilities. The study also highlighted the achievements and challenges facing the e-School project in Mumbi Girls. This section gives a summary of findings and conclusion of this study. The chapter ends with a list of suggestions for further study.

### **Summary of the findings**

#### **The e-School Hardware and software in relation to access to ICT**

**a) Hardware.** Concerning hardware this study made observations. Firstly, the facilities are barely enough to provide sufficient access for e-learning resources during a normal science lesson. A high student computer ratio of one to twenty five (1:25) at school level, and one to seven (1:7) at class level compares unfavorably with the international standards of one to one (1:1) or one to two (1:2)

Secondly the e-School facilities are not being used for e-learning in the most strict sense, rather as facilities for learning computer studies. Teaching computer studies is just a fraction of the objectives of the NEPAD e-School facilities. The provision of a forum for newly emerging e-learning approach is being overlooked to a large extent.

Thirdly, the placement of the ICT resources in one ICT laboratory is greatly limiting access. A centralized room can only be accessed one at a time. Teachers and students must wait until a computer lesson is over and when they are not attending another lesson.

Fourthly, the ICT laboratory layout exposes the issue of ergonomics. Students who must occupy the perimeter bench have to sit with legs towards the wall, as they look behind their shoulders, presenting strain to the lumbar and shoulder muscles. Closely related to this finding is the competition for the most comfortable middle bench amongst students

**b) Software.** Relating to software, this study made two observations: First, none of the programs installed are homemade or tailored to meet the objectives of the Kenyan secondary school science syllabus. The science teachers and students have to sieve through the existing programs until the desired content is achieved. This by itself has a time element which teachers are resisting.

Secondly, private software developers are making their own programs and infiltrating into schools and sell those programs. The contention to this observation is that policy issues relating to ICT should be developed and implemented in the strictest sense.

### **Professional and academic qualifications of the respondents**

**a) Professional and academic qualifications.** With regard to academic and professional qualifications, the researcher observed that all the seven (7) (100%) respondents are graduates of with either a college diploma or a university degree. A college diploma or a university degree is an indicator that the respondents are highly qualified to grasp content in ICT training with ease. Secondly, being qualified, the teachers can spend more time experimenting with methodology, rather than content.

### **b) The qualifications of teachers in ICT.**

The study observed that the science teachers' are deficient of adequate training and competence in the use of ICT. Teachers who are not well trained in ICT will shy off from utilizing such resources in classroom instruction.

Secondly the study revealed that five (5) (71.4%) against two (2) (28.6%) of the respondents received their first ICT exposure not at their teacher training institution, but training in other institutions. The implication is that the Teacher Training Programs are inadequate in preparing teachers in ICT.

### **Competence of teachers to handle the e-School facilities**

This study observed that a high proportion of respondents do not have adequate skills to handle the hardware facilities and have difficulties in handling the installed software. Without knowledge of the installed programs teachers cannot facilitate their lessons using the e-learning approach.

The study further observes that all the science teachers are trained to make basic computer files using a word processing program, spreadsheet and database management programs. The three areas form the basics of ICT training forming an opinion that the respondents are trained in the basics of the technology.

This study also revealed that all respondents (100%) are for the opinion that they require more training on how to utilize ICT resources for classroom instruction.

#### **Extent of use of ICT resources by science teachers**

This study revealed that inadequate use of ICT resources in almost all areas. The inadequate use was observed to be due to three factors.

Firstly, the ICT laboratory is fully engaged in the teaching of computer studies, so teachers can only access the facilities when such a room is not being used for any other purpose. The computer studies are given a first priority, and teachers must postpone their priority until such a time when they are free and the ICT resource room is free.

Secondly, the computer studies teachers are fully utilizing the ICT facilities when teaching their subjects, but the use of the resources to further the other objectives of the NEPAD e-School project, e.g. to harnessing ICT technology to improve, enrich and expand education, was observed to be at minimum.

Thirdly, due to inadequate time and facilities, teachers stream to the ICT laboratory over lunch hour, the same time when the students are completing their assignments and sharpening their ICT skills. This precipitates competition between teachers and students.

The study further revealed that a major impediment to ICT adoption and utilization is because the relevant programs tailor-made for the Kenyan schools are non-existent. In some cases, only

fragments of the syllabus can be covered by use of ICT. The existing programs are based on foreign syllabi or too detailed beyond the level of the student

Lastly, the study revealed that the low key utilization of ICT resources by teachers was due to inadequate exposure with the technology. Most teachers are not experts in the use of ICT resources.

### **Recommendations**

This study revealed issues that led to the following recommendation

1. That the roll out of the NEPAD's e-School project be postponed until such a time when teachers are well mentored and exposed on how to incorporate the technology as a new instructional tool. Otherwise it may be impossible to sustain the project unless the teacher capacity is beefed up.
2. While in-service for practicing teachers is recommended, this study suggests that student-teachers must be oriented towards ICT adoption right from the first semester in campus. The student-teachers need to try out their ICT skills in lessons during microteaching, teaching practice and during their actual practice.
3. That the quality and standards office should become more aggressive in enforcing ICT adoption to schools. An ICT taskforce mandated to enforce ICT policies should be placed on a performance contract and its effectiveness monitored
4. A home made digital syllabus in line with the Kenyan syllabus need be developed. Digitizing should start with those subjects that require urgent methodology reform such as science and mathematics.
5. The Ministry should develop policies regarding timetabling, examination analysis and entry of school records. Teachers should be encouraged to present their exam scripts in form of soft copies. They should be encouraged to key in their continuous assessment tests and exam results on a spreadsheet, maintain a digital class register, and maintain other data electronically. The policy should be enforced at the school level by the Principal.
6. A revision of the teacher training curricular must be considered with a view of orienting it to the emerging issues in ICT.
7. The computer laboratory layout need be revised so that competition for strategic positions is reduced and ergonomic considerations are provided for.

9. The study proposes a comprehensive in-servicing oriented towards ICT for science teachers. The training should be voluntary, and viewed as part of teacher professional development, which should be used as criteria for promotion. Those lacking ICT skills, and those showing resistance to its use, should be demoted or phased out from service.
10. This study proposes that all NEPAD demo schools be declared regional support centers when the project is adopted nationwide.

### **Suggestions for further research**

1. The study restricted itself to the study of the NEPAD e-School project. Other schools under a different ICT program were not covered. There is need for a study that can explore the achievements and challenges of other ICT programs in Kenyan secondary schools
2. This study examined the role ICT can play in the teaching and learning of Biology, chemistry and physics. However, ICT is not always suited for use by the science teachers and science students. The role of ICT in the teaching and learning of other school subjects can well be covered by another study.
3. The study did not address the details of the suitability of educational software, which form the core element of ICT use in education. There is need for a study to exhaustively cover the suitability of the existing education software with a view of providing sound recommendations to policy makers and program developers

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**E2012-24: Perspectives of Stakeholders on the Effects of HIV and AIDS on Primary School Pupils' Drop Out in Kisumu Municipality, Kenya**

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**Abstract**

Kisumu Municipality is one of the areas that has high HIV and AIDS prevalence rate of 15% compared to a national prevalence rate of 7.3%. The HIV and AIDS scourge has resulted into many orphans who are vulnerable to many forms of exploitation such as a sexual exploitation, negligence and child labor. These forms of exploitation are bound to affect participation of children in education. HIV and AIDS prevalence rate in Kisumu Municipality was 15% and the drop out rate in primary schools was 17% in 2008. HIV and AIDS was considered to be a factor contributing to drop out of pupils in primary school in Kisumu Municipality. The purpose of this study was therefore to establish perspectives of stakeholders on the effects of HIV and AIDS on primary school pupil dropout in Kisumu Municipality, Kenya. Objectives of the study were to; establish selected stakeholders perspectives on the extent to which HIV and AIDS social factors; find out stakeholders perspectives on the extent to which HIV and AIDS economic factors influence primary school pupil drop out; find out the strategies school administration use to mitigate primary school pupil drop out due to HIV and AIDS and find out challenges faced by schools and government in mitigating pupil drop out due to HIV and AIDS in Kisumu Municipality. The study was guided by a conceptual framework that tried to illustrate how HIV and AIDS could affect primary school pupil drop out. The study adopted a descriptive survey design. The study population consisted of one Municipal Education Officer (MEO), one Quality and Assurance Standards Officer (MQASO), 17933 standard 7 and 8 pupils, 117 head teachers and 234 classes 7 and 8 class teachers.. Data collected was by use of questionnaires, interview schedules and focus group discussion guide. Quantitative data was analyzed using descriptive statistics in form of frequency counts, means and percentages. Qualitative data was coded and analyzed as themes and sub themes emerged. The study findings revealed that HIV and AIDS have had an impact on the school going children. It has exposed children who are orphaned to go through lots of challenges due to lack of providers and care takers. The study found out that there are quite a number of strategies that the schools and the government are using to reduce drop out in the primary schools within the municipality. The study also revealed that there are quite a number of challenges in the process of mitigating primary drop out. To improve on the quality of education and learning in primary schools in Kisumu Municipality this study recommended that the government should put in place measures to reduce the rapid increase of orphans due to HIV and AIDS effects, increase the amount of funds set aside for HIV and AIDS affected or infected pupils, ensure quality health services for all, eradicate graft in conveying funds for personal effect for orphans due HIV and AIDS ,and educate the society on the effects of HIV and AIDS. The findings of this research are useful to policy makers, Non Governmental Organizations, well wishers, head teachers, teachers and all stakeholders in eradicating school dropout in educational institutions.

Key Words: *Perspectives, Stakeholders, Effects, HIV/AIDS, Primary School Pupils' dropout, Kisumu Municipality*

### **E2012-30: The Challenges of Teaching the Revised English Syllabus**

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#### **Abstract**

The research is an assessment of the multifaceted role that English plays as a medium of interaction/ instruction or service subject, a compulsory discipline at all levels of education and as the official language of the republic of Kenya. As a medium of instruction, English services the teaching of all other disciplines of the curriculum. Though a third or even fourth language to

learners of English it is used for interaction between teachers and learners and amongst the learners themselves. English is also an examinable discipline at different summative levels in the education system. It is also a major tool used to achieve both the curriculum goals of education and the national goals enshrined in vision 2030. The research will attempt to address the apparent gap in the interpretation, implementation and the evaluation of the revised syllabus. The main objective will be to determine the extent to which the mandate of the teacher, in the teaching of English meets the needs of the learners of English in Kenyan secondary schools. The research design will take on a quantitative approach using questionnaires administered to respondents from secondary schools in Nakuru County. Random sampling technique will be used to pick out a broad spectrum of respondents. The findings will inform curriculum developers and the ministry of education the challenges that the teacher is grappling with in preparing learners to acquire English as a foreign language and the bearing this has on learners of English.

### **E2012-31: Performance Contracting as a Paradigm Shift in the Utilization of Teaching & Learning Resources: Perceptions of Tutors in Technical Institutes in Rift Valley, Kenya.**

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#### **Abstract**

Every year thousands of students leave the regular formal educational institutions in Kenya, but they cannot progress to higher levels of formal education. Despite past investments in Kenya's Technical, Industrial, Vocational Education and Training (TIVET) subsector, many school leavers fail to access TIVET. This is because the subsector is said to be facing many challenges related to wastage of resources, irrelevant training and turnover of personnel. The government of Kenya introduced performance contract signing in the year 2004. The performance contracts were aimed at improving resource utilization in public institutions among other objectives. This study sought to establish the perceptions of Kenyan tutors in Technical Institutes in Rift Valley about the impact of performance contracts as a paradigm shift on the utilization of teaching and learning resources. The study adopted a survey strategy. The study population comprised of tutors, Heads of Department and Principals of Technical Institutes in Rift Valley. The stratified random sampling technique was applied in the selection of the study sample. This involved the grouping of tutors into 8 strata according to the available departments. Thereafter the proportionate random sampling technique was applied to get an equal proportion of respondents from each stratum. The purposive random sampling technique was used to sample the heads of department and principals. Questionnaires and interviews were used to collect data. This entailed the supplying of questionnaires to tutors, heads of department and principals of the sampled Technical Institutes. Interviews were conducted with principals of the sampled institutions. The data collected were analyzed by use of descriptive statistics. The findings of the study revealed that performance contracting had not led to tutors being trained on the proper utilization of learning and teaching resources. The study concluded that financial constraints hindered tutors from being trained on the utilization of modern learning and teaching resources. The study recommends that the gains made in the implementation of the performance contracting strategy should be strengthened with the availing of more financial resources to ensure that the required learning & teaching resources are all made available. The findings would help education policy makers to address the issue of performance contracts from an informed position as well as get insight on how to apply performance contracts in the optimum utilization of resources.

Key Words: *Paradigm shift, Performance contracting, Resource utilization, Teaching and learning.*

### **E2012-33: Evil Eye: An African Overview**

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#### **Abstract**

Oral literature genres stimulate intellectual growth and enable learners to use their critical and creative thinking skills. However, they are dismally performed genre in Kenya Certificate of Secondary Education (K.C.S.E) English Examination. The poor performance is attributed to the inappropriate and ineffective teaching methods used in literature among other factors. Oral literature genres require appropriate teaching methods in order to achieve the intended instructional goals. Co-operative Learning Approach (CLA) is a method designed for all students' to work in small groups of four to six and receive rewards based on group, rather than individual performance. Research on co-operative learning in various subjects such as poetry in English has shown its importance in improving learners' achievement, inter-group relations and attitudes towards the subject of study. Therefore this study was designed to investigate the effects of cooperative learning approach (CLA) on the student's achievement and attitudes towards the study of Oral literature genres. Solomon four quasi experimental group design was used. Two groups E<sub>1</sub> and E<sub>2</sub> received a treatment of CLA whereas C<sub>1</sub> and C<sub>2</sub> groups were taught using the conventional methods. The population of the study was 7000 Form 3 Secondary school students from Kisii District. The study comprised of a total sample size of 160 students. Two instruments, namely Student Attitude Questionnaire (SAQ) and Oral literature genres achievement test (OLGAT) were used. The test instruments were constructed by the researcher and given to two Egerton University language and literature experts to check on both the construct and content validities. The instrument was pilot tested in one secondary school in Gucha District. The reliability of the SAQ test instrument was estimated at 0.893 using Kuder-Richardson formula 21 (K – R21). OLGAT and SAQ were administered to the learners. Data analysis was performed using the statistical package for social sciences (SPSS). The ANOVA and t-test were employed to test for significance at  $\alpha = 0.05$ . The results showed that the students exposed to CLA had higher achievement and attitude than the students exposed to the conventional methods. The researcher concluded that CLA was an effective method which English and literature teachers should be encouraged to use in the instruction of English and Literature. The Study recommended a long term research involving the use of CLA in different school category in order to determine the effectiveness of CLA approach.

### **E2012-34: Improvement of Internal Efficiency of Primary School Education: A Case of Kandara District, Murang'a County, Kenya**

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#### **Abstract**

The reforms undertaken in education sector by the government aim at addressing both the overall goals of national economy recovery strategy and international commitment. The rationale for those reforms has been to improve efficiency and cost effectiveness in resource utilization. By making primary education free to all children regardless of their social classes, it is hoped that the handicaps

that were inherited in being poor would be removed. However, the education sector is still faced with issues of access, equity and quality. Many children are unable to achieve education due to various reasons like ignorance of their parents to enroll them in schools, household burdens and poverty. This has hampered achievement in accessing education especially where children are forced to drop out of school because of lacking basic needs like food and uniform. It is in the wake of such alarming trend of dropout rates that the researcher sought to assess on improvement of internal efficiency of primary school education. The study adopted descriptive research design to collect data. Data analysis was done through organizing the data and tabulation in frequency tables and percentages. Study findings revealed that schools were understaffed and had inadequate facilities; parents neglected to monitor their children's school going activities. The study concluded that there were indications that guidance and counseling was needed to reduce repetition and dropout rates. The researcher recommended that the government should; ensure no understaffing in schools; launch public awareness campaigns regarding the problem of dropout and ensure parental cooperation for completion of primary cycle of education.

Key words: *improvement, internal efficiency and primary education*

**E2012-35: Relationship between Teacher Burnout Level and Classroom Performance  
Among Teachers in Public Secondary Schools - Case Study Nyandarua North District,  
Kenya.**

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**Abstract**

Burnout is a state of mental, emotional and attitudinal exhaustion. It is a very important condition in any organization since it has an economic implication. It contributes to ill health of an individual. Various studies report different recurring stressors in teaching profession such as high work load, staff conflict, overcrowded classrooms, reduced social support, students' behaviour problems, and individual gender. Research indicate that the quality of instructions depend on the teachers health. The level of burnout varies from one organisation to another and from time to time. The study aimed at establishing the relationship between burnout level and classroom performance among public secondary school teachers in Nyandarua North District. A correlation study design was used. Stratified random sampling was used to obtain a sample n=82 teachers from a target population of 245 teachers in 24 secondary schools. A questionnaire was used to collect the data. The questionnaire was hand scored and analysed using statistical package for social science. (SPSS).The level of teacher burnout was established to be low while the average teacher performance was moderate. A correlation coefficient of -0.1620 was obtained between teachers burnout and teacher classroom performance which is a negative relationship which is weak. The correlation coefficient obtained indicated that an increase in teacher burnout would lead to a decrease in teacher classroom performance while a decrease in teacher burnout would lead to an increase in teacher classroom performance. Different health promoting conditions such as assessment of risks of health, provision of appropriate information and training on health issues are recommended in order to establish a health work force. All the stakeholders in the Ministry of Education should address the level of burnout among the teachers with the aim of improving their health and thus promote their classroom performance.

Key words: *Teacher Burnout Level, Interventions, Health, Classroom Performance.*

**E2012-36: Theology, Innovation and Society: A Way Forward for Developing Dialogical Theology in Contemporary Africa**

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**Abstract**

Theology and society are inseparable - due to the fact that they are both composed of that which makes for both human and universal well-being. Indeed the two have through the ages immemorial inspired each other in the pursuit of a better world. It means, therefore, that defining theology and society in isolation is un-meaningful - for Africa in particular. This paper delves into developing a theology of dialogue as an innovating factor towards creating harmony and equilibrium in a multi-cultural and multi-religious African society. In approaching the subject, the author shall endeavour to outline pre-colonial, colonial and post-colonial religious histories in Africa. This is in order to unearth and establish whether a theology of dialogue in African society has existed/exists, or not. If it has, what methods have made it successful? If this is not so, what are the factors producing the failure? In this paper the author shall use the Midzi-Chenda community of Coastal Kenya as a case study population. This choice is due to their diverse and long-lived inter-cultural and inter-religious experiences, particularly with the Arab, Portuguese and British conquests along the East Coast of Africa. The triple conquest experiences influenced the Midzi-Chenda community negatively and positively in all spheres of their life-system; economic, political and religious, compelling them to embrace foreign culture, religion and politics, all of which gradually shaped their theological parameters. This latter experience and the contemporary post-colonial religious wave significantly situate the theology of dialogue as a benchmark for innovation in African society.

**E2012-37: Tugen Men and Women's Perception on FGM in Relation to their Participation in Household and Community Socioeconomic Development Activities in Baringo County.**

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Female Genital Mutilation, which is the partial or total cutting away of the female genitalia, has been practiced for centuries in parts of Africa and other regions of the world as one element of a rite of passage. An investigation of the Tugen men and women's perception on FGM in relation to their participation in household and community socioeconomic development activities in Baringo County shed light upon numerous obstacles to its elimination. There was a gap in the analysis of the factors contributing to persistence of FGM among Tugen women of Baringo County as it had not been empirically investigated. The purpose of this study was to establish factors contributing to persistence of FGM among Tugen women of Baringo County. The study adopted the ex post facto-causal comparative research design. The study was conducted in three divisions namely Kisanana, Mogotio and Esageri in Koibatek district in Baringo County. The selection of these divisions was based on the information provided by the District Health Management Team to the effect that these were the divisions where the practice of FGM was likely to be high. Purposive and quota sampling was used in selecting participants in the area of study. The research data was collected using questionnaires and an interview schedule. Piloting of the instruments was done at Marigat division in Marigat district in Baringo County to provide the required information on its reliability and

establish the time taken to administer the instruments in order to make necessary modifications and adjustments before commencing data collection in the field. The questionnaires' items were considered reliable after yielding a reliability coefficient of at least 0.70. The data collected were analyzed by use of descriptive and inferential statistics. Statistical Package for Social Sciences (SPSS) version 17 for windows was used to analyze the data. The study generated information regarding the factors contributing to persistence of Female Genital Mutilation among Tugen women of Baringo County. The findings from the study might also help Ministry of Gender and Social services, Government of Kenya and local community leaders to take serious the fight against FGM practice and look for strategies to eliminate it.

Key words: *Female Genital Mutilation, Alternative Rite of Passage, Gender Based Violence, Traditional Birth Attendants, Psychosocial and Health Wellbeing, Perception.*

### **E2012-38: Structural Changes in Technical and Vocational Education and Training (TVET) Curriculum in Kenya: Focus on Engineering Programmes**

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#### **Abstract**

Technical and vocational education and training (TVET) has emerged as one of the most effective human resource development strategies that Kenya needs to embrace in order to train and modernize their technical workforce for rapid industrialization, national development and achievement of the Kenya Vision 2030. The paper is intended to explore the structural changes and reviews the TVET-engineering curriculum in Kenya had undergone since independence in 1963 to the Current competency based training (CBT) curriculum. The paper further documents key lessons that can be learnt in every curriculum and effects it had on employability. TVET- engineering training started far back before colonization, but in 1970s the training was formalized from apprenticeship, to technician curriculum, followed by Technical Education Programme (TEP) curriculum and current the TVET Competency Based Curriculum. The literature review and the findings will inform the my PhD research work that is addressing the need for more employable technician engineers, thus an attempt to cross the existing gap of 122, 201 required skilled technician engineers in the current labour market. The study adopted an explanatory survey design. The study critically analyzed the various TVET engineering curriculum and further study interviewed people who have gone through engineering training in the various curriculum. The study adopted multistage sampling technique, within which purposive sampling and snow ball sampling sufficed in identify the respondent mainly in teaching profession, working in industry or company and those in non engineering professional. Research finding shows the TVET engineering curriculum have undergone four major structural changes in terms of pattern of study over a period of 50 years since independence. The curriculum content analysis in all curriculums reveals very little change in content matter but there are significant differences in the duration from one level to other in the various curriculums. While it was straight forward to be employed in 1970s and early 1980s due to the need of skilled workforce majority of respondent who went through the technician systems had no vertical mobility for skills advancement and this limited them a great deal. Today despite opportunities for vertical mobility the employment is not assured.

Key words: *Structural Changes, TVET engineering Curriculum, Technician Engineering Training*

**E2012-40: Roles of Community Based Organizations (CBO's) Catering for the Social Welfare Needs of Orphans Positively Living with HIV/AIDS. A Case of Faith of Hope Centre in Kakamega.**

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**Abstract**

Studies' explaining the role of community based organizations in catering the needs of HIV positive orphans has not been adequately addressed. The research sought to study the role of community based organization in catering for the social welfare needs of HIV positive orphans. The research utilized survey design. The objectives of the research were to establish the role of the CBO's in catering for the social welfare needs of HIV/AIDS orphans, investigate the type of social welfare needs of HIV/AIDS orphans, investigate the type of social welfare needs catered for by the community based organization and investigate the challenges faced by the CBOs in provision of services. Based on the objectives, the study found out that CBOs play a great role in catering for the social welfare needs of HIV positive orphans and the entire community. CBOs use activities such as workshops, medical camps, awareness and campaigns and HIV testing and counseling to provide for the needs. Challenges in service delivery are faced by the CBOs due to financial and resource accessibility. The study recommends that CBOs should be given adequate support by the government and communities in order to encourage them to participate fully for the well being of the orphans positively living with HIV/Aids.

Key words: *Orphans, Community based organizations & social welfare needs.*

**E2012-41: Biology Education: A Teachers Perspective on the Challenges in the Delivery of Content and Performance in Biology. A Case of Bungoma County, Kenya**

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**Abstract**

Biology is a teaching and learning subject at secondary school level in Kenyan schools. Higher education does not exist in isolation but is a build up from knowledge gained at lower levels of education. Biology plays a key role in industrialization and other sectors of the economy. Biology is practical subject, which equips students with concepts and skills that are useful in solving the day-to day problems of life. The study of biology aims at providing the learner with the necessary knowledge with which to control or change the environment for the benefit of an individual, family or community. However, the secondary school students' performance in biology as a learning subject in the Kenya Certificate of Secondary Education (KCSE) in Bungoma District has been quite low over the years. The public outcry and concern by parents, teachers, educationists and students about poor performance in science subjects and mathematics in national examinations is a clear indication that factors influencing student's performance in these subjects need urgent investigation. The aim of this study is to investigate the influence of teacher related factors on performance of secondary school students in biology. The Cross-sectional descriptive research design was employed in this study. Nine (9) secondary schools were randomly selected for study

out of 139 schools in Bungoma district. Different categories of schools were used depending on the school set-up and these are (i) Single- gender boys boarding schools (ii) Single- gender girls boarding schools (iii) Single- gender girls day schools (iv) Co-educational boarding schools (v) Co-educational day schools (vi) Co-educational boarding / day schools. Co-educational schools were considered to reduce possible biases. A total of three hundred and sixty (360) form three students were randomly selected for the study. A student questionnaire (SQ) and a teacher questionnaire (TQ) were used as the main instruments for data collection. Class mark lists were used as tracking records of performance in biology. Data collected were analyzed using descriptive statistics. The study established that boys perform better than girls in biology. Female teachers were found to have a higher level of science anxiety in the teaching of biology compared to the male teachers. It was established that most teachers still used the traditional lecture method in the teaching of biology and only a smaller percentage were using the SMASSE(ASEI/PDSI) approach. This study was expected to significantly contribute in the provision of information that could be used by teachers, parents, educationists and policy makers to improve on the teaching, learning and performance of students in biology.

### **Introduction**

According to Hawes (1979), the late 1960's saw the planning and development of new science syllabuses in the United States of America and Britain after the launching of the Sputnik by Russians in 1957. In the early 1960's an American science curriculum project, the Biological Sciences Study Committee (BSSC) was formed. The preparation of the biology curriculum was based on the British Nuffield science courses. These curriculum developments spilled over into developing countries in Africa in the early 1970's. The introduction of highly sophisticated and expensive scientific and technological education for the developing African states was done without regard to laying foundations in secondary schools for fundamental growth of knowledge, skills and attitudes necessary for understanding them. The importation of science curriculum packages into Africa had far reaching repercussions on the development and implementation of the biology curriculum and that of other science subjects like physics, chemistry and mathematics at secondary school level in Kenya from that time to-date.

In East Africa, the Secondary Science Project (SSP) was supported by an organization in Britain called the Curriculum Research and Development Overseas (CREDO). The SSP biology course has since been amalgamated with the traditional biology course to form the new biology course for all secondary schools. The birth of Science Education Programme for Africa (SEPA) in 1969 saw the establishment of science curriculum development centre at the Kenya Institute of Education (K.I.E).

Since 1963 at independence, the education system in Kenya has undergone fundamental changes. The main reason why the Government of Kenya decided that science and technological subjects be taught in school was the recognition of the important role, science and technology education play in the economic, social and industrial development (Republic of Kenya, 1972). The Government of Kenya also spends over 30% of the annual budget on education (Republic of Kenya, 1989). Eshiwani (1993) observed that a large proportion of this money is channeled towards the improvement of science education. However there is no evidence that this increased expenditure has necessarily been associated with improved performance in science subjects on the part of the learners at the secondary school level (SMASSE Project, 2000).

In Kenya many science teachers are at present experiencing considerable disquiet as a result of the demands made on them, and the various strategies advocated. In recent years a spirit of change and innovation has pervaded science education activities in this country. Science education has been in a lot of lime light, for example the project called Strengthening of Mathematics and Sciences in Secondary Education (SMASSE), which was initiated by the Ministry of Education to provide in-service refresher training for science and mathematics teachers. In the SMASSE in-service training, teachers are given information that is integrated with hands-on activities and inquiry that assists teachers to have more interest and less anxiety when teaching.

The Government of Kenya has particularly felt a need to improve the science education it offers so as to build up a knowledgeable manpower required for its industrial and technological transformation (Republic of Kenya, 1999; SMASSE Project, 2000). In this regard, existing practices must be reviewed from time to time in the light of new development and changing requirements. In Kenya today, the most dominant feature of the education system is academic performance (Chepchieng, 1995). As such explanations for good and poor student academic performance have been exhaustive, yet controversy still exists among scholars as to what contributes singly or jointly towards students' poor performance (Chepchieng, 1995). Eshiwani (1984) also gives us an insight into the reasons why learners perform poorly in science subjects; he suggests the following reasons: inadequate time allocated for learning science satisfactorily, inadequate instruction material, low level and inadequate training of teachers, the nature of the science curriculum-it is highly abstract and seems irrelevant to the learners' immediate environment. This leads to the learner's negative attitude towards science.

In Bungoma district the essential elements have been an emphasis on science and technical subjects. Different methods of teaching are being used by biology teachers, with the hope to optimize learning on the part of the learners. An improved instructional technology is making inroads in the school system and institutions are of a new kind, intended to make learners achieve higher (SMASSE Project, 2000). A study of this kind also draws importance from the fact that achieving the aims of industrialization can be jeopardized if a large proportion of anticipated beneficiaries do not have adequate access to appropriate kinds of education and training in science.

Biology has no limits and involves every aspect of a person's life. Biology is a branch of natural science that involves the study of living things. The word biology comes from the Greek words *bios* which mean life and *logos* which mean knowledge. Therefore, biology means the knowledge of life (Kenya Institute of Education, 2005). Biology has a lot of relevancy in every day's life because it helps man to understand himself and the environment around him. Biology naturally leads to career and employment opportunities. It is continuously opening up various professions to men and women in medicine, agriculture, conservation, research, home science and industry. According to the Kenya Institute of Education (2005), the importance of biology to humanity can be outlined as follows:

- (i) The learning of biology helps us to know how to use natural resources more efficiently in industry e.g. in bio-technology, food production, building and textile and paper industries.
- (ii) The learning of biology helps us to understand changes in the environment and the factors affecting these changes, in order to know how human needs are influenced.
- (iii) The learning of biology is important in helping mankind to find effective ways of preventing, treating and curing diseases and home management techniques e.g. better methods of food preservation, efficient food preparation and care of the family
- (iv) The learning of biology is important in helping the improvement of agricultural yields through scientific research.

### **Statement of the Problem**

The performance of students in biology in the Kenya Certificate of Secondary Education (KCSE) has been unsatisfactory over the years in many secondary schools in the country (KNEC, 2000). In Bungoma District, the performance has been lower than expected in this subject as indicated by

records from the District Education Office. This has caused a lot of public outcry and concern about the performance in science subjects and mathematics (KNEC, 2000). Studies focusing on the impact of different factors on performance in biology at secondary school level are not well conceptualized. This lack of sufficient knowledge regarding these factors and their influence would militate against the country's aspiration to achieve the 'Vision 2030' and the Millennium Development Goals (MDGs). This is because biology is one of the key science subjects that contribute towards industrialization, environmental conservation, medical research, food management and improved agricultural production. It is therefore important to study the influence of these factors on performance in biology.

### **Purpose and Objectives of the Study**

The purpose of this study was to determine the influence of teacher related factors on performance in biology as a learning subject at the secondary school level in Bungoma District.

The specific objectives of this study were to:

- (i) To investigate the influence of the teachers' gender on performance in biology.
- (ii) To investigate the influence of teachers' science anxiety on performance in biology.
- (iii) To investigate the influence of the teachers' academic level of professional training on performance in biology.
- (iv) To investigate the influence of the teachers' teaching experience on performance in biology.
- (v) To investigate the influence of the teachers-pupil classroom interactions on performance in biology.

### **Research Questions**

The study addressed the following research questions:

- (i) What is the influence of teachers' gender on performance in biology?
- (ii) What is the influence of teachers' science anxiety on performance in biology?
- (iii) What is the influence of the teachers' level of professional training on performance in biology?
- (iv) What is the influence of the teachers' teaching experience on performance in biology?
- (v) What is the influence of the teacher-pupil classroom interactions on performance in biology?

### **Significance of the Study**

The findings of this study will have both theoretical and practical benefits to the future of science education in Kenya. The study is expected to contribute to the advancement of knowledge about science education and biology education in particular. The study may lead to improved strategies in teaching and learning of biology not only in Kenya but also in other parts of the world. The study may also be of immediate benefit to the Ministry of Education (MOE) and the National Council on Science and Technology (NCST) in the formulation of future science education policies aimed at enhancing students achievement in science subjects related to biology, which are chemistry, physics and agriculture. This study will assist teachers in helping students to develop positive attitudes towards the learning of biology. It will also assist parents to understand their role in helping their children towards the learning of biology.

### **Scope of the Study**

Teacher factors that could influence performance of students in biology were focused. The teacher factors the study addressed were: gender, science anxiety, professional training, and teaching experience, teaching methodologies, teacher expectations and teacher-pupil interactions in the classroom. The study also attempted to investigate the genesis of the positive and negative attitude towards the teaching of biology and the genesis of science anxiety in the teaching of biology. The population for the study consisted of biology teachers and biology students at the form three level in Bungoma District in the Western Province of the Republic of Kenya

### **Background to the study**

Banu (1985), examined attitudes towards sciences held by secondary school students in Gongola State, in Nigeria. He concluded that the quality of science teachers and development of more relevant curriculum might improve students' attitude toward science subjects. Shumba (1993) surveyed the attitudes of students of form two and form four towards science subjects in Zimbabwe. It was noted that there was a significant difference between attitudes of the students at different levels. In this study, he cited the teachers' influence as a possible reason with the impoverished attitudes of students. It was also indicated that the secondary school science teachers in the Harare Region where the study was carried out reported lack of facilities and resource materials to support hands-on activities. He recommended that the pre-service teacher education should not rely on the convenient lecture method, as this could not inculcate positive attitude towards sciences by the prospective teacher. He observed that teachers may lack enthusiasm of making science subjects

enjoyable to students due to lack of practical instrumentation and experimental techniques especially in cases of physics, chemistry and biology. These skills are relevant in industrial practice and production.

A student learning biology will understand the value of concepts learnt or taught when he can see their utility in practical life (Shumba, 1993). Attitudes are very important for effective learning (SMASSE Project, 2000). Galloway (1985) typically, found that teachers held stereotyped ideas about parents and children from different social groups. These leads to consequent teacher expectations of children' abilities (Persell, 1977). Most of the research involving learner attitudes has utilized the pupil gain on achievement tests as the sole or primary description of changed pupil behavior, to what Galloway (1985) called "academic problems". Actually this achievement tests explore only a small portion of the cognitive domain and disregard the affective and psychomotor domains (Bloom, 1956). Burgess (1973) found that higher achieving schools are those which maximize the interaction between ability of pupils in mathematics and expert teaching in related sciences like biology, chemistry and physics. The reasons given for problems in science education include; inadequate facilities, lack of resources and money, lack of time for adequate science instruction, teachers lack of knowledge and the poor preparation of elementary teachers to teach science (Yager & Penick, 1990).

Chepcheng (1995) observes that there is a need to investigate deeply on the influence of family background on academic performance. In an effort to address the need for a supportive learning environment, the Ominde Report (1964) recommended boarding schools, because students at home may find inadequate facilities and no place for study other than the crowded family hut, no library and lack of a studious atmosphere. Since all these are characteristics of low socio- economic groups of the society, they create a socio-economic inequality that is likely to create variation in academic performance of students. Research by Brimer (1969) examined the relationship between pupils and school characteristics and pupils achievement in public examinations at "ordinary" (O-level) and "advanced" (A-level). The findings indicated that family influence of early childhood rearing were most effective in the early stages of education in relation to the child's readiness to learn. It was argued that by the time the 'O' levels were taken, most of the selective variables arising from family background and prior educational background will already have taken effect.

In Africa, it has been argued that education emphasized achievement and information acquisition, based on examination scores and academic certification (UNESCO, 1999). The findings indicated that this is at the expense of learning, which is the application, rather than the acquisition of information, concept formation and development of analytical skills (Gatheru & Shaw (1998). In addition the authors argue that examinations in Kenya major on testing factual information rather than skill acquisition. The fundamental focus of education in Kenya has been preparing people for employment rather than training for education; an unwanted side effect of this over- emphasis on examinations is that teachers may focus only on the knowledge and skills that are testable by such examinations, to the exclusion of everything else (UNESCO, 1991).

There is need for teachers to teach for understanding (Proctor, 1994). This is the ability to take knowledge, concepts, skills and facts and apply them to appropriate new situations (Kiboss, 1997). Eshiwani (1993) found that factors which influence students' achievement in science subjects and mathematics are directly related to the students' attitude towards these subjects. He reveals that factors include availability of resources such as laboratories, libraries, textbooks, laboratory equipments and chemicals. Several factors that militate for or against pupils' academic performance. Some of these factors tend to give leverage to the male-child at the expense of the girl-child (Mondoh, 2001). A girl's participation and performance in science and mathematics is influenced to varying degrees by the way she perceives Science, Mathematics and Technological (SMT) subjects in relation to her life now and in the future; by the attitudes of other students, in particular her male peers and by the attitudes of her teachers, parents and society at large (FAWE, 2004). Since independence, education reviews in Kenya have addressed the issue of gender inequality in the educational system. For instance the Gachathi report (1976) noted that the girl-child education is less developed than that of the boys. This was attributed to the traditional beliefs and prejudices held by people regarding the roles and occupations of women in society.

Numerous researchers have found gender differences in attitudes towards science, science anxiety and science achievement (Czerniak, 1989; Czerniak & Chiarelott, 1990). The Social Cognitive Theory according to Bandura (1997) suggests that the low levels of self-efficacy that many female teachers and students experience are related to gender expectations and beliefs. The findings indicated that females experience more science anxiety, have more negative attitudes towards learning science, and perform more poorly in science than males. Certain school subjects are

viewed as gender related, many science subjects for example, are often viewed as “males” subjects (Bandura, 1997). Research on gender biases in education seems to indicate that both the content of the curriculum and the delivery of the curriculum are equally important in addressing issues of efficacy and equity in science education (Carlson & Buskist, 1997). The authors observed that preponderance of women in elementary education given the high level of science anxiety among females, suggests that elementary students lack role models who can encourage positive attitudes towards science. Research on the impact of the role models on students’ attitudes and performance suggest the need of career education including equity education (Proctor, 1994).

Raizen and Michelson (1994) suggested several strategies on which to increase equity in science and in mathematics, including career education in science, providing female role models in science, and teaching spatial thinking to females. Raizen and Michelson (1994) also recommended inquiry, hands-on or manipulative materials for females. Bandura (1997) also reported that increased self-efficacy and decreased anxiety could be achieved through modeling, by watching other females succeed in science, being exposed to females in science careers, or observing competent female teachers, girls may elect to take more science-related careers. Hong, Woo and Jeong (1995) reported that females favored the social-problems approach to teaching science more than did males. The authors observed that females might learn science more effectively if scientific, societal, and technological concepts were integrated into the curriculum and finally, instruction that places emphasis and lowers anxiety of science for females. Research by Enochs, Scharman and Riggs (1995) suggested that teachers need to be aware of the general classroom and school practices that encourage gender biases and point out to children gender stereotypes in texts, films, media, education materials and society as a whole

Science anxiety is a product of low self efficacy (Yager & Penick, 1985). Research on science anxiety involving over 2,000 students and 50 teachers supports the Social Cognitive Theory that low self-efficacy in science leads to high anxiety and reduced performance among many elementary students and their teachers (Czerniak, 1992). Students as early as the third grade, exhibit anxiety towards science (Czerniak, 1992), and students’ interest in science starts declining between the third and seventh grade (Horton & Hutchinson, 1997). Females, as early as the third grade, exhibit more anxiety than their male counterparts (Czerniak, 1992). This science anxiety may contribute to students, particularly females, low enrolments in science related careers at higher education

(Westerback, 1984). Similarly, in other research on anxiety and performance; Westerback and Long (1982) indicated that a high level of anxiety accompanies poor student performance in most academic areas, and Spielberger and Syderman (1994) reported that highly anxious students tend to lack self confidence, curiosity and adventurousness.

Social Cognitive Theory according to Bandura (1997) suggests that anxiety is a result of feelings of inefficacy; anxiety then leads to avoidance of situations that arouse the feelings of inefficacy. Providing evidence of this relationship, some teachers reported in informal interview that they do not teach much science because they were not very good at it, they taught science only because they had to and hence they did it in a perfunctory manner, when possible they traded this responsibility with someone who was better prepared (Bandura, 1997). The impression that these teachers felt powerless to affect in a positive way, their students' science learning was disturbing but not totally surprising (Horton & Hurtchinson, 1997). Viewed in the light of research concerns, education in general and related with self-efficacy among students and teachers in particular, these teachers' attitudes and behaviors are understandable (Horton & Hurtchinson,1997). Teachers repeated negative experiences with science may include personal failure in science as a student or poor experiences with science instruction from their previous instructors (UPDATE Project, 1992). In addition to these findings, the teacher's negative experiences may include lack of adequate time allowed for preparing science teaching, lack of science content background needed to teach the subject effectively, lack of administrative support, and lack of funding for supplies and equipment. This repeated negative experiences, as a student and as a teacher, result in a low sense of self-efficacy that provides high levels of anxiety towards science and science teaching (UPDATE Project, 1992). Negative attitudes towards science teaching, poor use of allocated time, and preference for teaching other subjects may result in low self-efficacy in science instruction and high science anxiety (Westerback & Long, 1990). Thus, teachers' anxiety over teaching science is likely to have noticeable effects on both the quantity and quality of science instruction which may impact negatively on students' attitudes towards the subject (Westerback &Long, 1990).

For students who are enrolled in science classes, increases in anxiety may result in lowered achievement (Spielberger & Syderman, 1994). Lawrenz and Cohen (1985) found that students gave "difficulty" as a reason for not enrolling in science and Westerback (1982) found that anxiety increased with the increased complexity and difficulty of learning tasks. Westerback and Long

(1990) suggested that programmed learning and gradual mastery (i.e., taking tasks in small steps until skills were gained and mastered) have been shown to increase skillfulness, knowledge and confidence and to decrease anxiety. Westerback (1982) found that teachers who provided clear expectations, opportunities for remediation and study support reduced anxiety towards science in the students. In summary, the use of programmed learning and mastery learning models seems to benefit not only highly anxious students but also prospective teachers (Bandura, 1997). Horton and Hutchinson (1997) suggested several classroom instructional practices that could reduce anxiety and help females and socially disadvantaged students to learn science and mathematics. These include building confidence by encouraging guessing, estimating, and testing and instruction in science that places less emphasis on “right answers” and facts which seems to build confidence in the students. In teachers, anxiety about teaching science seems to be lowered after experiences with science content and science pedagogy (Goldsmith, 1986). Westerback (1984) reported that a sequence of hands-on science content courses reduced prospective teachers’ anxiety about teaching science. Similarly, Czerniak (1992) found that anxiety towards teaching science was significantly lowered after completing a science methods course. Science anxiety has been established to have a bearing on both the teaching and the learning in science subjects (Nyongesa, 2010).

According to SMASSE Project (2000), biology as a science subject requires an integration of both theoretical and practical work to make it easily understood by the students. This, therefore, calls for application of a myriad of teaching aids to enable learners to concretize biological principles, concepts and facts. This requires various resources/learning materials and facilities to facilitate the teaching-learning process (Dollan & Clarke, 1979). Aiken and Aiken (1969) concluded that teachers of science, in contrast with the teachers of mathematics, generally recognized that teaching for development of favorable attitudes in the learners was an important part of their work. Newton and Tarrant (1992) observed that the attitudes and behaviors of teachers within classrooms may have a strong influence on the development of attitudes and values towards science by students. In addition the authors pointed out that the teachers’ attitude towards the curriculum influence the students’ attitude towards the same curriculum. There is a positive relationship between teachers’ attitude and their teaching methods (Newton & Tarrant, 1992). The authors point out that a positive attitude is commonly promoted as a necessity for effective implementation of curriculum innovations.

Kangoro (2007) observed that, failure of some students to do well in biology could be attributed to the teachers' atrocious attitude towards students who ask questions in between the lesson. The author observed that some teachers gave wrong answers to students, which the students discover and end up losing confidence in the teacher. It is generally accepted that one of the most highly credited methods of classroom teaching is the use of questions, it is sad that some teachers ignore this classic methodology (Boit, 1986). It is the opportune time for teachers to redefine the art of questioning in classroom teaching (Kangoro, 2007). Traditional instructional practices that centre on teacher dominated pedagogy predominates our schools (Changeiywo, 2001). The author observes that learning activities in most secondary schools centre on the textbook and past examination papers. Linder (1992) argues that students' perceptions of physics may be affected negatively by the way the subject is presented; the author observes that this applies to all other subjects. Research on teaching behavior indicates that there are teaching methods that influence students' achievement more positively than others (Wenglinsky, 2000). The author further argues that there was a correlation between high academic achievements of students and classroom practices of the teachers.

Earlier studies on teacher effectiveness centered mainly on the personal qualities of the teacher and the performance of the student in terms of cognitive ability, for example (Bloom, 1956; Gage, 1963; Brimer, 1969; Burgess, 1973). However some researchers began to carry out systematic observation of actual laboratory and classroom activities (Kyle, Penick & Shymansky, 1979). This approach involves the reduction of teacher-student behavior into interpretable categories. It is an attempt to obtain objective, detailed, qualitative and/or quantitative descriptions of interactions that occur during the teaching-learning processes of science (Kyle, Penick & Shymansky, 1979). Lack of curiosity and innovativeness evident in many spheres of human endeavor all around us may be a reflection of the teaching methods that dulled curiosity rather than nurturing. (Ndirangu 1991). Ginsburg and Opper (1979) argue that instead of imparting factual information, the teacher should create situations where learners will ask questions, experiment and discover facts and relationships.

Kochlar (1992) argues that teaching methods should nurture an environment of students' creativity in learning. Freire (1970) reinforces this by contending that teachers should use problem-posing teaching methods that create a challenge to experiment, explore and look for links between concepts. As students look for answers, they develop functional understanding because they go

through the reasoning involved in the development and application of the concepts they learn (Freire, 1970). Students must learn how to use concepts in the solution of relevant problems (Blosser, 1989). The author argues that only through this would the learners perceive the applicability of what they are taught in school to situations of experience.

Gage (1963) noted that on the basis of efficiency as measured by percentile attainment, by lasting impression on the minds of learners, by persistence in memory (up to 56 days), by encouragement of independent thought and self reliance and by popularity among the students, the three methods rank;- experiment method, lecture method, book method. He asserted that carefully and neatly drawn diagrams do not increase the students' knowledge of science. He observed that work in elementary science must be based on daily experiences and observation by pupils. Elementary science in schools should be largely, if not entirely qualitative and not quantitative. Many studies in science education have demonstrated positive students' outcome for instructional strategies promoted in the generation of science curricula in the 1960s and 1970s. This strategies included; inquiry, open ended experimentation, students directed activities and hands-on experiences (Kyle *et al*, 1979).

From a meta-analysis of 105 studies comparing new science curricula with traditional approaches, Kyle *et al* (1979) concluded that elementary students had more positive academic and attitude outcomes when science curricula emphasized process skills. Consequently, addition of science process skills may increase efficacy, reduce anxiety and improve academic performance. Inquiry approaches to science instructions have a positive effect on students' attitude and achievement in science (Ashton, 1984). Berliner (1984) indicates that the majority of elementary teachers rely heavily on the use of lecture and textbooks. The author posits that it is essential that teachers learn to use instructional practices that positively affect science learning instead of relying solely upon the use of textbooks and lectures

Cognitive psychologists ascribe a more active role for the learner in determining whether or not effective learning takes place (Heinrich, Molenda, Russel & Smaldino 1995). Thus, the learners' previous knowledge and experiences, expectations, interests and beliefs have an impact on the way learning takes place (Ndirangu, 2000). Flanders (1970) observes that learners should be engaged in meaningful learning tasks in order to construct knowledge for themselves. The relationship between

the teacher and the pupils in the Kenyan classroom is authoritarian and impersonal (Anderson, 1970). The author observes that the underlying basis for interaction is that students have come to school to be taught, the teachers' role is therefore to tutor them. Teacher-pupil interactions are greatly affected by class sizes (Mule 1994). This is supported by the study of Eggleston, Galton and Jones (1975) who posits that learning in crowded classroom is less effective compared to one that is less crowded.

Traditionally, it is believed that in school, a child tends to compensate for the failure of the home to provide the necessary educational background, and if home background is found to be more important than schooling, it can be held to be even more responsible for the inadequacy of children's education (Cullingford, 1985). Galloway (1985) observed that schools exert a very substantial influence over the learners' behavior and attitudes, the fact that some schools have fewer problems while others are overwhelmed by problems has more to do with school factors than with factors within the catchment area of the school. School factors exert an important influence on the learners' educational progress (Nyongesa, 2010).

Teacher expectations are affected by testing and tracking procedures which are biased against some learners (Persell, 1977). In addition, the author observes that; given the less powerful position of the lower class children in society, they appear to be more negatively influenced by teacher expectations. It is not altogether surprising that teachers are commonly disappointed by the lack of parental concern and unhelpful that any further parental involvement could be beneficial (Mortimore & Blackstone, 1982). Parents meanwhile expect clear authorities from the teachers and look to them to provide the skills, behavior and attitude formations, which teachers may assume are to some extent parents' responsibility while parents may wonder about their own role and whether they are capable of helping (Persell, 1977).

The quality of teachers is dependent on the selection of top quality candidates for teaching, their pre-service education and continuous professional development (Kang'ethe & Nafukho, 2000). A study by Kariuki and Kibera (1996) revealed that 57% of a second year Bachelor of Education cohort at a local university in Kenya did not like being teachers, even after having completed their teaching practice. They ended up in this programme after failing to get their first career choices. For them, teaching was a stopgap measure while looking for better careers. Such teachers would

naturally go to school to 'work' rather than teach and would not really exert themselves in order to teach well, these points to the need for the universities and teacher-education colleges to select only those students who choose teaching as their first career choice to join teacher education programmes (Kariuki & Kibera, 1996). They opined that the kind of people, who join the teaching profession and the way they are trained, is at the heart of all problems of educational quality, which any worthwhile educational reforms in Africa, must address.

### **Conceptual Framework**

The conceptual framework used in this study is based on the Systems Theory presented by Joyce and Weil (1980). A whole which functions as a whole by virtue of the interdependence of its parts is called a system; and the method which aims at discovering how this is brought about in the widest variety of systems has been called the General Systems Theory (Banathy, 1968). From the General Systems Theory is derived the systems concept (Mukasa – Simiyu, 2001). The independent variable is expected to bring about or account for a difference or a change in the dependent variable; the researcher builds the independent variables into the design in order to determine the effects of those factors on the dependent variables (Kathuri & Pals, 1993). According to Kothari (2003), an extraneous variable is an independent variable that is not related to the purpose of the study but may affect the dependent variable. Organismic variables are a special class of variables that appear like independent variables but are not directly controlled by the researcher (Orodho, 2005). The author opines that these variables are special extraneous variables. Figure1 shows the conceptual framework

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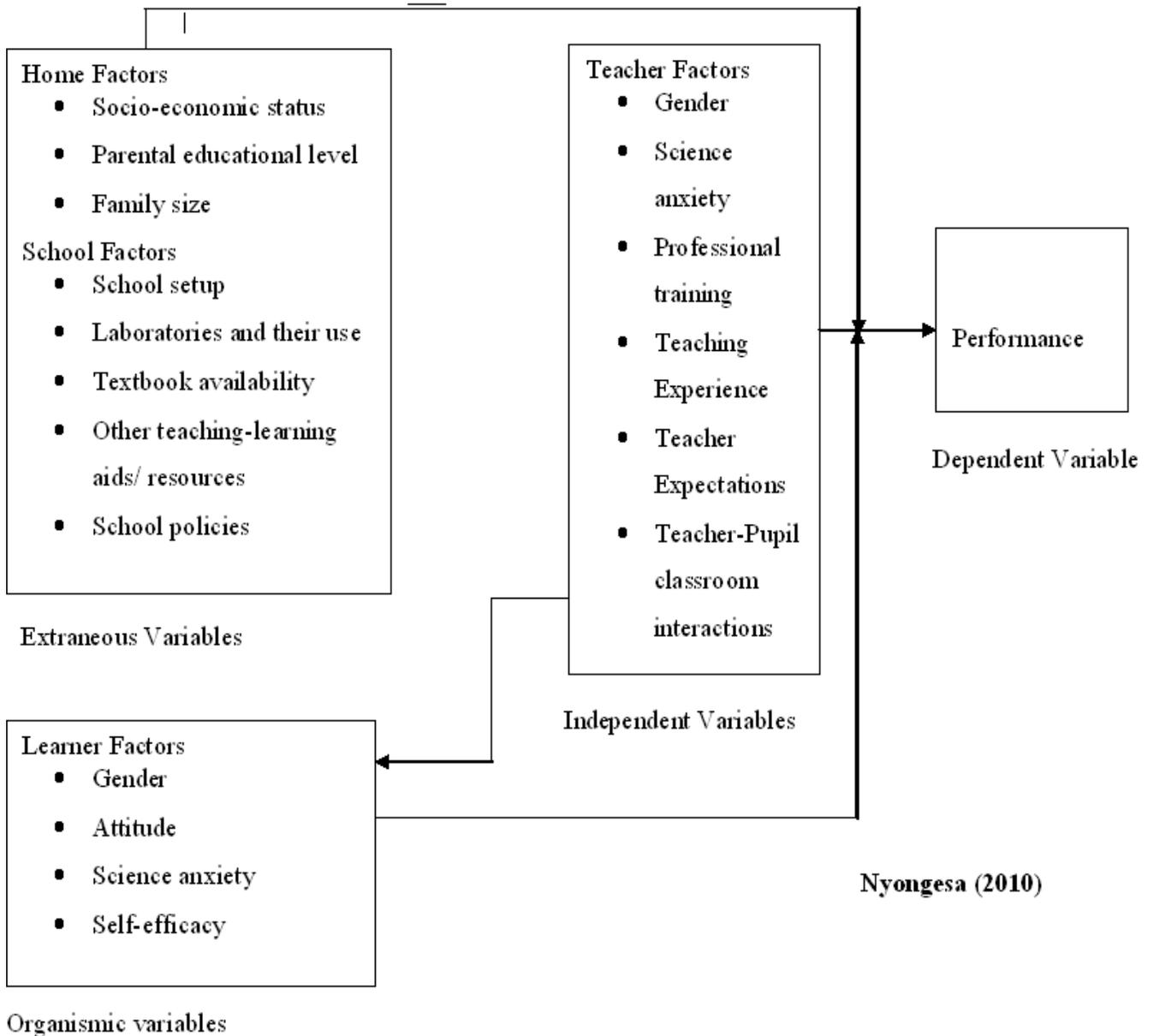


Figure 1: The Relationship between Home Factors, School Factors, Teacher Factors, Teacher Factors with Performance.

### Methodology

The Cross-Sectional descriptive survey design was employed in this study. According to Wiersma (1995), this research design involves collection of data at one and only one point in time from a random sample representing some target population. The questions asked in this research design

are: What are the characteristics of the variables? What are the relationships and possible effects among the variables? In this design the treatment is included by selection rather than manipulation (Orodho, 2005). The purpose of this design is to find causative relation between events or situations. In this design it may not always be possible to assume the simple causative relation between independent and dependent variables (Orodho, 2005).

### **Population**

There were 139 secondary schools in the district as reflected by the District Education. From the DEO's records, Bungoma district had a total of 264 biology teachers by the time of the study; out of this number 101 were female while 163 were male. This was the target population of teachers in this study. From the same records the district had a total of 9,901 form three students in the year 2007, in this population 4871 were boys and 4030 were girls. This was the target population of students in this study.

### **Sampling Procedures and Sample Size**

The study drew the sample from the registered secondary schools as reflected by the District Education officer's (D.E.O's) office records. Table 1 shows the number of secondary schools by category according to the type of school set-up and the number of schools that were selected for study per category.

**Table 1: Number of Registered Secondary Schools and Their Categories According to the School Setup.**

<b>Type of school setup</b>	<b>No. of schools</b>	<b>No. of schools selected for the student sample</b>
Single gender boys boarding schools	10	1
Single gender girls boarding schools	18	1
Single gender girls day schools	2	1
Co-educational boarding schools	2	1
Co-educational day schools	77	3
Co-educational boarding and day schools	30	2
<b>Total</b>	<b>139</b>	<b>9</b>

Source: District education office, Bungoma, 2007

A representative sample of 9 secondary schools was used for the student sample. The schools were selected using the Quota sampling technique as advocated by Kathuri and Pals (1993). This type of

sampling is the equivalent of stratified sampling, with the added requirement that each stratum is generally represented in the sample in the same proportion as in the entire population (Kathuri & Pals, 1993). The objective of the Quota sampling technique is to include various groups or quotas of the population in the study (Mugenda & Mugenda, 1999). The simple random sampling technique was applied in selecting schools from each category; this ensured that all schools in the district had an equal chance of being selected for the study. Purposive sampling was used to select the teacher sample for the study. Purposive sampling is a sampling technique that allows a researcher to use respondents that have the required information with respect to the objectives of the study (Mugenda & Mugenda, 1999). The authors argue that in this sampling technique the cases are handpicked because they are informative or possess the required characteristics. Therefore in this study all teachers of biology at various levels in all the 139 schools formed the teacher sample. A simple random sampling technique as advocated by Borg and Gall (1989) and Van Dalen (1979) was applied to select the student sample. This procedure involves assigning a number or any other identifying symbol and then using the number or symbol to select the sample size (Kathuri & Pals, 1993). For schools with more than one stream, only one stream was selected using the simple random sampling technique. The students in this selected stream were respondents to the student questionnaire (SQ). 360 students from the schools were the sample size used. 35 teachers from the teacher population formed the teacher sample. Both sample sizes can be justified from the formula of Krejcie and Morgan (1970). This formula is as follows:

$$S = \frac{X^2 NP(1-P)}{d^2 (N-1) + X^2 P(1-P)}$$

in which

S= required sample size

N=the given population size

P= population proportion that has been assumed to be 0.5 as this magnitude yields maximum possible sample size required.

d= the degree of accuracy as reflected by the amount of error that can be tolerated – the value of d being 0.05

X<sup>2</sup>= the table of value of chi square for one degree of freedom relative to the desired level of confidence, which is 3.841 for the 0.95 confidence level. This formula was adopted by Kathuri and Pals (1993).

## **Instrumentation**

Information was collected using the questionnaire. Two categories of questionnaire were used; a Students Questionnaire (SQ) and a Teachers Questionnaire (TQ). The questionnaires had closed form items. Mark lists kept by the teachers as tracking records were used to find information on average performance up to the form three level.

The Strait – Trait Anxiety Inventory (STAI) which was part of the questionnaire was used to collect data from the teachers related to science anxiety. This is a standardized test originally developed to study the relationship between anxiety and learning. Westerback (1984) and (Czerniak 1989, 1992) adapted the STAI to measure anxiety and self - efficacy about teaching science. The STAI was used to measure the levels of science anxiety of the teachers.

### **Data Analysis**

The data were analyzed by use of descriptive statistics. The data were analyzed using the *Statistical Package for Social Sciences (SPSS-11.5)* on computer. Systematical content analysis technique (Orodho, 2003) was used where the responses were classified according to meaning. In this analysis both designation and attribution of characterizations and descriptors are used (Orodho, 2003). This was necessary to underline assertions that could be characterized in a particular way. Designation was important to determine the frequency with which certain concepts were mentioned. Attribution was important to examine the frequency with which certain characterizations and descriptors were used with emphasis on descriptive phrases and qualifiers.

## **Background information on participants**

### **Gender of the teachers in the study**

Traditional beliefs and prejudices held by people regarding the roles, occupations and participation of women in the society have made gender issues an important aspect for consideration in the education of men and women (UNESCO, 2006). Table 2 carries information about the distribution of the teacher sample in terms of gender.

**Table 2: Gender of the Teachers in the Study**

<b>Gender</b>	<b>F</b>	<b>%</b>
Male	21	60.0
Female	14	40.0

<b>Total</b>	35	100.0
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Data collected from the District Education Officer's (DEO's) records indicated that Bungoma district had a total of 264 biology teachers. Among this population 163 teachers (61.7%) were male and 101 teachers (38.3%) were female. Information from Table 2 shows that the biology teachers who participated in the study were males (60.0%) and females (40.0%). This information agrees with the data obtained from the DEO's Office that male biology teachers were more than the female biology teachers in the district. This could confirm the common perception that certain school subjects are often viewed as gender related. Many science subjects for example are often viewed as 'males' subjects (FAWE, 2004)

**Highest academic level to which teachers pursued biology as a subject**

The knowledge, the intelligence and academic excellence the teachers possess have a direct bearing on the quality of education provided by schools in any country (UNESCO, 1991). Table 3 carries information on the highest academic level to which the teachers pursued biology as a subject.

**Table 3: Highest Academic Level to Which Teachers Pursued Biology as a Subject**

<b>Level</b>	<b>F</b>	<b>%</b>
Masters Degree	2	5.7
Bachelors Degree	25	71.4
Diploma	7	20.0
Certificate	1	2.9
<b>Total</b>	35	100.0

The largest number of teachers (71.4%) in the district had pursued biology as a subject up to Bachelors Degree level. This implied that the teachers had good grounding content knowledge in the subject area. Information from Table 3 shows that majority of biology teachers had sufficient content of the subject by virtue of their academic level in biology.

### Highest level of professional training of the biology teachers

The professional skills that teachers possess always impact on the attitude of learners towards any particular subject in the school's curriculum (Cox & Carpenter, 1989; UPDATE Project, 1992). Professional training of teachers is at the heart of all problems of instructional quality (UNESCO, 2006). The professional skills of a biology teacher contribute positively or negatively towards the levels of science anxiety of the learners (Nyongesa, 2010). The author posits that a professional teacher must have the adequate content knowledge of the subject far ahead of the learners, because it takes expert knowledge to handle the attitude and science anxiety of the learners in biology. Table 4 shows the distribution of the teacher sample according to their highest level of professional training.

Table 4: Highest Level of Professional Training of the Teachers

Level	f	%
B.Ed, M.Ed	1	2.9
B.Ed, M.Sc	2	5.7
B.Sc,P.G.D.E	6	17.1
B.Ed	19	54.3
D.Ed	5	14.2
Untrained Graduate (B.Sc)	0	0.0
Untrained Diploma holder	1	2.9
Untrained Certificate holder	1	2.9
<b>Total</b>	<b>35</b>	<b>100.0</b>

Most of the teachers (54.3%) held a B.Ed Degree as their highest level of training. This implied that a large number of biology teachers in Bungoma district had sufficient professional training to teach biology at secondary school level.

### Biology teachers by years of teaching experience

Teachers experience is always significant in the quality and quantity of instruction in the classroom (Wenglinsky, 2000). The author opines that long serving teachers are always more acquainted with the realities of classroom management. Teachers with a longer experience also display a high sense of confidence and self-efficacy in dealing with the learning problems of the learners (Bandura, 1997). The author asserts that long serving teachers also act as role models to influence pre-service

teachers and most young teachers tend to copy more from the long serving teachers in terms of professional practice. Long serving teachers may also exhibit a high sense of self- direction which is related to the level of self-efficacy (Evans & Tribble, 1986). Table 5 shows the distribution of the teachers’ sample according to their teaching experience of biology in years.

**Table 5: Teachers by Years of Teaching Experience.**

<b>Teaching Experience</b>	<b>F</b>	<b>%</b>
Less than 1 year	3	8.6
1-5 years	6	17.1
6-10 years	10	28.6
More than 11 years	16	45.7
<b>Total</b>	<b>35</b>	<b>100.0</b>

From Table 5 the largest population of the teachers (45.7%) had taught for more than eleven years. This implies that most of the teachers had adequate experience to teach biology at secondary school level. A good percentage (28.6%) had taught biology for between 6-10 years. This means that the district had a good number of experienced biology teachers.

**Gender distribution of the students**

Some of the factors that militate for or against students’ academic performance tend to give leverage to the male -child at expense of the girl –child (Mondoh, 2001). Against this background, this study was interested in the distribution of the student sample in relation to gender. Table 6 carries information about the distribution of the student sample in terms of their gender.

**Table 6: Gender Distribution of the Students in the Study**

<b>Gender</b>	<b>F</b>	<b>%</b>
Male	168	46.7
Female	192	53.3

Information in the Table 6 shows that the students who participated in the study were males (46.4%) and females (53.6%). In this table female students who participated were more than the males. This is because out of the nine (9) schools sampled two (2) schools were girls’ only schools. This automatically gave a higher number of female students in the sample.

**The number of students in terms of gender distribution in selected schools**

The educational attainment of girls has been associated with the type of educational institution one attends (UNESCO, 2003). Table 7 shows the distribution of the student sample in the different types of schools selected for the study as related to their gender. The schools were identified by the numbers 1-9.

**Table 7: The Number of Students in Terms Of Gender Distribution in Selected Schools.**

No. of school	Type of school	Gender distribution		
		M	F	Total
	Single gender Boys boarding school	40	—	40
2.	Single gender Girls boarding school	—	40	40
3.	Single gender Girls day school	—	40	40
4.	Co-educational boarding school	28	12	40
5.	Co- educational Day and boarding school	21	19	40
6.	Co- educational Day and boarding school	21	19	40
7.	Co-educational Day- school	23	17	40
8.	Co-educational Day-school	24	16	40
9.	Co-educational Day-school	11	29	40
<b>Total</b>		168	192	360

Information in Table 7 shows that in most co-educational schools, girls are usually the minority. This agrees with the report by UNESCO (2003). This could have an influence on the attitude and science anxiety of the girls in the learning of biology, especially when the number of male biology teachers is more than that of the female biology teachers. The subject in such a school would appear to be male dominated.

**Results and Interpretation**

### **Teacher expectations in terms of students' performance in biology**

Teacher expectations have a bearing on the attitude and science anxiety levels of the learners particularly when the learners are aware of the level of expectation the teacher has of them (King&Wiseman, 2001)). Table 8 shows the distribution of the teachers' sample according to their general expectations of their students in terms of their achievement in biology at national examinations.

**Table 8: Teacher Expectations in Terms Of Students' Performance in Biology**

<b>General expectation of teachers</b>	<b>f</b>	<b>%</b>
Very low	0	0.0
Low	3	8.6
Average	22	62.9
High	6	17.1
Very high	4	11.4
<b>Total</b>	<b>35</b>	<b>100.0</b>

Information from Table 8 indicates that most teachers (62.9%) had average expectations of their students in terms of achievement in biology at national examinations. From this table it can also be observed that all teachers had some level of general expectations from their students in terms of performance at national examinations. The students' self-efficacy is generally linked to the teachers' expectations (Bandura, 1997).

### **Factors that determine teacher expectations of their students' performance**

Frequent times teachers may find it difficult to know how their learners rate in comparison with those at similar schools; consequently some teachers develop inappropriate expectations as to what the learners can achieve (UNESCO, 1991). Table 9 shows the distribution of the teachers' sample according to the factors that determine their expectations of their students' achievement in biology at national examinations.

**Table 9: Factors that determine Teachers' Expectations of their Students' Performance in Biology**

<b>Factors</b>	<b>f</b>	<b>%</b>
Teaching experience	4	11.4
Testing and tracking of students records	23	65.7

Family background of students	6	17.1
Race of students	1	2.9
Appearance and behavior of the students	1	2.9
<b>Total</b>	35	100.0

Information from Table 9 shows that the largest proportion (65.7%) of teachers developed their general expectations of their students depending on the testing and tracking of students' records. Information from this table also indicates that teachers' judgment of students' academic ability may be influenced by family background of the child and other factors like teaching experience, race of the students and appearance and behavior of the students

### **Teaching methods most frequently used by teachers in biology**

Biology as a science subject requires an integration of both theoretical and practical work to make it easily understood by the students (SMASSE Project, 2000). Table 10 carries information on the teaching methods most frequently used by the teachers while teaching biology.

**Table 10: Teaching Methods Most Frequently Used by Teachers in Biology**

<b>Teaching methods</b>	<b>F</b>	<b>%</b>
Experiment method	7	20.0
Demonstration method	4	11.4
Project work	2	5.7
Lecture method	14	40.0
Field trips	0	0.0
SMASSE(ASEI / PDSI) approach	8	22.9
<b>Total</b>	35	100.0

Information from Table 10 shows that the largest proportion of teachers (40%) still used the conventional lecture method while teaching biology. This is contrary to the recommendations of curriculum developers and the Quality Assurance and Standards directives. It is expected that through field trips the learners would acquire attitudinal skills; however none of the teachers (0.0%) frequently used field trips to teach biology. This could be attributed to financial constraints and many schools could not afford to take students for frequent field trips. Only (22.9%) of teachers had

embraced the ASEI / PDSI approach as advanced by the SMASSE Project (2000). This implies that the Ministry of Education in conjunction with other stakeholders should organize for more in-service seminars for teachers on this teaching approach. This approach has been recommended by the Ministry of Education and most teachers had been in-serviced. This approach emphasizes a learner centered teaching methodology that integrates hands-on activities, eyes-on activities and experimentation with one of its main objective being to change the attitude of the learners by their teachers through this new teaching approach (SMASSE Project, 2000)

### **Factors that elicit negative attitude of students towards learning biology**

In relation to the teaching and learning of biology, attitudes begin to develop on the first encounter between the teacher and the learner, once formed they play a key role in determining students' learning and performance in biology (Nyongesa 2010). Table 11 carries information, which according to the teachers could be some factors that could elicit negative attitudes of the students towards teaching biology.

**Table 11: Factors that Elicit Negative Attitude of the Students towards Learning Biology.**

<b>Factors</b>	<b>f</b>	<b>%</b>
Quality of teaching methodology frequently used.	10	28.6
Authoritarian and impersonal teacher- student interaction in class.	13	37.1
Large class size that minimize teacher- student interaction in class.	12	34.3
<b>Total</b>	35	100.0

Information from Table 11 indicates that most teachers (37.1%) observed that authoritarian and impersonal teacher- student interaction in class could be the major factor that contributes to negative attitude of the students towards learning biology. Quality of teaching methodology frequently used and large class sizes also contribute significantly in the formation of negative attitude of the learners towards the teaching of biology.

### **Factors that elicit positive attitude of the students towards learning biology**

Attitudes are very important for effective learning; a negative attitude towards learning biology makes the learners to dislike the subject and may not appreciate the efforts of teachers in assisting

them to achieve higher in the subject while a positive attitude will make the learners to like the subject and put in more effort to compliment the work of the teachers (Twoli, 1996). Table 12 carries information that according to the teachers are some factors that could elicit positive attitudes of the students towards learning biology.

**Table 12: Factors that Elicit Positive Attitude of the Students towards Learning Biology**

<b>Factors</b>	<b>F</b>	<b>%</b>
Quality of teaching methodology frequently used.	10	28.6
Democratic and personal teacher- student interaction in class	13	37.1
Small or medium sized classes that maximize teacher-student interaction.	12	34.3
<b>Total</b>	35	100.0

Information from Table 12 indicates that democratic and personal teacher-student interaction in class elicits positive attitude towards learning biology. This according to the teachers could be the major factor that contributes to positive attitude. The quality of teaching methodology frequently used, teacher-student interaction in class and class sizes could have an influence on the attitude and science anxiety of the learners towards biology (Nyongesa, 2010). The quality of classroom life, teachers' attitude and teaching style and class sizes are all important but from Table 11 and Table 12 it is apparent that the type of teacher-student interaction in class seems to be a stronger indicator of educational quality in biology classes.

**Factors that elicit science anxiety among teachers in their teaching of biology**

The teaching approach, methodology and how the professional skills and practices of the teacher are displayed may be dependant on the level of science anxiety the biology teacher has (Nyongesa, 2010). Table 13 carries information that shows the distribution of the teacher sample on the main causes of science anxiety in their teaching of biology

**Table 13: Factors that Elicit Anxiety among Teachers in their Teaching of Biology.**

<b>Factors</b>	<b>f</b>	<b>%</b>
Lack of adequate teaching time	8	22.9

Lack of adequate content background	4	11.4
Lack of professional training.	1	2.9
Lack of sufficient laboratory equipment and apparatus	11	31.4
Long and congested syllabus.	11	31.4
<b>Total</b>	35	100.0

From Table 13 a large proportion of teachers (62.8%) observed that a long and congested biology syllabus and lack of sufficient laboratory equipment and apparatus were major causes of anxiety in their teaching of biology. Some teachers (22.9%) felt that lack of adequate time allowed for teaching biology could be their cause for anxiety.

### **Teachers' Perceptions of the students' attitude towards biology of both genders**

Teachers always have first hand information as regards their students (Jung, 2000). Table 14 carries shows the distribution of the teacher sample on how they perceive the attitude of students towards biology in relation to the students' gender.

**Table 14: Teachers' Perceptions of the Students' Attitude towards Learning Biology related to the Students' Gender.**

Teachers' Perceptions	f	%
Boys have more positive attitude than girls.	16	45.7
Girls have more positive attitude than boys.	10	28.6
There is no difference in attitude of the boys and the girls	5	14.3
No response / NA	4	11.4
Total	35	100.0

Information in Table 14 indicates that a large proportion of the teachers (45.7%) opine that boys have more positive attitude than girls towards the learning of biology. Some teachers (28.6%) observed that girls had a more positive attitude than boys towards the learning of biology.

### **Teachers' Perceptions of the students' performance in biology of both genders**

Numerous research findings have in the past indicated disparities in performance in SMT subjects in relation to the gender of the students (FAWE, 2004). From these findings, boys generally perform better than girls in these subjects. Table 15 carries information that shows the distribution of the teacher sample on how they compare the performance of their students in biology as related to the students' gender.

**Table 15: Teachers’ Perceptions of the Students’ Performance in Biology related to the Students’ Gender.**

Teachers’ Perceptions	f	%
Boys perform better than girls.	18	51.4
Girls perform better than boys.	10	28.6
There is no significant difference in performance between boys and girls.	3	8.6
No response / NA	4	11.4
Total	35	100.0

Information from Table 15 indicates that a larger proportion of teachers (51.4%) opine that boys perform better than girls in biology tests, assignments and national examinations. While (28.6%) of the teachers held a view that girls performed better than the boys.

**Teachers’ Perceptions about influence of teachers’ gender on learning in biology**

Teachers need to be aware of the general classroom life, personality types and school practices that encourage gender biases (Obura, 1991). The author asserts that teachers should be aware of and point out to the children gender stereotypes in texts, media, education materials and society as a whole. Table 16 shows information regarding the perceptions of teachers on how the gender of the teacher influences the learning of students in biology.

**Table 16: Teachers’ Perceptions about the Influence of The Teachers’ Gender on The Learning in Biology.**

Teachers comparison	f	%
Male students prefer male teachers	3	8.6
Female students prefer male teachers	5	14.2
Male students prefer female teachers	2	5.7
Female students prefer female teachers	3	8.6
Teacher’s gender has no influence on students’ learning in biology	22	62.9
Total	35	100.0

From Table 16 the largest proportion of (62.9%) the teachers opine that teacher’s gender has no influence on the learning of biology. Therefore the teaching and learning process according to these teachers is not influenced by the teacher’s gender.

**Teachers’ reasons for dissatisfaction in relation to the teaching of biology**

Career or job satisfaction contributes a lot to achievement of the anticipated results (UNESCO, 1991). A teacher who suffers from career dissatisfaction is likely to contribute negatively in terms of performance of the learners in biology; this is because the teacher will have lower self-efficacy and high levels of anxiety. This kind of teacher is likely to develop negative attitude towards the students and his/her interaction with the students will be negative and this may contribute to a negative attitude of the students towards biology with the likelihood of the students developing high levels of anxiety towards the subject (King & Wiseman, 2001). Table 17 shows the distribution of the teacher sample regarding the reasons the teachers had that could make them to have dissatisfaction with the teaching career as relates to the teaching of biology

**Table 17: Teachers’ Reasons for Dissatisfaction in Relation to the Teaching of Biology.**

<b>Reason for dissatisfaction</b>	<b>f</b>	<b>%</b>
Low salary scale	3	8.6
Teaching was a last option career choice	6	17.1
Low achieving students cause discouragement and burn- out	19	54.3
School administration never involves teachers in decision-making.	3	8.6
Biology is not my main teaching subject	4	11.4
<b>Total</b>	<b>35</b>	<b>100.0</b>

Information in Table 17 indicates that there are various reasons that can cause teachers’ dissatisfaction as related to the teaching of biology. This information indicates that a larger proportion of the teachers (54.3%) were affected by low achieving students who cause discouragement and burn- out. Discouragement and burn-out caused by low achieving students was cited as a main cause of dissatisfaction in relation to the teaching of biology. Some teachers (17.1%) indicated that teaching was their last option career choice. This implies that for these teachers, teaching was a stopgap measure while looking for better careers. Such teachers will naturally go to school to ‘work’ rather than teach and would not exert themselves in order to teach well (Wenglinsky, 2000). This points to the intrinsic aspects of the job.

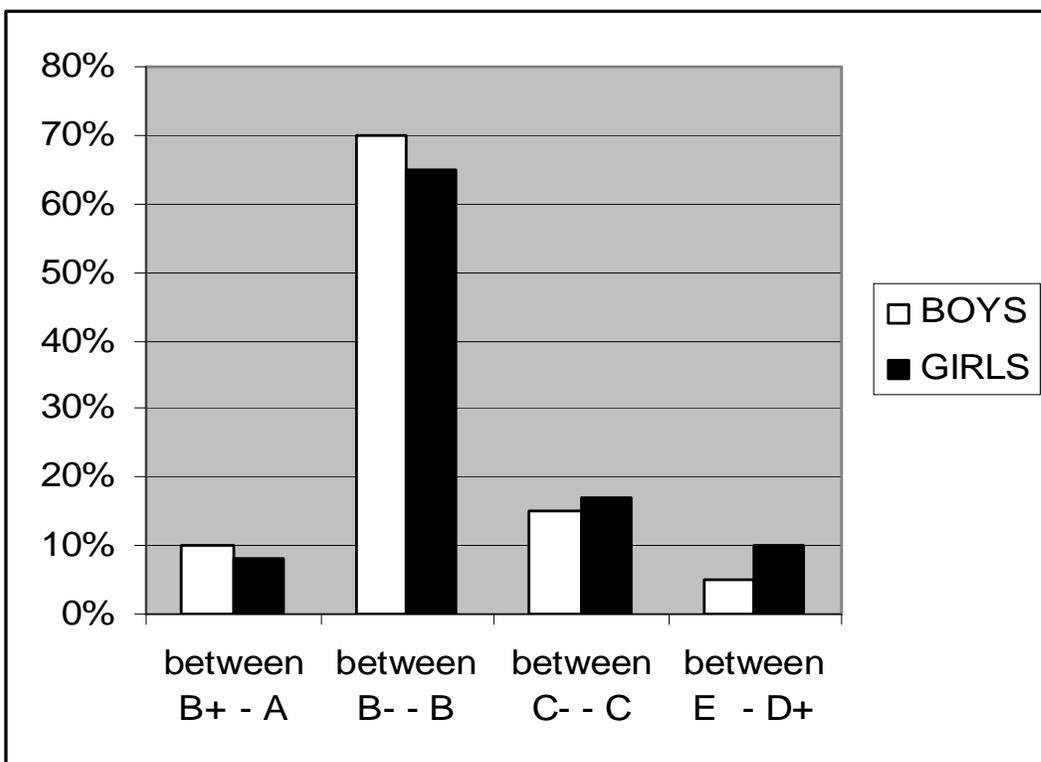
### **Science anxiety levels of the biology teachers**

Science anxiety has been related to the teachers' performance in science, highly anxious teachers tend to lack self confidence, curiosity and creativity in their teaching approaches (Spielberger & Syderman, 1994). Table 18 shows the mean scores of the levels of science anxiety that biology teachers had as related to their gender. The table shows the mean scores and numbers of valid responses to the STAI in measurement of the levels of science anxiety of the biology teachers.

**Table 18: Means Scores Of The Levels Of Science Anxiety Of Biology Teachers.**

<b>Variable</b>	<b>Gender</b>	<b>Mean</b>	<b>N</b>
<b>Anxiety scale</b>	M	2.1	21
At ease – anxious 1-2-3-4-5-6-7	F	2.6	14
<b>Confidence scale</b>	M	2.2	21
Confident-fearful 1-2-3-4-5-6-7	F	2.4	14
<b>Interest scale</b>	M	2.2	21
Curious – uninterested 1-2-3-4-5-6-7	F	2.4	14
<b>Total mean scores</b>	M	<b>6.7</b>	
	F	<b>7.6</b>	

Mean scores for the anxiety scale, confidence scale and interest scale are higher for the female teachers than the male teachers. The total scores of the means are higher for the female teachers (7.6/21) as compared to the male teachers (6.7/21). This implies that female biology teachers have a higher level of science anxiety in relation to the teaching of biology. This is likely to have noticeable effects on both the quantity and quality of science instruction which may impact negatively on the students' attitude towards the subject (Westerback, 1984). Figure 2 shows the general performance of students in biology since joining form one in relation to their gender.



**Figure 2: The General Mean Grade Performance in Biology of the Students.**

Information in Figure 2 indicates that male students had an overall better performance than the female students in biology. For the higher grades between B+ and A the male students had (10%) representation while the female students had (8%) representation. The female students on the other hand had a higher representation in lower grades. The lowest category of the grades between E and D+ the female students still led by (10%) while the male students had (5%) representation. This implies that biology is among the gender related science subjects.

**Reasons for disliking biology as related to the students' gender**

While it is true that the largest proportion of students liked biology, there were a proportion of them who disliked the subject. Table 19 shows the distribution of the student sample according to the reasons that made them to dislike biology. The table shows the distribution in relation to the students' gender.

**Table 19: Reasons for Disliking Biology as Related to the Students' Gender.**

	Gender M		Gender F		Total
Reason	F	%	f	%	

Poor teaching foundations given in form one	34	20.2	46	23.8	80
Difficult scientific terminology	66	39.3	96	50.0	162
The teacher express very high expectations of the students in terms of performance	19	11.3	18	9.5	37
Authoritarian and impersonal teacher- student interaction in the classroom	49	29.2	32	16.7	81
<b>Total</b>	168	100.0	192	100.0	360

Information in Table 19 reveals that male and female students had diverse reasons for disliking biology. However some reasons stand-out as common for both genders. Table 19 also reveals that forty nine male students (29.2%) and thirty two female students (16.2%) disliked biology because of the authoritarian teacher -students' interaction in class. This implies that most male students were negatively influenced by the authoritarian teacher- student interaction in the classroom.

#### **Factors that determined students' attitude towards biology related to gender**

Table 20 shows the distribution of the student sample according to the main factor that determined their attitude towards learning biology as related to their gender.

**Table 20: Factors that determined Students' Attitude towards Biology related to Gender**

<b>Factor</b>	<b>Gender M</b>		<b>Gender F</b>	
	<b>F</b>	<b>%</b>	<b>f</b>	<b>%</b>
Teaching methodology frequently used	34	20.0	39	20.0
Career prospects and choices	116	70.0	96	50.0
Kind of teacher-student interaction in the room	8	5.0	38	20.0
Level of expectation	8	5.0	19	10.0

the teacher has from students in terms of performance				
<b>Total</b>	168	100.0	192	100.0

Information in Table 20 shows that most students' attitude was due to the high career prospects and choices that biology offers. This implies that most of the students of both genders were intrinsically driven to study biology because of the high career prospects and choices. Information in Table 20 also reveals that the teaching methodology frequently used is an important factor determining student's attitude towards learning biology. Thirty four (20.0%) of the male students and thirty nine (20.0%) of the female students held a view that the teaching methodology frequently used influenced their attitude towards biology. The kind of teacher – student interaction in the classroom tended to have higher influence on the attitude of the female students (20.0%) as compared to the male students (5.0%). The level of expectations the teacher had from the students in terms of performance also seemed to influence female students' attitude more than that of the male students.

### **Discussion of Research Findings**

In a classroom setting, academic performance in biology varies from one student to another (Nyongesa, 2010). The author posits that this occurrence is usually observed despite the fact that the students are subjected under the same syllabus, curriculum and school facilities among other factors. This suggests that variability in academic performance in biology from one individual student to another can be attributed to other factors such teacher related factors. In this study it was found that girls are minority in co- educational schools. This finding is similar to that of UNESCO (2003). The report indicated that in most co- educational schools girls are usually the minority and hence there is a strong gender bias in subject choices available for girls. According to UNESCO (2003) there are three main reasons why male students always dominated co-educational schools. First, that there is cultural proclivity for seeing talk by women as too much talk. Second, social pressure requires that females could be good listeners and their verbal participation is seen as less important. Three, women are discouraged from talking by verbal and non-verbal messages such as delayed feedback, speech interruptions and withholding of active listening responses like nods or just by gazing at them.

### **Influence of Teachers' Perceptions on Performance in Biology in terms of Students Gender**

This study found that teachers' perceptions and comparisons about the performance of their students in biology rated the boys higher than the girls. This finding is similar to that of Nanda (1991). The teachers' influences at school have also been found to be a hindrance to girls' option for science and mathematics (Boit, 1986). Studies have shown that teachers tend to carry the societal expectations of girls into the school and therefore treat boys different from girls (Whyte, 1984). Some teachers are said to actually discourage girls by uttering statements like "mathematics and science are not meant for girls" (Wamahiu, Opondo & Nyagah, 1992). The negative societal perceptions regarding female involvement in science and technological fields are also transmitted within the educational system through books. According to a study carried out in Kenya by Obura (1991), it was found that textbooks in schools are a major socializing factor in the lives of children. First and foremost the text books present models of people. They present behavior and thought patterns which they imply are good to copy. The school as a social institution is authoritative and the textbooks used there carry authoritative messages on role models. It was established from the teachers that boys have a relatively more positive attitude than the girls. This finding is similar to those of Banu (1985), Kwon (1904) and those of Horton and Hutchnison (1997). Lucas and Dooley (1982) asserted that women report less positive attitude towards science than do men.

### **Influence of Teaching Methodologies on Learning and Performance in Biology**

Whyte (1986) established that certain teaching styles and methods tend to favor boys. The findings in this study indicated that most teachers of biology still use the traditional lecture method. The fact that boys had a more positive attitude towards biology as compared to the girls agrees with the findings of Whyte (1986). The author asserted that boys show greater adaptability to traditional approaches of teaching which require memorizing abstract and unambiguous facts which have to be acquired quickly. Boys are more willing to sacrifice deep understanding of correct answers achieved at speed. Chepcheng (1995) asserted that early socialization which children are taken through tends to make them develop attitudes that tend to support to the mistaken notion that mathematics and sciences are not for girls. This makes the girls to have a negative attitude towards science subjects but concentrate on other subjects.

### **Influence of Teacher-Pupil Classroom Interactions on Learning and Performance in Biology**

Students of both genders who reported their dislike for biology cited the authoritarian and

impersonal teacher – student interaction in class as the main causes for negative attitude towards the subject. Anderson (1970) established that the relationship between the teacher and the pupils in the Kenyan classroom was authoritarian and impersonal. In addition he observed that the underlying basis for interaction is that the students have come to school to be taught, the teachers' role is therefore to tutor them rather than to provoke them to learn. Students are not treated as thinking human beings that had their own views and experiences, which could be used to lead them, see the relevance of the new information they are learning (Anderson, 1970). Seli (2006) observed that teachers as role models were responsible for formation of positive attitudes towards a curriculum. Teachers' behavior and teaching practices have significant implications for female students' persistence, academic achievement and attainment (FAWE, 2004).

Most teachers have differential expectations for students' responses in activities like teacher-led class discussions, where boys are spoken to more frequently and asked higher order questions (Kombo, 2004). This definitely discourages the girls and leads to a relatively lower attitude. These differential expectations about the students in reference to their gender are a reflection of the broader societal biases about the role of women in society and the academic capacity of girls.

### **Influence of Teacher Expectations on Learning and Performance in Biology**

Findings of UNESCO (2003), observed that male and female teachers believe that boys are academically superior to girls; classroom observations in Kenya indicated that most teachers pay more attention to boys than girls or completely ignore the girls. At times boys received more attention in the distribution of text books and other learning materials and at times teachers reinforce the belief that girls lack spatial and analytical thinking (UNESCO, 2006). This is internalized and conclusively accepted thus justifying the self – fulfilling prophecy that there are certain subjects that are not for girls. Failure or success can be created by how the teachers' expectations could influence the attitude of the learner towards biology and contributes towards the learners' anxiety in biology (Nyongesa, 2010). The potential for the self-fulfilling prophecy effects of the teacher expectations exists when these expectations are inaccurate and inflexible, this could have damaging consequences for the students' educational performance (Proctor, 1994).

In this study it was found that most teachers did not have high or very high expectations of their students in terms of academic achievement in biology. Most teachers were found to have average

expectations of their students. Studies have shown that teacher expectations have a bearing on the attitude of students towards learning. Webster (1966) found that children achieved higher levels of academic success in schools where the teachers made it obvious that they expected a high proportion to do well in public examinations. It was noted that children are likely to work better if taught in an atmosphere of confidence that they can do well in tasks set for them (Webster, 1966). Wenglinsky (2000) pointed out that individuals tend to achieve a higher level of academic success when the expectation that they will succeed at a learning task is communicated to them. He observed that the teacher must convey his honest belief on his part that the students can achieve highly in the tasks. . Teachers' experience is an important factor that may determine teacher expectations; new inexperienced teachers but well intentioned may be socialized by older teachers into their own negative attitude towards the learners (Nyongesa, 2010).The author opines that, the main reason that determines teacher expectations of the students can have obvious educational implications that could be negative or positive in terms of performance. Some teachers could spend more time interacting with students for whom they have higher expectations (Persell, 1977). Nyongesa (2010) observes that these expectations could influence the attitude and the science anxiety of the learner as related to biology.

Westerback and Long (1990) found that socially disadvantaged learners have a greater need for more immediate gratification of reinforcement. Learning can be improved when they received frequent conformations of their achievements or gains; this improves on the positive attitude of the learners. They further suggested that the teacher should plan learning activity so that short range goals are clearly obvious to students. From the findings of this study it can be concluded that boys perform relatively better than the girls in biology because they have a relatively more positive attitude than the girls towards the subject.

### **Influence of the Science Anxiety of the Teachers on Learning and Performance in Biology**

This study found out that female teachers exhibit higher levels of science anxiety to towards the teaching of biology, as compared to the male counterparts. This findings are similar to those of Gorrell and Capron(1990).Science anxiety is a product of low self-efficacy (Yager & Penick, 1985). Bandura (1997) developed the Social Cognitive Theory from a programmed research on social development that had spanned several decades. The major construct emerging from this research is the construct of self-efficacy, a cognitive processing mechanism that guides human action. Self-

Efficacy, according to Bandura (1997) is one's perceived performance capabilities in a given situation or activity. This perceived performance capability affects behavior and attitude. According to Bandura (1997) people gather information about their self-efficacy in various ways. He observes that through various experiences; people observe others succeeding or failing in given situations and develop expectations for their own performance accordingly.

Gorell and Capron (1990) defined teacher self-efficacy as a belief that one's abilities can bring about positive changes in students behaviors and achievement. Teachers may believe that the environment and other factors beyond their control limit their abilities to bring about change in children. Such teachers feel helpless and give up trying to help children learn. Gorell and Capron (1990) suggested that without a belief in their ability to affect student performance, teachers do not accept responsibility for motivating students' learning. High levels of self-efficacy have been associated with greater student achievement and greater teacher commitment to student achievement as well as higher expectations for children Ashton, Webb & Doda 1983). The authors assert that teachers with a high level of self-efficacy seemed to take personal responsibility for student's learning. They tended to feel that if a student was not learning, it was not the student's fault or deficiency, but the inappropriateness of the teaching method, and these teachers changed their methods until success was reached. In other words, they persisted in helping students with difficulties in learning, and they were less critical in their feedback when students gave wrong answers. (

Gorell and Capron (1990) found that teachers with higher self-efficacy had a strong academic focus in their classrooms; they used games for instruction, used more innovative teaching techniques, monitored student's performance more closely, and taught by whole class instruction than teachers with lower self-efficacy. In addition, the authors believed that the behaviors, which are closely related to those in the effective school literacy, provided more supervision and resulted in more on-task behavior and less loss of time in transition from one activity to another. Finally, higher level of teacher self-efficacy was associated with better lines of questioning; high-efficacy teachers were better able to lead children to answers and were less likely to give students answers than low-efficacy teachers (Gorell & Capron, 1990). The sources of teaching dissatisfaction may be similar irrespective of the teachers overall level of dissatisfaction. (Westerback, 1994). However this could be issues of importance to all teachers or at least to most and not just to those who report a high

satisfaction at work; a sense of job satisfaction may enhance the teachers' quality of teaching (Nyongesa, 2010). On the other hand, a feeling that you are doing a good job as reflected by the good performance of the students may be an important source of satisfaction (Westerback, 1984). While job satisfaction will not necessary help a person become a better teacher, consistent lack of satisfaction at work may be associated with frustration and ultimately with the apathy associated with burn- out and this will influence the quality of instruction (Wenglinsky, 2000).

Teachers with low levels of self-efficacy demonstrated less commitment to helping students learn (King & Wiseman, 2001). They gave up quickly on children who failed and gave students answers rather than waiting for a response (Gorell & Capron, 1990). These teachers according to these authors exhibited lack of "witticism", that is, they often failed to recognize task behavior in their classrooms while working with small groups and preferred more rigid behavior controls. Results of studies on science anxiety have been consistent with studies of self-efficacy in general (Nyongesa, 2010) Poor self-efficacy may lead to science anxiety, thus providing a possible explanation for fewer entries into scientific careers (Guyton, Fox & Sisk, 1991). The authors found that pre-service teachers' level of efficacy could be increased by using self-directed learning. This type of self directed instruction may be beneficial in raising pre-service teachers' levels of efficacy and should be tried in other educational settings. Research on the impact of various experiences on self-efficacy and effective performance suggests that role models for effective science teaching, especially for elementary teachers, are a necessary component in teacher education (Bandura, 1997). Many studies in education have determined that role models, especially in the field setting, greatly influence teachers, for example Evans and Tribble (1986) summarized research in teacher education and concluded that role models such as co-operating teachers influence pre-service teacher's more than theoretical preparation on campuses.

Teachers with high self-efficacy believe that they can control their own classroom management skills, and they plan and select curriculum effectively (Ashton, Webb & Doda, 1983). Teacher education programs need to prepare teachers for the realities of classroom management, particularly in science. For example, if a teacher with a low sense of efficacy becomes easily flustered by classroom interruptions of routine and prefers rigid environments, this teacher would probably be easily bothered by hands-on instruction, open-ended instruction, or other less rigid teaching strategies shown to affect positively the attitudes and achievement in children (Ashton,

1984). Experiences with management and control of science classes, which differ in some ways from other subject areas due to the laboratory, inquiry-based nature of science, should be an integral part of teacher education courses (Ashton, Webb & Doda, 1983). Therefore, it is crucial that pre-service teachers have experiences with exemplary practicing science teachers. The degree of self-direction is also related to levels of efficacy (Ashton, 1984). The author reported that the structure of organization in schools can affect teachers' sense of efficacy. Teachers often believe that they have little control over decision-making that takes place in school. Teacher educators should address this concern by involving prospective teachers in discussions of ways to influence classroom and curricula decisions and ways to cope with the subordinate position of teachers in the school structure (Orodho, 1996).

### **Conclusions**

Emerging trends according to the findings of this study indicated that the gender of the teacher and the teaching experience in years in this age of science education, were not the key factors that influenced performance of secondary school students in biology directly but rather indirectly. Teacher perceptions, teaching methods applied, the type of teacher –pupil classroom interactions, teacher expectations of students in terms of performance and science anxiety levels of the teachers – partly contributed by lack of job dissatisfaction or satisfaction were the key factors that influenced performance in biology.

The conclusions made were based on the findings of the study as presented and discussed. A basic question relates to the proper role of the biology teachers in enhancing the learning of biology. What criteria should guide us in determining what the teacher can try to do, much less what he or she can do? Where must the teacher begin? Can the biology teacher effect sufficient change of attitude and learning behavior in biology? There is no sufficient understanding of the effects that various teaching practices have on raising or lowering student attitude and science anxiety gender-wise. From this; it is inevitable to conclude that the students, the teachers, the school and the parents have a crucial role to play towards successful achievement in biology (Nyongesa, 2010).

It can also be concluded that if we measure the cost in terms of unfulfilled human desires, underdeveloped capabilities and unexplored potential for improving the quality of biology education, any amount of money needed to do the job will be well worthy the expenditure. This is

in consideration of the fact that, we are living in an age in human history of high technology and industrialization where biology education plays a key role (Nyongesa, 2010). The author posits that for better students' achievement in biology, the teacher should not be isolated and the parents' role should not be taken for granted. It is inevitable to conclude that the parents and the community must forge a clear working relationship with the teachers and with the school. It must be accepted that the parents which in essence are part of the community are key components in the professional work of teachers who are also products of the community. The traditional role of the school is conceived to be that of transmitting the culture and a conservator of the existing social system, and all the consequences which ensue. (Nyongesa, 2010). On the other hand, the learning problems with which the school must deal with do not exist in isolation, the school where the teacher is found should act as a locus of activity in coordinating the solutions to these problems (Nyongesa, 2010) The author opines that therefore teachers of biology must consider the emotional, social and intellectual constructs if we are to examine the total educational goal of schools in a free society. The instructional materials should be free of gender biases and stereotypes. Finally, it can be concluded that for some students very high teacher expectations in terms of their performance makes them to like subject, this implies that this kind of students knew that they can measure to the teachers' expectations (Nyongesa ,2010). The author further posits that, for those students who knew that they are unable to measure up to the teachers' expectations they tend to dislike the subject. Figure 3 shows the inter-relationship between the genesis of teacher expectations of the students, their outcomes and their influence on performance in biology as envisaged by this study.

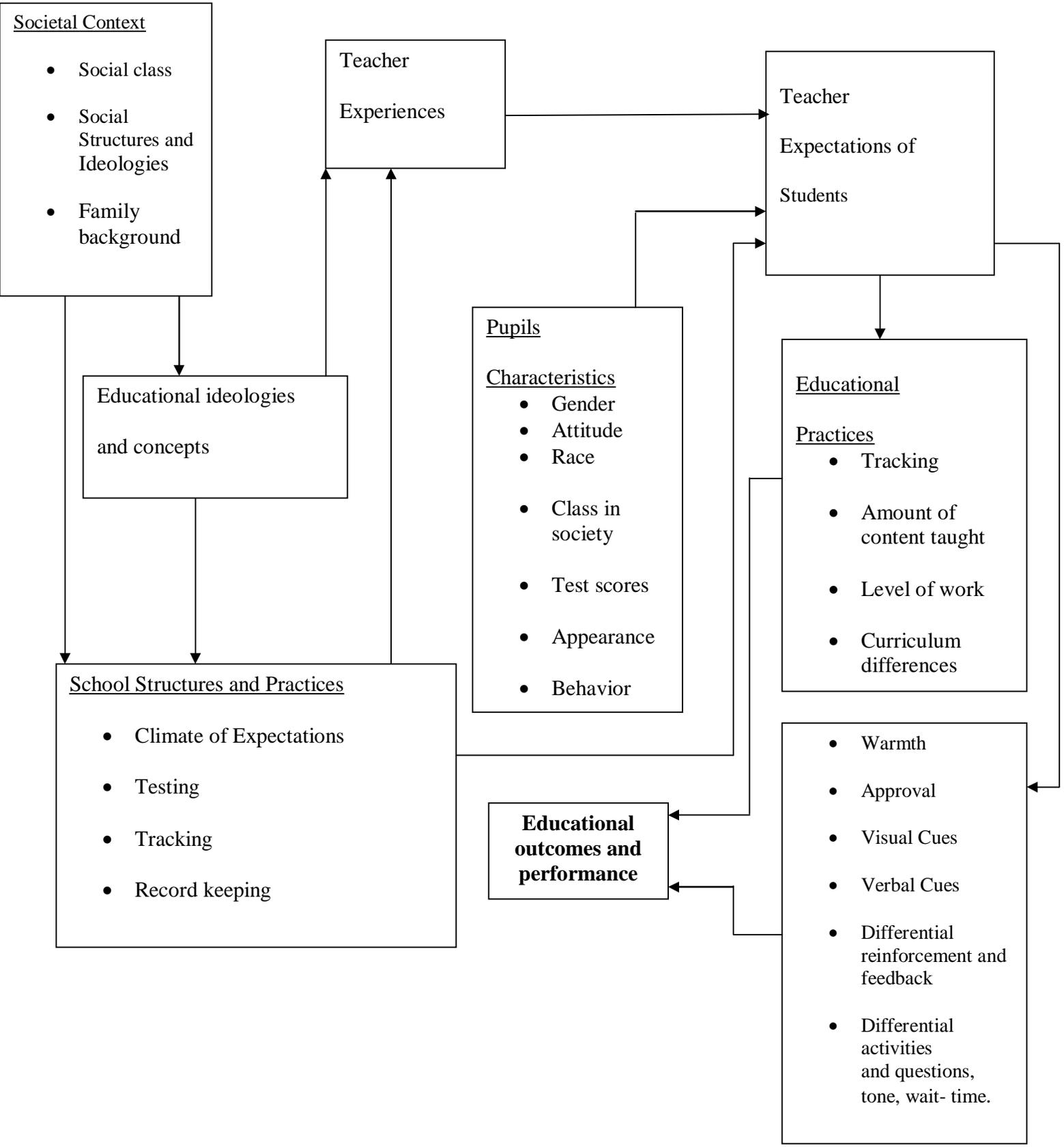


Figure 3: Inter-relationship between Genesis of Teacher Expectations and their outcomes

## **Recommendations**

Most children have some difficulties. Teachers on the other hand are not perfect, and schools being institutions (however child centered) can not be ideal for every child all the time. Given normal attention, most problems can be dealt with. Some avenues are listed below without elaboration at this point.

- (i) Since teachers are much a product of societal attitudes as the students, they should be empowered to take up the responsibility of implementing the relevant changes in their classrooms, schools and institutional communities in order to participate fully in promoting gender equity and equality in education and training from a life cycle approach. Such an approach in engendering the education system is likely to yield greater returns among generations of students.
- (ii) It is important that researchers are brought on board when it comes to education policy planning and implementation.
- (iii) The government has to put in place systems to ensure gender mainstreaming in education. The little known National Task Force on Gender, Education and Training, has remained moribund since it has set up in 1994. It must be revived so that it can provide the guidelines for gender mainstreaming in education. Without putting in place such strategies, achievements of EFA and MDGs on Industry and Higher Education will continue to remain a pipe dream.
- (iv) Teachers of biology should provide opportunities for all children to participate in demonstrations and experiments. The students should be given recognition for their projects by having their exhibits displayed to other pupils as well as to their parents at periodically organized community science fairs. This helps to tap the creative skills and abilities of the children.
- (v) The Ministry of Education and policy makers should ensure that the instructional materials, the curriculum and examinations are gender sensitive. This calls for the need to develop a criterion for evaluating gender – biases and stereotypes in instructional materials especially textbooks for all the National Curriculum Development Centers and Examination Council.
- (vi) The creativity teaching approach that will prepare students for industrial work should be embraced by teachers of biology in an attempt to motivate their students and boost the attitude of the learners in biology.

- (vii) Teachers of biology should embrace the ASEI /PDSI approach as advanced by the SMASSE Project which can improve on students' attitude and creativity much required in Industry, to bridge the gap in The Global Economy.

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**E2012-43: An Inviting School in Urban Low Socio-Economic Setting: A Case Study of A Public Primary School In Kibera Slum, Kenya**

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**Abstract**

Truly inviting schools do exist in growing numbers throughout the United States, Canada, South Africa, Hong Kong and other countries. These schools do not happen by accident but are the products of optimism, trust, respect, care, and purpose(Purkey & Novak, 2008). Invitational education is a significant and relevant theoretical model of practice that addresses the total educational environment: social, physical, cognitive, spiritual, and emotional (Smith, 2011). Developed by William W. Purkey, Invitational Education is democratically oriented, perceptually anchored, self-concept approach to the educative process. Democracy is a social ideal based on the

conviction that all people matter and can grow through participation in self-governance (Purkey & Novak, 2008). According to Purkey & Novak, 2008, people who are affected by decisions should have a say in formulating those decisions. This model postulates that each person creates their own reality through their perceptions of what they believe to be real (Combs, Richards and Richards, 1998; Combs & Gonzales, 1994; Kelly, 1995, 1963; Jourard, 1971 cited in Smith, 2011). The perceptual tradition maintains that all human behavior is a product of how people see themselves and the situations in which they are involved (Purkey & Novak, 2008). Human energy and motivation are always there but the role and responsibility of educators is to influence the direction this intrinsic energy and motivation will take. Human motivation is always there and it is a force that comes from within each person. However, this motivation is determined by how an individual see himself or herself-self-concept. Smith (2011) argued that a person's self-concept can change and develop as a result of inviting or encouraging acts. In this paper, I present findings on the five aspects -5Ps as perceived by pupils and teachers of a public primary school in an urban low socio-economic setting in Nairobi, Kenya.

## **INTRODUCTION**

This study was carried out to determine the perceptions of pupils and teachers on the school climate/environment of a public primary school in Kibera slum. The purpose of the study was to determine how the school is 'inviting' using the adapted the Inviting School Survey (ISS) questionnaire. The research question that guided this study was: "*What are the perceptions of pupils, and teachers, in the public primary schools in Kibera, on the how their school climate/environment is inviting?*" It was hypothesized that "*there is no significant difference on the perceptions of pupils and teachers in the public primary school in Kibera on how their school climate/environment is inviting*".

The finding of this study was to explain how the school climate/environment in a public primary school in urban low socio-economic setting was inviting. Such information would provide requisite information needed for future policy formulation and improvement the school climates of public schools in slums worldwide. This study was carried out in a public primary school in Kibera, which is in the vicinity of Nairobi city, Kenya. The school had a population of five hundred and twenty nine (529) pupils- 98.5% of them resides within the slum- from nursery to grade 8 with eighteen teachers (18) – seven (7) employed by Teachers Service Commission (TSC) and eleven (11) by the parents. The study participants were grade 8 pupils and the teachers in the school. Fifty-eight grade 8 pupils, and eleven teachers responded to the ISS, which represented 84% return rate for and 61% return rate for teachers.

### **Theoretical Perspective of the Study-Invitational Education Theory**

The study adopted the '[\*Invitational education theory\*](#)' addressing the total educational environment by emphasising on *people, place, programs, policies* and *processes* in the school.

*"Our educational mess consists of mandatory retention of schools, high stake testing, ruthless competition, zero tolerance, disheartened teachers, and other "disinviting" factors that contribute to mean-spirited schools (Novak, Rocca, & DiBiase, 2006)"*.

Invitational Education is a significant and relevant theoretical model for application by teachers and counselors (Smith, 2011). It is a self-concept approach to teaching, learning, and democratic

practice that offers a perspective for addressing, evaluating, and transforming the total school environment (Novak & Rocca, 2006)". Invitational Education is based on perceptual psychology and self-concepts tenets, and provides a model for educative and counseling practice to promote people to realize their potential in all areas of worthwhile endeavors. Developed by William W. Purkey (Purkey & Schimdt, 1996; Purkey & Novak, 1996) it is a democratically oriented, perceptually anchored, self-concept approach to the educative and counseling process. It focuses on five environmental areas that support or hinder an individual's success or failure, namely *people, places, policies, programs, and processes* (5 "P<sub>s</sub>") (Smith, 2011).

*"How do we create schools and institutions of higher learning education where people want to be, want to learn, and want to support?(Novak & Rocca, 2006)"*

The goal of the inviting approach is to have people work together to construct the ethical character, social practices, and educational institutions that promote a fulfilling shared life(Purkey & Novak, 2008).

An inviting school can be realized through the combined efforts of concerned educators, community leaders, other support staff, students/pupils and families. Violence behaviors (Issurdatt, 2011),sexual abuse/molestation (Obara & Macharia, 2011) and deplorable physical environment (Earthman & Lemasters, 2009) are some of issues that make most public schools *disinviting*. The nature of school administration, demands that the school head teacher or principal deals with each and every aspect of children, design programs that strengthen the home/school/community partnership and address barriers to student learning. Teachers serve as catalysts in promoting student wellbeing and successful completion of school (Instruction, 2010). They are involved on day-to-day basis with turning the school's '*disinviting*' aspects into '*inviting*' aspects. Knowledge, of invitational education theory enhances their capacities to positively influence *people, place, programs, policies* and *processes* in the school.

Disturbing conditions in public schools worldwide such as violent behaviors and sexual molestation are known to impede provision of quality education to children. In Kenya, two national committees- the Presidential Committee (Sagini, 1991) and Wangai Taskforce (2001)- were formed to look into student unrest in public secondary schools (Republic of Kenya, 1991, 2001). They were formed due to spate of incidents of students' unrest in secondary schools and found several reasons for the student unrest among them lack of communication and undemocratic practices in schools. Both committees proposed increased stakeholder involvement and improved dialogue with students. However, schools, especially public schools, needs to be made more inviting to students, teachers and parents to solve the problem of student's unrest in schools. This is with the realization that everything and everyone in and around school adds to, or subtracts from, the educative process. School conditions or circumstances within the school impact upon a pupil (Costin, 1969, p. 13).

Adults, including teachers and support staff, in the school setting bring unique knowledge and skills to the school system, student support services team which is instrumental in furthering the purpose of the schools - to provide a setting for teaching, learning, and for the attainment of competence and confidence (Instruction, 2010). They deal with each and every aspect of student, moulds future generations by inculcating moral values and ethical life. Ideally, the roles of adults can be summarized as making the school appealing to all those involve with it – an inviting school. To ensure that the child today receives quality education, the adults should impact all the five aspects of a school- '*people*', '*places*', '*processes*', '*programs*' and '*policies*'-5P's which is known as the "*practice of Invitational Education*". The goal of the inviting approach is to have people work together to construct the ethical character, social practices, and educational institutions that promote a fulfilling shared live. In this paper, we will discuss the 5Ps and the state of a public school in urban low socio-economic setting in Kenya with regards to the practice.

## RESEARCH DESIGN, METHODOLOGY AND ANALYSIS

This research was situated within the philosophical tradition of pragmatism and utilized the mixed model research design. A mixed method approach was preferred to minimize the weaknesses of both in single research studies (i.e. qualitative or quantitative) and across studies (Pelto & Pelto, 1978; Schensul, Schensul, & LeCompte, 1999; Creswell, 2003, p. 178; Johnson & Onwuegbuzie, 2004; Nastasi & Schensul, 2005). While pragmatism was recognized as the most useful philosophy to support mixed methods research since it was found to be well-developed and attractive for integrating perspectives and approaches (Johnson, Onwuegbuzie, & Turner, 2007).

Basically, while the research question and the hypothesis could have been carried out any public primary school in any urban low socio-economic settings, a purposeful choice was made to focus the questions to a public primary school in Kibera slum. Both qualitative and quantitative data was collected through the use of mixed-method questionnaire which consisted of both closed ended and open-ended questions. The closed-ended questions used a five-point response scale (*5-Strongly Agree; 4-Agree; 3-Not Sure; 2-Disagree and 1-Strongly Disagree*) to determine the level of agreement or disagreement to each statement. A total of fifty items were used to seek participant's views on '*people*' (10 items), '*place*' (12 items), '*processes*' (10 items), '*programs*' (8 items) and '*policies*' (10 items). Participant's perceptions were sought on how the 5Ps in the school could be considered 'inviting'.

Permission to conduct this study was secured from the National Council for Science and Technology (NCST)-Kenya; Ministry of Education (MoE), Kenya; Director City Education (DCE, Nairobi), the head teacher of the public primary school in Kibera and the Human Research Ethics Committee at Australian Catholic University (HREC-ACU), Australia. Consent was secured from the participant of the study through signing two copies of the consent forms and returning the researcher's copy and retaining their copy. The participants were briefed about the study and all their questions were answered before responding to the questionnaire. They were not forced to participate in the study and did not have to complete the questionnaire or give reasons for declining not to complete it. All data collected were confidential while no real participant or school name is mentioned in the study report.

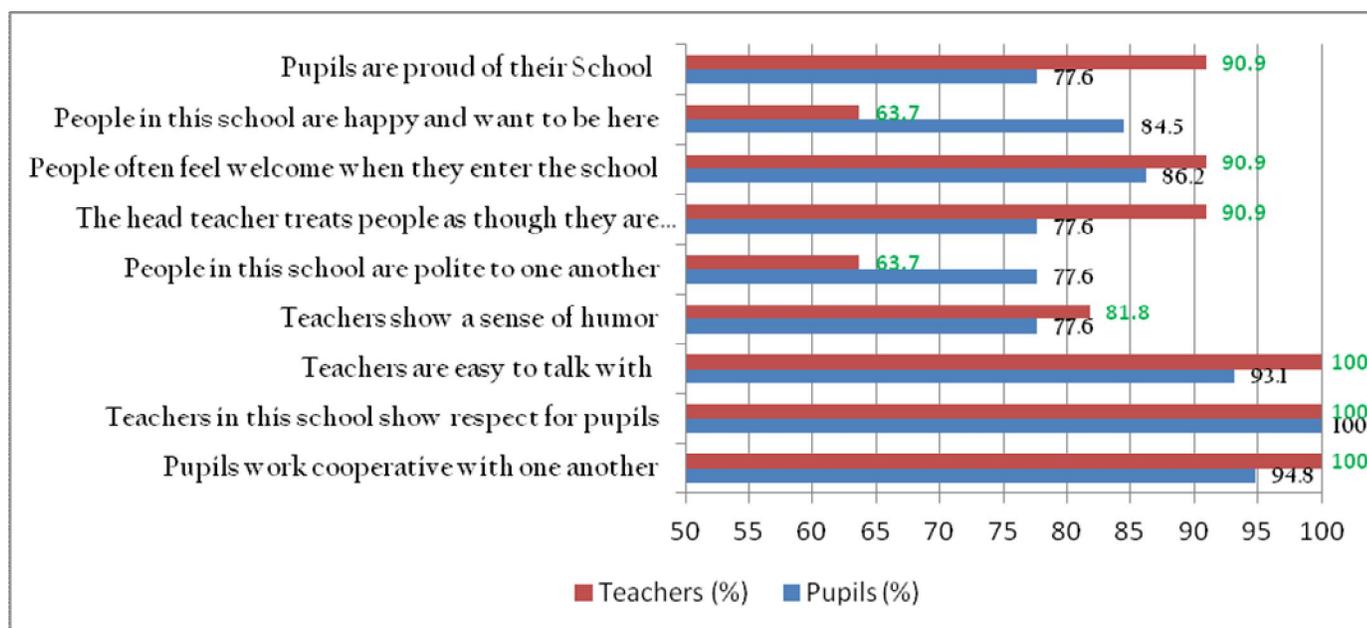
The data was entered with the aid of Statistical Package for Social Science (SPSS) version 19 for quantitative data and Nvivo 9.2 package for qualitative data. The reliability statistics –Cronbach's alpha ( $\alpha$ ) for pupil's and teacher's questionnaires was found to be 0.851 and 0.841 respectively which is statistically acceptable. Both descriptive statistics i.e. frequencies, mean, standard deviation ( $\sigma$ ) and percentages; and inferential statistics i.e. MANOVA were used to report the findings of the study. Typological and taxonomical analysis was done by listing all emergent themes or patterns –ideas, concepts, terminologies or phrases used from the open-ended questions with the aid of Nvivo 9.2. From prior themes i.e. 5Ps, the researcher developed a typology, a classification system taken from the patterns and themes identified (Patton, 2002 cited in Ratcliff, 2008, p. 128). The following section presents the findings, discussion and conclusion of the

perceptions of participants on the 5Ps- *people, place, processes, programs and policies*- of the public primary school in Kibera.

### STUDY FINDINGS, DISCUSSION, CONCLUSION & RECOMMENDATIONS

**(a) People:** Ten (10) ISS items were used to determine the perception of participants on how the ‘*people*’ in the school working cooperatively, showing respect, easy to talk to, and humorous, polite, treat others responsible, feel welcomed, and are proud to belong. Figure 1 below shows that more than 75% of both pupil and teacher respondents perceive teachers as easy to talk with; show respect to their pupils and humorous while the pupils work cooperatively. More pupils (77.6%) than teachers (63.7%) felt people in the school are polite to one another. Similarly more pupils than teachers agreed that people often feel welcomed when they enter the school. However, teachers (90.9%) felt more than the pupils (77.6%) that the head teacher treats people as though they are responsible. More than three-quarters of the respondents stated that the pupils are proud of their school but only 63.7% of the teachers state that people are happy and want to be there.

**Figure 42:** Percentage (%) of Pupils and Teachers who 'Strongly Agree' and 'Agree' on Statements about 'People'



**Table 9:** Mean (m) and Standard Deviation (σ) of pupils' and teachers' responses on statements about the 'people'

Statement	Mean (m)		Std. Dev (σ)	
	m <sub>p</sub>	m <sub>t</sub>	σ <sub>p</sub>	σ <sub>t</sub>
Pupils work cooperative with one another	4.34	4.45	0.690	0.522
Teachers in this school show respect for pupils	4.79	4.73	0.409	0.688
Teachers are easy to talk with	4.60	4.73	0.748	0.467
Teachers show a sense of humor	4.03	4.00	1.059	0.632
People in this school are polite to one another	3.81	3.36	1.100	1.433
The head teacher treats people as though they are responsible	4.21	4.09	1.088	1.136
People often feel welcome when they enter the school	4.43	4.18	0.939	1.168

People in this school are happy and want to be here	4.29	3.64	0.859	1.286
Pupils are proud of their School	4.24	4.27	1.097	0.641

From Table 1 above, both teacher and pupil respondents concurred that the pupils in the school work cooperatively ( $m_p=4.34$ ,  $m_t=4.45$ ,  $\sigma_p=0.690$  and  $\sigma_t=0.522$ ) and are proud of their school ( $m_p=4.324$ ,  $m_t=4.27$ ,  $\sigma_p=1.097$  and  $\sigma_t=0.641$ ). They also agree that people often feel welcome when they enter the school ( $m_p=4.43$ ,  $m_t=4.18$ ,  $\sigma_p=0.939$  and  $\sigma_t=1.168$ ) and that the head teacher treats people as though they are responsible ( $m_p=4.21$ ,  $m_t=4.09$ ,  $\sigma_p=1.088$  and  $\sigma_t=1.136$ ). Both respondents concur that teachers in this school are easy to talk with or approachable ( $m_p=4.60$ ,  $m_t=4.73$ ,  $\sigma_p=0.748$  and  $\sigma_t=0.467$ ), humorous ( $m_p=4.03$ ,  $m_t=4.00$ ,  $\sigma_p=1.059$  and  $\sigma_t=0.632$ ) and show respect to their pupils ( $m_p=4.79$ ,  $m_t=4.73$ ,  $\sigma_p=0.409$  and  $\sigma_t=0.688$ ). They both feel people are happy and want to be in the school ( $m_p=4.29$ ,  $m_t=3.64$ ,  $\sigma_p=0.859$  and  $\sigma_t=1.286$ ). However, their opinion are varied on whether people in the school are polite to one another ( $m_p=3.81$ ,  $m_t=3.36$ ,  $\sigma_p=1.100$  and  $\sigma_t=1.433$ ) with most teachers being undecided.

**(b) Places:** Twelve (12) ISS items were used to determine the perception of participants on the aspect of 'place' was to be determined by their responses on classroom desks, the freshness of the air in the school, the compound, the restrooms (or toilets), notice boards, the head teacher's office, availability of space for individual study, safety measures and lighting. Figure 2 below shows that the more than 75% of the pupil respondents indicated that their classrooms desks were pleasant and comfortable (93.1%) and offer a variety of furniture (desks) arrangements; school compound was clean and well-maintained (75.9%); the air smells fresh (77.6%); the lighting in the school is more than adequate (82.8%); there are comfortable chairs or seats for visitors (63.8%) and that the head teacher's office is attractive (79.3%). Only a few teacher respondents (*see Table 2 below*) indicated that the pupil's desks were pleasant and comfortable (27.3%); head teacher's office was attractive (27.3%) and lighting in the school was adequate (36.4%). More than half of the teachers indicated that the air smells fresh (54.6%), the school compound is clean and well-maintained (63.7%) and that classrooms offer a variety of furniture (desks) arrangements (54.6%). No teacher indicated that the school has comfortable chairs or seats for visitors. Though more than half of the pupil respondents agreed that their toilets are clean and properly maintained (56.9%) and the water taps were in good repairs (69.0%), more than 70% of the teachers had a contrary opinion. On the availability of a space or room available for them for private study, 53.4% and 18.2% of pupil and teacher respondents agreed respectively. Only a few pupils indicated that safety measures (i.e. fire alarms) were not well posted (18.9%) and the notice board was not attractive and up-to-date (36.2%) compared to 9.1% of the teachers.

**Figure 43:** Percentage (%) of Pupils and Teachers who 'Strongly Agree' and 'Agree' on Statements about 'Place'

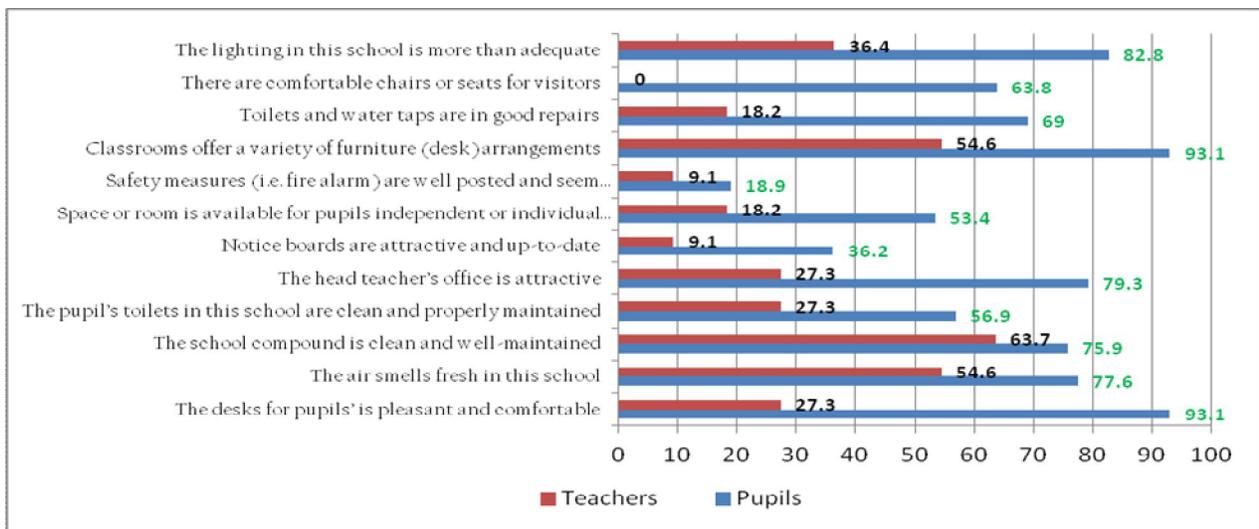


Table 10: Mean (m) and Standard Deviation ( $\sigma$ ) of pupils' and teachers' responses on statements about the 'place'

Statement	Mean (m)		Std. Dev ( $\sigma$ )	
	$m_p$	$m_t$	$\sigma_p$	$\sigma_t$
The desks for pupils' is pleasant and comfortable	4.41	2.45	0.974	1.214
The air smells fresh in this school	4.07	3.18	0.915	1.250
The school compound is clean and well-maintained	4.02	3.36	1.084	1.362
The pupil's toilets in this school are clean and properly maintained	3.34	2.45	1.345	1.293
The head teacher's office is attractive	4.05	2.18	1.176	1.250
Notice boards are attractive and up-to-date	2.48	1.82	1.709	1.079
Space or room is available for pupils independent or individual study	3.07	1.82	1.786	1.401
Safety measures (i.e. fire alarm) are well posted and seem reasonable	1.60	1.64	1.696	1.120
Classrooms offer a variety of furniture (desk) arrangements	4.52	3.00	0.978	1.612
Toilets and water taps are in good repairs	3.60	2.45	1.450	1.128
There are comfortable chairs or seats for visitors	3.55	0.82	1.501	0.874
The lighting in this school is more than adequate	3.45	2.27	1.477	1.618

Table 2 above shows that both teachers and pupils concurred that the safety measures (i.e. fire alarm) are not well posted ( $m_p=1.60$ ,  $m_t=1.64$ ,  $\sigma_p=1.696$  and  $\sigma_t=1.120$ ) and that the notice board was not attractive and up-to-date ( $m_p=2.48$ ,  $m_t=1.82$ ,  $\sigma_p=1.786$  and  $\sigma_t=1.401$ ). However, the views of the teachers were contrary to those of pupils on the several aspects including, (i) that the pupils' desks were pleasant and comfortable ( $m_p=4.41$ ,  $m_t=2.45$ ,  $\sigma_p=0.974$  and  $\sigma_t=1.214$ ), (ii) desk arrangement ( $m_p=4.52$ ,  $m_t=3.00$ ,  $\sigma_p=0.978$  and  $\sigma_t=1.612$ ), (iii) school compound was clean and well-maintained ( $m_p=4.02$ ,  $m_t=3.36$ ,  $\sigma_p=1.084$  and  $\sigma_t=1.362$ ), (iv) freshness of air in the school ( $m_p=4.07$ ,  $m_t=3.18$ ,  $\sigma_p=0.915$  and  $\sigma_t=1.250$ ), (v) attractiveness of the head teacher's office ( $m_p=4.05$ ,  $m_t=2.18$ ,  $\sigma_p=1.176$  and  $\sigma_t=1.250$ ), (vi) availability of space or room for pupils' private study ( $m_p=3.07$ ,  $m_t=1.82$ ,  $\sigma_p=1.786$  and  $\sigma_t=1.401$ ), (vii) state of pupils toilets ( $m_p=4.79$ ,  $m_t=4.73$ ,  $\sigma_p=0.409$  and  $\sigma_t=0.688$ ), (viii) state of water taps ( $m_p=3.34$ ,  $m_t=2.45$ ,  $\sigma_p=1.345$  and  $\sigma_t=1.293$ ), and (ix) adequacy of lighting in the school ( $m_p=3.45$ ,  $m_t=2.27$ ,  $\sigma_p=1.477$  and  $\sigma_t=1.618$ ). According to the teachers the pupil's desks were neither pleasant nor comfortable; the pupils' toilets were neither clean nor properly maintained while the head teacher's office was unattractive. The teachers stated that the school lacked comfortable seat for visitors and a space or room for private studies for the

pupils. However, the teachers were undecided on the freshness of the air, variety of arrangement and compound cleanliness and maintenance while the pupils were comfortable with these aspects.

(c) **Processes:** Ten (10) ISS items on the school ‘*processes*’ targeted included decision-making process, vandalism of property, assistance to pupils’ with special problems, awarding of marks, class interactions, and counselling. Figure 3 below shows that more than 75% of both respondents, pupils and teachers, stated that teachers in this school are willing to help pupils who have special problems, encourage them on self-confidence, counsel them about their future lives, and share out-of-class experience with them. Marks for tests and examinations are fairly assigned and a great percentage of the pupils pass examinations. According to 72.7% of the teachers, the head teacher involves everyone in the decision-making process compared to 48.3% of the pupils who think so. Though, most of the teachers think that the pupils have opportunity to interact during class activities, only 69.0% of them concurred. Over half of both respondents think that many people in the school are involved in making decisions. While 96.6% of the pupils think that their teachers appear to be happy and enjoy their job, only 63.7% of the teachers indicated so.

Figure 44: Percentage (%) of Pupils and Teachers who ‘Strongly Agree’ and ‘Agree’ on Statements about ‘Processes’

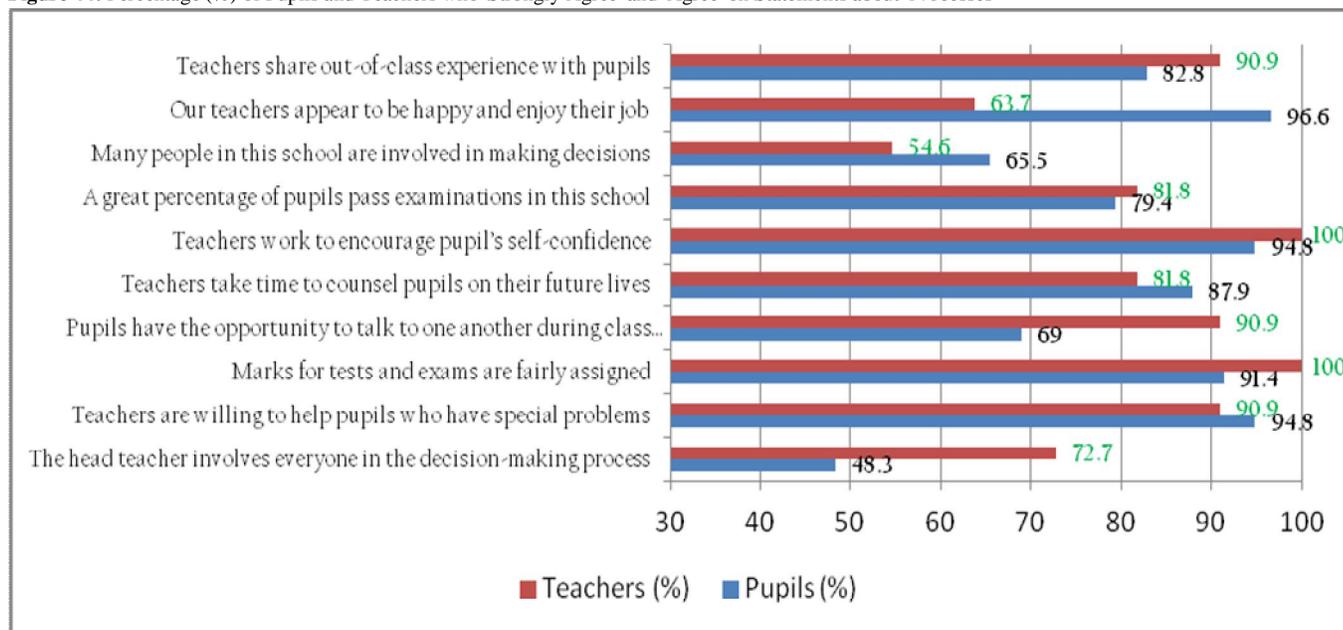


Table 11: Mean (m) and Standard Deviation (σ) of pupils’ and teachers’ responses on statements about the ‘processes’

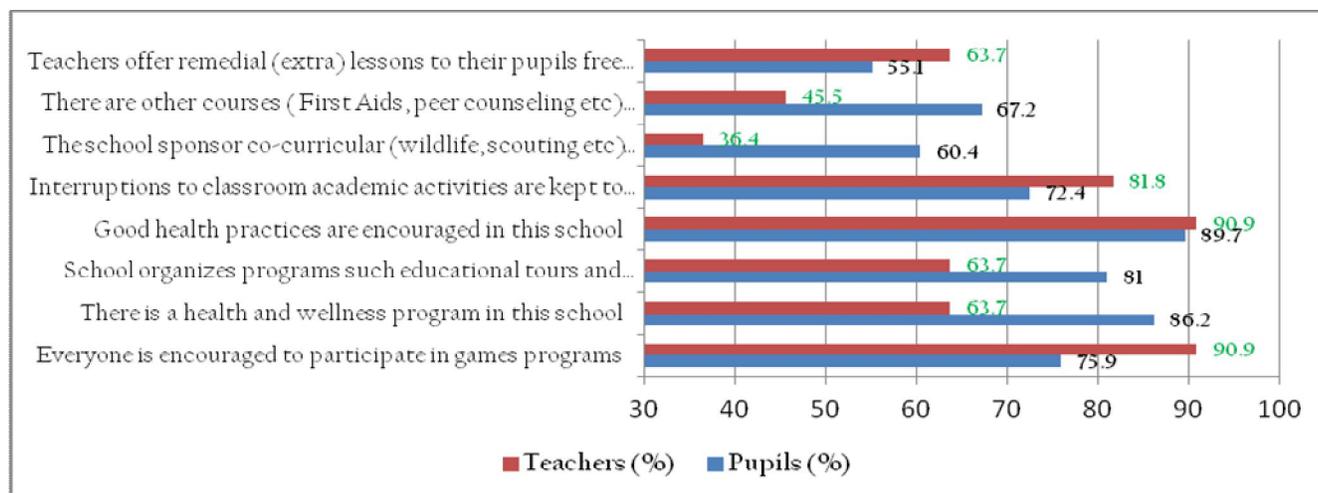
Statement	Mean (m)		Std. Dev (σ)	
	m <sub>p</sub>	m <sub>t</sub>	σ <sub>p</sub>	σ <sub>t</sub>
The head teacher involves everyone in the decision-making process	3.26	4.18	1.540	1.079
Teachers are willing to help pupils who have special problems	4.57	4.55	0.704	0.688
Marks for tests and exams are fairly assigned	4.48	4.64	0.800	0.505
Pupils have the opportunity to talk to one another during class activities	3.41	4.55	1.707	0.934
Teachers take time to counsel pupils on their future lives	4.28	4.09	1.005	1.375
Teachers work to encourage pupil’s self-confidence	4.67	4.82	0.574	0.405
A great percentage of pupils pass examinations in this school	4.05	3.55	1.083	0.820
Many people in this school are involved in making decisions	3.74	3.27	1.133	1.191

Our teachers appear to be happy and enjoy their job	4.66	3.64	0.548	1.027
Teachers share out-of-class experience with pupils	4.14	4.09	1.161	0.539

Table 3 shows that there is consensus between teachers and pupils that in the school, teachers are (i) willing to help pupils who have special problems ( $m_p=4.57$ ,  $m_t=4.55$ ,  $\sigma_p=0.704$  and  $\sigma_t=0.688$ ), (ii) take time to counsel pupils on their future lives ( $m_p=4.28$ ,  $m_t=4.09$ ,  $\sigma_p=1.005$  and  $\sigma_t=1.375$ ), (iii) work to encourage pupil's self-confidence ( $m_p=4.67$ ,  $m_t=4.82$ ,  $\sigma_p=0.574$  and  $\sigma_t=0.405$ ), (iv) appear happy and enjoy their job ( $m_p=4.66$ ,  $m_t=3.64$ ,  $\sigma_p=0.548$  and  $\sigma_t=1.027$ ), and (v) share out-of-class experience with pupils ( $m_p=4.14$ ,  $m_t=4.09$ ,  $\sigma_p=1.161$  and  $\sigma_t=0.539$ ). Both agree that marks for tests and exams are fairly assigned ( $m_p=4.48$ ,  $m_t=4.64$ ,  $\sigma_p=0.800$  and  $\sigma_t=0.505$ ) and that a great percentage of pupils in the school pass examinations ( $m_p=4.05$ ,  $m_t=3.55$ ,  $\sigma_p=1.083$  and  $\sigma_t=0.820$ ). Teachers indicated that the head teacher involves everyone in the decision-making process ( $m_p=3.26$ ,  $m_t=4.18$ ,  $\sigma_p=1.540$  and  $\sigma_t=1.079$ ) and that pupils have opportunity to interact during class activities ( $m_p=3.41$ ,  $m_t=4.55$ ,  $\sigma_p=1.707$  and  $\sigma_t=0.934$ ) but in both instances the pupils are undecided.

**(d) Programs:** Eight (8) ISS items were used to determine perceptions on the school 'programs' included their participation in games, availability of programs such as health and wellness, educational tours and excursion, and free remedial lessons. Participant's views on health practices, interruptions to academic activities, co-curricular activities and provision of life skills courses such as First Aids, peer counselling among others were determined. Figure 4 below shows that more than 75% of the participants agreed that everyone is encouraged to participate in games programs and to practice good health. According to 86.2% and 63.7% of the pupil and teachers respectively the school has a health and wellness program. While 81.0% and 63.7% of pupils and teachers respectively indicated that the school organizes educational tours and excursions for pupils. A great percentage of pupils (67.2%) than teachers (45.5%) think that the school organizes life skills courses such as First Aids, peer counselling among others for pupils. Both pupils (72.4%) and teachers (81.8%) are of the view that the school ensured that these programs (games, co-curricular etc) are conducted with minimum interruptions to academic activities. Whereas 60.6% of the pupil respondents think the school sponsors co-curricular (wildlife, scouting etc) activities other than games or sports only 36.5% of the teachers agrees. According to 55.1% and 63.7% of the pupils and teachers respectively were of the view that their teachers offer free remedial lessons for slow learners.

**Figure 45:** Percentage (%) of Pupils and Teachers who 'Strongly Agree' and 'Agree' on Statements about 'Programs'



**Table 12:** Mean (m) and Standard Deviation ( $\sigma$ ) of pupils' and teachers' responses on statements about the 'programs'

Statement	Mean (m)		Std. Dev ( $\sigma$ )	
	$m_p$	$m_t$	$\sigma_p$	$\sigma_t$
Everyone is encouraged to participate in games programs	3.88	4.36	1.258	0.924
There is a health and wellness program in this school	4.47	3.54	1.012	1.293
School organizes programs such educational tours and excursions	4.12	3.18	1.077	1.601
Good health practices are encouraged in this school	4.26	4.36	0.870	1.206
Interruptions to classroom academic activities are kept to a minimum	3.69	3.91	1.273	1.044
The school sponsor co-curricular (wildlife, scouting etc) activities other than games or sports	3.43	2.45	1.557	1.572
There are other courses ( First Aids, peer counseling etc) out of school curricula that are organized for pupils	3.62	2.82	1.694	1.779
Teachers offer remedial (extra) lessons to their pupils free of charge	2.98	3.18	1.924	1.991

Table 4 above shows that both the teachers and pupils agreed that in their school (i) everyone is encouraged to participate in games programs ( $m_p=3.88$ ,  $m_t=4.36$ ,  $\sigma_p=1.258$  and  $\sigma_t=0.924$ ), (ii) there is a health and wellness program in this school ( $m_p=4.47$ ,  $m_t=3.54$ ,  $\sigma_p=1.012$  and  $\sigma_t=1.293$ ), (iii) good health practices are encouraged ( $m_p=4.26$ ,  $m_t=4.36$ ,  $\sigma_p=0.870$  and  $\sigma_t=1.206$ ), and (iv) interruptions to classroom academic activities are kept to a minimum ( $m_p=3.69$ ,  $m_t=3.91$ ,  $\sigma_p=1.273$  and  $\sigma_t=1.044$ ). They are both undecided on whether the school sponsor co-curricular (wildlife, scouting etc) activities other than games or sports ( $m_p=3.43$ ,  $m_t=2.45$ ,  $\sigma_p=1.557$  and  $\sigma_t=1.572$ ) and provision of free remedial (extra) lessons ( $m_p=2.98$ ,  $m_t=3.18$ ,  $\sigma_p=1.924$  and  $\sigma_t=1.991$ ). While teachers are undecided on whether the school organizes life skills courses such as First Aids, peer counseling among others for pupils ( $m_p=3.62$ ,  $m_t=2.82$ ,  $\sigma_p=1.694$  and  $\sigma_t=1.779$ ), the pupils indicated existence of such courses.

- (e) **Policies:** Ten (10) ISS items on school '*policies*' that were targeted included how call were being received and responded to; teacher preparedness; daily attendance; <sup>1</sup>departure of school bus; freedom of expressions; stopping vandalism of school property; notes and messages to parents and grading practices. Figure 5 below shows that more than three-quarters of the respondents indicated that teachers are generally prepared for class; the daily attendance by pupils and staff is high; the school policy permits and encourages freedom of expression by everyone; and that the messages and notes sent home are positive. However, 72.5% of the pupils indicated that all telephone calls to this school are answered fast and politely compared to 36.4% of teachers who concurred. A higher percentage (72.7%) of teachers agreed that everyone arrives on time compared to 56.7% of the pupils. While 72.7% and 81.8% of the pupils and teachers respectively stated that that the grading practices in the school are fair. 81.0% and 54.6% of pupils and teachers respectively think that people in this school will try to stop destruction of school property.

**Figure 46:** Percentage (%) of Pupils and Teachers who 'Strongly Agree' and 'Agree' on Statements about '*Policies*'

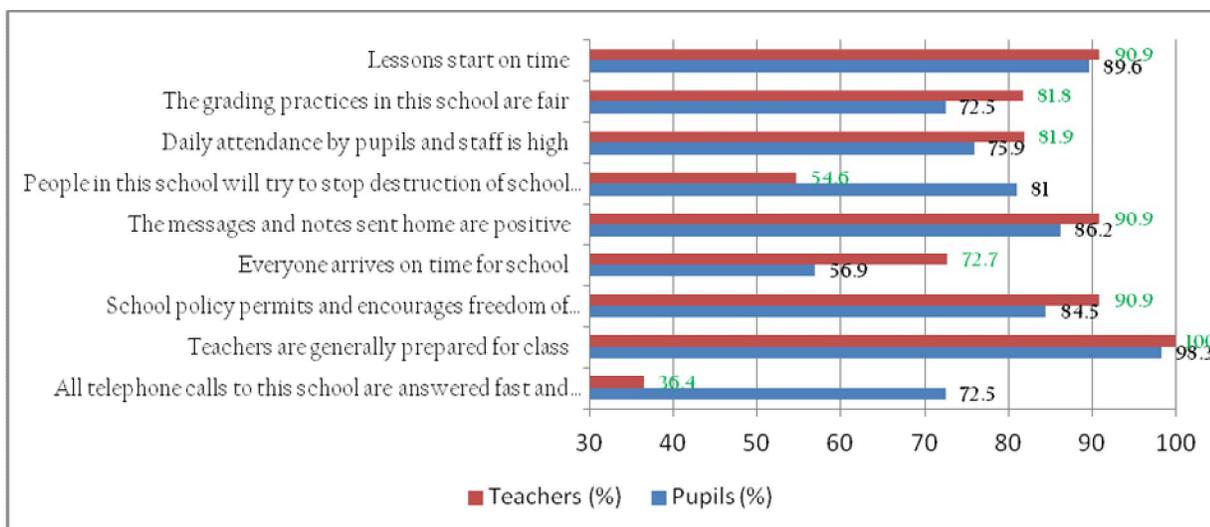


Table 13: Mean (m) and Standard Deviation (σ) of pupils' and teachers' responses on statements about the 'policies'

Statement	Mean (m)		Std. Dev (σ)	
	m <sub>p</sub>	m <sub>t</sub>	σ <sub>p</sub>	σ <sub>t</sub>
All telephone calls to this school are answered fast and politely	3.81	2.27	1.420	2.054
Teachers are generally prepared for class	4.72	4.82	0.555	0.405
School policy permits and encourages freedom of expression by everyone	4.22	4.18	1.027	1.168
Everyone arrives on time for school	3.19	3.45	1.191	1.214
The messages and notes sent home are positive	4.16	4.27	1.073	0.647
People in this school will try to stop destruction of school property	4.09	3.55	1.380	1.036
Daily attendance by pupils and staff is high	4.09	4.00	1.064	1.183
The grading practices in this school are fair	3.81	4.09	1.407	0.701
Lessons start on time	4.41	4.18	0.937	1.471

Notes: <sup>1</sup>The item on school bus was removed since the school does not have a bus.

Table 5 shows that there is concurrence between pupil and teacher respondents that; (i) the teachers are generally prepared for class ( $m_p=4.72$ ,  $m_t=4.82$ ,  $\sigma_p=0.555$  and  $\sigma_t=0.405$ ); (ii) school policy permits and encourages freedom of expression by everyone ( $m_p=4.22$ ,  $m_t=4.18$ ,  $\sigma_p=1.027$  and  $\sigma_t=1.168$ ); (iii) the messages and notes sent home are positive ( $m_p=4.16$ ,  $m_t=4.27$ ,  $\sigma_p=1.073$  and  $\sigma_t=0.647$ ); (iv) people in this school will try to stop destruction of school property ( $m_p=4.09$ ,  $m_t=3.55$ ,  $\sigma_p=1.380$  and  $\sigma_t=1.036$ ); (v) daily attendance by pupils and staff is high ( $m_p=4.09$ ,  $m_t=4.00$ ,  $\sigma_p=1.064$  and  $\sigma_t=1.183$ ); (vi) the grading practices in this school are fair ( $m_p=3.81$ ,  $m_t=4.09$ ,  $\sigma_p=1.407$  and  $\sigma_t=0.701$ ); and (vii) that lessons start on time ( $m_p=4.41$ ,  $m_t=4.18$ ,  $\sigma_p=0.937$  and  $\sigma_t=1.471$ ). However, both teachers and pupils are undecided on whether everyone arrives on time for school ( $m_p=3.19$ ,  $m_t=3.45$ ,  $\sigma_p=1.191$  and  $\sigma_t=1.214$ ). Though the pupils felt that all telephone calls to this school are answered fast and politely the teachers disagreed ( $m_p=3.81$ ,  $m_t=2.27$ ,  $\sigma_p=1.420$  and  $\sigma_t=2.054$ ).

## CONCLUSION

From the findings above the following conclusions are made about this school that the;-

1. Pupils work cooperatively and are proud of their school but the classroom activities are not offering them opportunity to positively interact.
2. Teacher are '*inviting*' since they are approachable, humorous; show respect for their pupils; willing to help pupils who have special problems; take time to counsel pupils on their future lives; work to encourage pupil's self-confidence ; appear happy and enjoy their job and share out-of-class experience with pupils.
3. The school administration i.e. the head teacher is '*inviting*' since people visiting feel welcomed and are treated all people responsibly while the decision-making process is inclusive.
4. physical environment of the school i.e. furniture, compound, water taps, pupils' toilet, head teacher's office, notice boards, safety measures ( fire alarms), lighting among others are not '*inviting*'.
5. School has several programs i.e. games, health and wellness and pupils are encouraged to participate actively with minimum interruptions to classroom activities. However, the school has not supported adequately other important programs such as clubs (wildlife, scouting) and training in life skills such as First Aids, peer counselling among others.
6. Policy of the school ensures teacher preparedness, regular attendance, and commitment, freedom of expression, effective communication, fairness and responsibility.

## **RECOMMENDATIONS**

To make the school more '*inviting*' the following recommendations are made;-

1. The school should enhance positive interpersonal relationship among the people in the school through offering courses on communication skills
2. The school should improve the physical environment especially the pupils' toilet, head teacher's office and the school notice board
3. Comfortable seats and chairs for visitors and a room for private study (i.e. library) for pupils should be provided
4. Proper maintenance of the existing facilities i.e. toilets, water taps among others is necessary
5. The school needs to plant trees around the compound to reduce the dust and improve the freshness of the air in the school
6. Safety measures including acquisition of safety equipments and posting of safety signs is necessary
7. There is need to introduce more programs such clubs/societies and offer life skill training to the pupils in the school
8. Teachers should be encouraged to offer free remedial (extra) lessons for pupils with special needs and those who are regarded weak or slow learners.
9. The school policy should enhance punctuality
10. It is important that a similar study be carried out in all schools to determine if they are '*inviting*' using the ISS instrument.

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### **E2012-44: Strategies Influencing Achievement in Mathematics and Competence in Soft Skills among Students in Technical Colleges in Kenya**

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#### **Abstract**

Mathematics is useful in daily life. It plays an important role in developing students' logical, creative and critical reasoning, optimize industrial processes, solve problems, function with linear and non-linear thought processes and communicate solutions briefly and precisely among other soft skills. Despite the critical role played by mathematics, low students' achievement in mathematics and low competence in soft skills had been witnessed. Low achievement and competence in soft skills had been a source of concern to stakeholders in technical and vocational education. That was because the input was not commensurate with the graduate output. Teaching styles in mathematics could be significant in determining the achievement in mathematics and competence in soft skills. Activity-based instructional processes and learning rather than expository means could improve achievement in mathematics and competence in soft skills. Yet, the use of multi-disciplinary approach that depends on using students' experiences in mathematics and science, project-based teaching and industrial-based activities had not been fully exploited in Kenya at least in East and Central Africa. The purpose of the study was to establish what activities in multi-disciplinary approaches could stimulate interest and deepen understanding of concepts in mathematics in technical colleges in Kenya. The findings and recommendations are expected to inform policy decision in establishing quality and relevance in training and accreditation in mathematics in technical colleges in Africa and world over. The study was carried out by a descriptive survey design. Colleges were enlisted using stratified random sampling. Random numbers were used for picking the sample respondents. Lecturer's questionnaire was administered to collect data on teaching styles. The results showed that multi-disciplinary approach with problem-solving in projects involving team-work with industrial staff and small group discussions of case studies in class deepened understanding of mathematics concepts served as the basis for industrial competence in soft skills and on-the job training for employability. The strategy of multi-disciplinary approach for improving students' achievement in mathematics and competence in soft skills in technical colleges in Africa and world over is recommended.

**Key terms:** Strategies, Students' collaboration, industrial staff, achievement in Mathematics, Competence and soft skills

## **1.0 Introduction**

Mathematics is foundational in scientific, technical, vocational and entrepreneurship training in technical, industrial, vocational and entrepreneurship training (TIVET) institutions in Kenya and world over. It plays an important role in critical thinking, logical thinking, effective decision making, and communication. Learning of mathematics is based on experimental and manipulative activities for competence-based training and assessment (CBTA) as well as competence in soft skills for creative problem-solving, critical thinking and effective decision making (Jackson, 2009; Jackson, Dukerich and Hestenes, 2008). Despite the critical role played by mathematics in daily life, students' achievement in mathematics technical and vocational institutions in Kenya (Bukhala, 2009; Amuka, Oyel and Gravenir, 2011; Obengo, 2011) and world over has persistently been low (Absi, et al., 2011; Jackson, 2009 and CRS, 2007).

Students in Kenya and the world over viewed learning of mathematics as mere reproduction of abstract concepts and non-practical applications making the discipline difficult (Absi, et al., 2011 and Khakala, 2009). Hence, low achievement in mathematics has been associated with deficiencies in instructions (Jackson 2009; Khakala, 2009 and Orado, LaTray, & Rozelle, 2011). Dominative teaching and learning approaches observed in institutions of learning has a display of the knowledge and skills of the instructor while students become passive recipients of the mathematical theories, principles, working procedures and algorithms making mathematics learning boring and unfruitful. Activities drawn from familiar surrounding are likely to raise questions in students mind. The process of seeking for answers lead to construction of knowledge. Activity-based learning in multi-disciplinary approaches can develop students' conceptual understanding in mathematics. However multi-disciplinary approaches that incorporate activity-based learning as a source of content and pedagogical strategies for developing students' conceptual understanding in mathematics has not been fully exploited. Hence, the impetus for this study is justified.

In Kenya, the National Council of Science and Technology (NCST) visions is a multi-disciplinary approach in meeting the need for competent-based training and assessment through science, technology, engineering and mathematics (STEM) scholars' development. Similarly, research in

STEM was heralded by Congressional Research Service (CRS) Report (2007) in institutions of learning in USA. STEM was initially responding to students' low achievement in science and mathematics in USA compared to their counterparts from Hong Kong, Singapore, and Chinese Taipei. The research project aimed at equipping students with a competitive edge for the 21<sup>st</sup> century creative innovations; prepare scientists, technologists, engineers and mathematicians who are globally and strategically placed for technological and scientific advancement. Low achievement in mathematics as well as low competence in Kenya and world over has been source of concern to the industries as consumers of scientific and technological knowledge and skills, student, parents/ guardians, instructors, educators, government among other stake holders because the graduates output is not commensurate with investment.

## **2.0 Literature**

The global view of provision of instructions in TIVET in the developed countries such as Britain, Germany, Japan among others is anchored on the advent of: digital simulation for learning in engineering, creative designing, architect, and actuarial science (Zachary, 2009); robot teachers (Gatonye and Mathenge, 2009); mobile phone learning (Nyantino, 2009), and the need for instructional activities that help students to effectively use the physical tools for enjoyment, nurturing social interactive, creative and innovative learning (Zachary, 2009 and Origa, 2000). The industrially upcoming superpowers have an enduring integration of recreation and sports in the TIVET instructions (Sriharikota, 2009 and Shobon, 1978). According to Zachary (2009) digital simulation overemphasis on TIVET instruction with out physical and hands-on activities produce creative and innovative graduates who are not in touch with the physical world.

The achievement of Japan to have modern education for scientific and technological progress promoting industrialization and economic growth faster than her peers such as: former West Germany, Israel, and United States of America (USA) has been associated with practical teaching and learning processes done in real-life situations (Kerre, 2010). Similarly, Shobon (1978) in Social Education Council recommended Practical training that involves students in activities done on the job and group activities in Japan institutions encouraged development of scientific and technological expertise. According to Kombo (2005:135) interactive teaching involving instructional activities:

*stimulate intellectual inquiry and the critical thinking skills necessary to serve the needs of the future. Schools events such as academic forums, science congress, seminars, and debates encourage critical thinking in students.*

Hence, cooperative learning activities that encourage limitless exchange of ideas among students in the institutions, across institution and academic staff through the use of ICT plat-form can play an important role in developing understanding of mathematics (Kearney, 2010). The use of ICT in teaching and learning play an important role in games and simulations. However, professors in these areas think that too much digital simulations with out students' hands-on activities involving use of physical tools can make them loose touch with the physical world (Zachary, 2009). The concern about lack of hands-on activities and having overuse of digital simulation in American Technical, Industrial, Vocational and Entrepreneurship Training (TIVET) arose as a result of the frustration of engineering, architect and creative design professors who found out that their best students had never taken apart a bicycle or built a model of an airplane (Zachary, 2009). According to the same report, overuse of digital simulation makes creative designers and engineers rebel against their alienation from the physical world.

The study by Kombo 2005:149) suggested that there exists a strong link between the cooperative learning and motivation to be competent by saying that:

*the more the students and teachers care about each other, the harder they will work to achieve mutual learning goals. Long-term and persistent efforts to achieve come from the heart not from the head. Individuals seek opportunities to work with those they care about. As caring increases, so do feelings of personal responsibility to do ones share of work, a willingness to take on difficult tasks, motivation and persistent in working toward goal achievement, and a willingness to endure pain and frustration on behalf of the group. All these contribute to group productivity. The success experienced in working together to get the job enhances social competencies, self-esteem and general psychological health.*

This means that the more the involvement of students in instructional activities the higher the chances of developing an all round person. The practice of multi-disciplinary approach in science, technology, engineering and mathematics STEM is desired (Earnest, 2009). Mathematics learning based on apprenticeship has been missing in Kenyan technical and vocational institutions. That may call for integration of teaching and learning experiences in Mechanics lessons by actualizing mathematical problems in activities in games and simulations as well as hands-on, minds-on and hearts-on. Activities carried out by students in experiments through improvisation in which the teacher plan for teaching, does the lesson, see and improve (**ASEI/PDSI**) approach as an intervention strategies was proposed to arouse and sustain curiosity and improving students'

competencies such as problem solving, analysis, synthesis, and application of relevant information in mathematics and science was used in secondary schools level by Strengthening Mathematics and Science in Secondary Education (SMASSE) (GoK, 2010). Hence, instructional activities play a key role in skills and knowledge acquisition for creative innovation. Hence, the impetus for this study is justified.

Small-groups-based instructional activities play important role in soft skills development (Kombo, 2005; Muthoni, 2012; Muthoni and Origa, 2000).The soft skills includes: critical thinking, psychological health; creative problem-solving; synthesis of knowledge; promoting self-esteem and facilitating teaching of meaningful content. Hence, students' achievement in mathematics can be improved through instructional activities which also develop soft skills. Hence, collaborative learning can also sustain students' motivation in learning Mathematics. This view was reinforced by Kombo (2005: 166) who observed that:

*cooperative learning promotes creative thinking by increasing the number of ideas, quality of ideas, feelings of stimulation and enjoyment, and originality of expression in creative problem solving....Cooperative learning in classroom goes beyond just achievement, positive achievement, and psychological health. ...It is the keystone to building and maintaining stable marriages, families, careers and friendships... the focus of on learning shifts from the teacher to the student.*

This suggests that involving students in cooperative learning activities also help teachers to shift from over-reliance on text question-and-answer to instructional activities which develop an all-round person and encourage instructors experiment on instructional alternatives. Kombo (2005) and Muthoni (2012) concurred that students' competence motivation can be sustained by encouraging the weak students to collaborate with their peers on instructional tasks that can arouse and maintain curiosity for increased motivation and academic improvement. Similarly, Origa (2000) and Khakala (2009) found that use of concrete objects and activity-based approaches encouraged deeper understanding of Mathematics concepts compared to approaches based on chalk and talk.

Village-centered craft oriented technical training in colleges is desired. This is because the experiences from the informal sector commonly known as *Jua Kali* sector in Kenya contributed to creative innovations. Gatonye (2009) observed that

*although universities have proven the most prolific in publishing research papers, with 194% growth in the last five years, it is the informal sector which leads in patenting of*

*practical innovations. The Permanent Secretary Ministry of Trade and Industry, Prof. Lonyangapuo, said that out of 10 patents registered since 2001, none were from local universities. Out of the 50 expected patents in the next 3 years, he said that most of them would come from Jua Kali sector.*

That meant that involvement of students in the informal (Jua-Kali) sector activities can complement provision of instruction in technical colleges and improve students' achievement in mathematics, develop on-the-job soft skills employability skills needed as well as encourage creative innovations. This is because *Jua Kali* perhaps provides greater opportunities for self-employment of the technical college students (Gatonye, 2009). Yet, the area on the role of informal sector as instructional activities for equipping trainees with soft skills had not been fully exploited.

Sustaining students' motive in mechanics goes beyond meeting the physiological needs. That calls for helping the students to identify another reason for pursuit of excellence in mechanics. The study by Gross (1996:97) postulated that:

*“ the master reinforcer which keeps most of us motivated over a long period of time is the need for a sense of personal competence, defined as our capacity to deal effectively with the environment. It is intrinsically rewarding and satisfying to feel that we are capable human beings to understand, predict, and control our world (a major aim of the study of science). The need for competence is seen to be continuous, ongoing motive. It cannot be satisfied fully. It is satisfied then it appears again because it not rooted in any physiological need” (Gross, 1996:97).*

This means that when the desire to be competent is sustained, individuals' productivity in terms of modeling mathematical relations, generating ideas, and problem-solving can be guaranteed. As soon as such individuals accomplish one task the sooner they embark on improving it or creating a new one. Hence, educators of mathematical calculation in mechanics will need to learn to trigger this need so as to sustain students' curiosity that will make them mathematicians for life and researchers. Hence, the impetus for this study is justified.

The need for competence in workers, trainees or students discharging their responsibilities in technologically competitive and intensive market conditions is necessary and urgent. The scores attained in curriculum based assessments in theoretical training is not sufficient evidence of competence without successful completion of On-the-Job-Training (OJT) programs. Competence standards gained by trainees in the workplace include all awareness, knowledge, skills and attitudes which are useful in bridging the gap between curriculums based training, help gain insight into what is provided in the course materials as well as practical training programs Khakala (2009) and

Mustafa (2012). Instructors and their trainees' collaborative activities in industrial settings (Kairu, 2012) as where the instructors are also producers, life-long learners, supervisors, role models of professionalism and partners in developing apprentices is desired.

### 3.0 Results and Discussion

The results from the questionnaires and interviews were analyzed and reported in a condensed for with agree, unsure or disagree. Table 1 shows the lecturers opinion on the students' achievement in mathematics in technical institutions in Kenya.

Table 1: **Achievement in Mathematics**

	<i>A-Agree</i>	<i>U- Unsure</i>	<i>D- Disagree</i>
<b>Achievement in mechanics includes:</b>	<b>A</b>	<b>U</b>	<b>D</b>
a) Ability to analyse situations and come up with a hypothesis	62	18	20
b) Make graphical and diagrammatical representations of phenomenon	76	6	18
c) Collect data, organise and analyse data, interpret data make conclusions	69	11	20
d) Form algebraic equations used in problem	57	10	33
e) Provide brief explanations of the mathematical results	30	3	67
f) Ability to work-out problem solving in class exercise	66	14	20
g) Solving problems in real life situations	75	2	23
h) Passing internal and curriculum based examinations in mathematics	96	3	1
<b>Factors found to influence achievement in mathematics includes</b>	<b>A</b>	<b>U</b>	<b>D</b>
a) Students view of mathematics as a mere reproduction of abstract ideas	90	4	6
b) Opportunities for practical applications	56	13	31
c) Qualifications of teaching staff	61	3	36
d) Attitudes towards mathematics	77	3	20
e) Involving students in teaching and learning activities	96	2	2
f) Availability of teaching/learning materials	92	2	10
g) Instructors and trainees industrial-based activities	78	6	16
h) Use of audio-visual resources charts, diagrams, models	95	3	2

The current study findings concurred with what ILO (2010), Kerre (2011), Kerre (2010) and Solomon (2011) asserted that on-the-job and off-the-job activities motivate students to work hard, encourage problem-solving skills development, develop industrial precautions and safety in the work place to protect the internal and the external public critical thinking, modeling mathematical relations and capacity to innovate. Similarly, the findings concurred with what Kerre (2011), Khakala (2009) and Mustafa (2012) asserted that designing systems that are environmental friendly, ability to work with green technology, able to take risks in an enterprise, use of mathematical thought processes to discuss and explain reasoning, use mathematical and numeracy skills to provide evidence for informed decisions, answer questions from assessors. The soft skills needed

are also needed in maintenances, repair and operations (MRO) Kerre (2010) as used in the supply chain management. The results in Table 2 shows the lecturers' opinion related to competence in soft skills developed in mathematics in technical institutions.

**Table 2: Competence in Soft Skills**

<b>Development of Competence in soft skills is necessary because:</b>	<b>F %</b>	<b>M %</b>
a) Promote physical and mental wellbeing	78	76
b) Help promote healthy interpersonal relationships and form lasting friendship (psychological health)	89	90
c) Help make informed and effective decisions	76	74
d) Develop full potential	68	72
e) Translate knowledge, attitudes, skills and values into action	73	74

The current study and the work by Kombo (2005), Muthoni (2012) and Origa (2000) agreed that there is need for soft skills development and these soft skills are developed through instructional activities. Kombo (2005) and Muthoni (2012) concurred with the current study that mental well-being, physical well being, interpersonal relationships, effective communication and team workmanship were prioritized in work-place competence.

Table 3 shows the specific soft skills developed through activities in mathematics in technical institutions in Kenya.

**Table 3: Soft Skills developed through Collaborative Activities in Mathematics**

<b>Soft skills include:</b>	<b>F %</b>	<b>M %</b>
a) Critical and creative thinking skills	60	69
b) Problem solving skills	49	60
c) Coping with stress	59	68
d) Negotiation skills	75	74
e) Entrepreneurship skills	51	49
f) Information handling skills	65	69
g) Effective communication skills	68	65
h) Conflict resolution skills	54	57
i) Assertiveness	45	42
j) Team-work skills	47	53
k) Sales and marketing skills	78	72
l) Ability to engage in community service	65	67
m) Instructional activities can develop soft skills	34	31

The current study and Chaffins (2010) concurred that soft skills include: job readiness skills such as: effective workplace communication; interpersonal skills which include conflict resolution, active listening, negotiations, ethical behavior, getting along with co-workers, assertiveness and managing stress. They also include job search skills such as finding job openings, resume writing,

interview skills, and networking and financial management to help trainees manage the money they earns. Similarly, the work by Mustafa (2012) is similar to the current study in that students taking technical and vocational training need to develop specific soft skills such as motivation, reflection, self-evaluation, self-guidance, critical and cross-disciplinary thinking, teamwork and problem-solving skills. The soft skills developed through mathematics include problem-solving, critical thinking, logical thinking (GoK, 2010; Jackson, 2009 and Khakala, 2009). The current study and Mustafa (2012) agreed that the skills developed through mathematics can train people to respond to complex demands, communicate with and understand others, plan ahead, make innovative choices and take risks and accept the consequences. Industrial-based activities develop hard and soft skills (Kerre, 2011). Table 4 shows the students opinion on the influence of instructional activities on students' soft skills development.

**Table 4: Influence of instructional activities in mathematics**

<b>Influence of instructional activities on students</b>	<b>A</b>	<b>U</b>	<b>D</b>
a) They are more actively involved	72	5	23
b) Students show great interest and responsiveness	87	1	12
c) Attend lessons more punctually and promptly	83	2	15
d) Carry discussion beyond class time	63	2	35
e) Students' interest and curiosity are aroused and sustained	59	12	29
f) Able to relate mathematics to real life experiences	78	11	11
g) Industrial activities can motivate trainees to keep working	93	3	4
h) Encourage team work	72	12	16
i) Provide opportunities to develop key competencies such as problem-solving, analysis, synthesis, and application of relevant information	87	6	7

The report by ILO (2010) concurred with the study findings that most African TIVET institutions have been unable to cope up with technological changes in the workplace and consequently producing graduates that are not suited to the industry. However, the industrial-based activities that involve academic staff and industrial staff and students can reduce the impact of inadequate or limited training facilities. The current study and the work by Kairu (2012) concurred that instructors in industrial attachment work as producers, life-long learners, supervisors, role models of professionalism and partners in developing apprentices. Supervised farming activities like visits to the market by TIVET students can provide students with opportunity to learn data handling techniques that are essential in market information process sing skills and experiences such as customers and clients handling.

#### **4.0 Conclusion and Recommendation**

The link between mathematics and soft skills is best illustrated by instructional activities that encourage problem-solving skills development. The activities develop problem-solving if they require creativity, insight, original thinking, imagination and application of the previously learnt knowledge and skills. Problem-solving that is in both mathematics and soft skills involve analyzing the situation, translating the results, illustrating the results, and seeing the alternative solutions. Problem-solving in mathematics is critical in soft skills development because it encourage reflective thinking, continuous monitoring and evaluation through continuous re-learning experiences (CRE). Supervised farm produce related activities like visits to the market by TIVET students can provide students with opportunity to learn data handling techniques, market information processing skills and experiences and customers and clients handling experiences. Games and simulation encourage enterprise orientations and negotiations skills to students. Instructional approaches that encourage on-the-job-training and off-the-job-training activities; activities in the informal sector; games and simulations; small-group discussions and collaboration between students and trainees could post higher scores in mathematics and develop soft skills among TIVET graduates. Competence in soft skills developed through mathematics activities include: critical and creative thinking skills, problem solving skills, coping with stress, negotiation skills, entrepreneurship skills, information handling skills, effective communication skills, conflict resolution skills, assertiveness, team-work skills, sales and marketing skills, ability to engage in community service and instructional activities in mathematics can develop soft skills. The results showed that multi-disciplinary approach with problem-solving in projects with team-work involving academic staff and industrial staff and small group discussions of case studies in class deepened understanding of mathematics concepts served as the basis for industrial competence in soft skills and on-the job training for employability. The strategy of multi-disciplinary approach for improving students' achievement in mathematics and competence in soft skills in technical colleges in Africa and world over is recommended.

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#### SYMPOSIUM 4

##### **L2012-01: Terror, Terrorist and Terrorism: A Global Justice and Human Rights Perspective**

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##### **Abstract**

Over the recent past, Kenya has experienced numerous terror threats and actual terrorist related deaths that have shocked the nation. Why now? And more importantly, why are we being attacked? Who is attacking us? And where will the next attack be? These are poignant questions that can only be understood when one appreciates terrorism and its implication. “Terror” “terrorists” and “terrorism” are concepts that are as old as humanity itself. This paper examines the view points and ideological perspectives into the quest to derive an acceptable definition of the terms and the possible difficulties that might be experienced in settling for a universally accepted definition. The paper also attempts an analysis of the multifaceted forces of terrorists ranging from the organizational, physiological, political, and psychological as well as the multi causal approach thereby attempting to answer the question: what exactly inspires terrorists into action? A hypothesis of terrorism is also attempted given the three widely recognized methods i.e. negative identity hypothesis, frustration aggression hypothesis and the narcissistic rage theory. The paper also then analyzes the terrorist mindset in a criminological manner in an attempt to understand what motivates a terrorist as well appreciate the group dynamics of terrorism. The question of whether terrorists should be afforded human rights is looked into vis -a -vie the victim’s perspective and the quest to find justice for victims as well as the suspected terrorists themselves. Being a relatively expensive undertaking, we look at how terrorism has been financed and an even more complex phenomenon of state sponsored terrorism. Finally, the paper seeks to identify possible social, political, economic as well as legal solutions towards combating terrorism thereby prevent shedding of innocent blood as presently witnessed world all over in a biblical perspective.

##### **L2012-02: Kenya Prisons: Towards Privatization and Reform of a Rotting Penal System**

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##### **Abstract**

This research paper is written to attempt and instigate a reform agenda for the Kenya Prison Service. Kenya Prison has been a department of inertia that has been besieged by many problems that have ranged from poor administrative policies, poor infrastructure to lack of contemporary penal practices. This paper will address a viable option of revamping the Prison Service through privatization by contracting out prison services. This privatization will be addressed on the following fronts: Propriety/Correctness of Prison Privatization, Cost of Prison Privatization vs. Cost to the Kenyan Government, Quality of services to be offered by privatizing, Quantity of services to be offered by privatizing, Flexibility of the private service providers vs. The State, Security of the prison facilities, Issues on liability, Issues on accountability, Corruption. This Research used a case study approach. Qualitative data was employed and gathered majorly from academic research. At the end of this paper the Government of Kenya via the Ministry of Home Affairs will have a feasible solution to solving an endemic problem in the Kenya Prisons Service that seems to have prevailed through the years with no end in sight and an avenue towards penal reform in Kenya.

**L2012-05: Media and Politics: Implications of the Kenyan Print Media's Use of Thematic Fronting and Backgrounding Strategies in Election Campaigns**

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**Abstract**

The Kenyan media plays a significant role in conveying news to the public and is rated as one of the most trusted institutions in Kenya. Thus, the Kenyan news reports have the potential of determining what the audience should know and how to react to the news. This is achieved through a deliberate choice of thought-provoking words in the news headlines. This paper examines the use of thematic fronting and backgrounding strategies in the discursive construction of newspaper headlines in the run-up to the 2007 election campaigns. The paper aims to identify the emotive words and phrases used by the mainstream local dailies' headlines, describe the linguistic strategies used to construct the phrases and outline their implications for the Kenyan governance and media ethics. A theoretical framework anchored in Critical Discourse Analysis (CDA) is applied in the analysis of fourteen newspaper texts purposively sampled from the four Kenyan mainstream local dailies (The Daily Nation, The Standard, The Kenya Times and The People Daily). The findings indicate that the Kenyan print media employs thematic fronting and backgrounding strategies in constructing thought-provoking news headlines. The paper observes that journalists contravene the journalistic art of objective news reporting and moderation in the run-up to any general election. In conclusion, the paper argues that the Kenyan media reportage has adverse implications in expressing and legitimizing unequal power relations, propagating ethnic polarization and personalized politics. This calls for a comprehensive legal framework to regulate the language and content of news reporting before any general election is held.

**Key Words:** *Kenyan Print Media, Thematic Fronting, Backgrounding, and Election Campaigns.*

**L2012-06: Judicial Radical Surgery in Kenya: Beyond Independence and Accountability**  
**Khamala A. Charles ,**

### **Abstract**

A 1989 World Bank Development Report recognized anticorruption and good governance as prerequisites for Sub-Saharan economic development. Kenya's democratic transition entailed inter alia economic liberalization and the rule of law. However, retention of the welfare-reducing Constitution perpetuated social injustice. In 2003, constrained by an absent "rule of law culture" and negative economic growth, the new Kenyan government chose incremental judicial reforms over comprehensive constitutional reforms. It assumed that retaining the "second best" Westminster Constitution while prioritizing construction of infrastructure, would necessarily result in "second best" overall social welfare. It was wrong. Nevertheless, the new Chief Justice implemented unprecedented "radical judicial surgery" recommending that half the purportedly-corrupt judiciary should be removed by Presidential tribunals of inquiry. Furthermore, newly-appointed High Court judges endorsed the "radical surgery." However, declining public confidence in the judicial reform process culminated in refusal by the opposition party to petition the hotly-disputed 2007 presidential election results, alleging biased courts. Widespread post-election violence further decreased overall social welfare, as indicated by the country's subsequent promulgation of a new Constitution. Ultimately, the High Court declared the "radical surgery" illegal. Given inconsistent and novel approaches to vetting of judicial professionalism, it is useful to learn lessons from previous and from comparative experiences in transitional contexts to critically determine the extent to which various scrutinizing procedures are predicated on political expediency, human rights principles or a combination of both. By applying "the general theorem of second best," this paper shall attempt to measure the impact of Kenya's radical judicial reform strategy on the independence and accountability of judicial officials, and on overall social welfare.

Key words: *Judiciary, reform, welfare, law, corruption, "second best"*

## **L2012-07: Hate Speech: How it Influences the Practice of Journalism in Kenya**

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### **Introduction**

- "The media's the most powerful entity on earth. They have the power to make the innocent guilty and to make the guilty innocent, and that is power, because they control the minds of the masses."

(MalcomX-American black militant leader.)

The media and the political class in particular are travelling on familiar road of negative ethnicity through hate speech as a medium.

Questions arise; what exactly is hate speech? What exactly is the origin of hate speech in Kenya?

And how should a journalist report it?

- Before the 2007 elections, the issue of hate speech did not play much in so far as Kenyan politics and media relation was concerned. After experiencing the impact of tribal hate because of hate speeches made by politicians and the media, there arose a feeling for the need to consider the potential effects of news reporting.
- A news reporter could cover hate speech story plainly only to find out later that he had set “fire” and it would be difficult to put it off what had ignited. And in the other hand, his boss at the newsroom, the editor would even further have the responsibility to run the story as it is so long as the quote of the statement is accurate, disregarding the “insensitiveness”- it goes to air or published. That is the role of a journalist in Kenya and elsewhere –to inform the masses on what public leaders pronounce. The media broadcasts the way information in form of news stories- a process that helps the public develop and digest healthy for a common good.
- In 2010, the national cohesion and integration commission (NCIC) took the court members of parliament Fred Kapondi and Wilfred Machage and politician Christine Miller. At the time of referendum on the New Constitution, Machage was quoted in the media having said in a press confidence “if the law is passed, the Kikuyus should prepare to leave Rift-Valley on masse”. This was just an example of events. Three politicians were acquitted. It was not easy to categorize hate speech now.
- In September 2011, the Media Council of Kenya (MCK) and NCIC signed a memorandum of understanding calling among other things, for the development of guidelines, “that lay out the responsibilities of the media and all other important players”. Whichever the

intentions on all sides, there are some intense arguments ahead not only on national level but also within individual newsrooms.

- In the history of Kenya and especially during the colonial period, European population during agitation for independence when African nationalists as a matter of public interest expressed opinions and propaganda that offended, shocked and even disturbed the colonial matters while on the contrary they still ignored utterances bordering hate speech to increasingly speed up its momentum as time moves towards electioneering period. After the provisions elections in 2007, Joshua Arap Sang, a Kenyan journalist based in a local vernacular radio station was summoned to appear before the International Criminal Court (ICC) at The Hague charged among prominent politicians with perpetuating ethnic violence through hate speech.

There seems to be no single definition of hate speech now. In fact, the issue of has been looked at and approached in several dimensions. Journalists-reporters, columnists and editors still question boundaries in a hate speech. Media institutions in general, too, still monitor on the subject. From languages of “deliberate”, intend to “incite” people over matters hanging from individual, ethnic race or religion. Hate speech still remains subject to be studied in Kenya and the world at large.

- Hate speech is a relatively new offence in Kenya and are such jurisprudence is limitation in itself. It has not been developed and that is why our courts base their experiences in other jurisdictions. Although Article 33 of the Kenyan New Constitution guarantees freedom of expression, it does not expound on hate speech, propaganda, incitement to violence or any advocacy of hatred that constitutes ethnic incitement, vilification of others or incitement to cause harm. The interpretation is to mean that in exercising their freedom of expression, journalist shall respect the rights, integrity and reputation of others.

- **However, there is the National Cohesion and Integration Act, 2008, which has come with more detailed explanation of what constitutes hate speech:**

i) A person who utters words intended to incite feelings of contempt, hatred, hostility, violence, discrimination against any person, group or community on the basis of ethnicity or race commits an offence whose punishment is imprisonment for a term not exceeding 5 years or fine of shs.1,000 000 or both.

ii) A newspaper, radio station or media enterprise that publishes such utterances repeated to above shall be liable to a fine not exceeding sh.1000 000.

Hate speech is any form of communication that disparages, degrades, dehumanises and /or demeans individuals or a group by promoting hatred and encouraging violence against an individual or group on basis of factors including, but not limited to religion, race, colour, ethnicity, gender, age, political and /or any other opinion, national or any other social origin. **(Source: Governance Forum:**

#### **Media checklist on Hate Speech, 2011)**

- Identifying hate is not easy as per the general definition but hate crimes in Kenya tend to be fuelled by stereotypes, particularly cultural and hate speeches especially at political campaign rallies. During such situations journalists during polarized electioneering period should be aware and not to be emotive as in the principles of conflict – sensitive journalism and that of taste and decency.
- Moreover, the NCIC Chairman Dr. Mzalendo Kibunja, says that the main criterion is whether airing such remains in the public interest. He gives an example of TV station running hate speech news item on the day of its happening would be appropriate, but running it every day for several days may not. So, how then would a case be brought against a media House for improper reporting of hate speech?

In Kenya, in most cases, editors decide not to use stories on fear of being sued. They

exercise self-censorship. It was not until in the recent developments of the events that information and communication Permanent Secretary Dr. Bitange Ndemo asserted a local newspaper for at the height of irresponsibility by running a story and related editorial- hate speech.

However NCIC officials however, have in several occasions assured journalists that they wont be prosecuted for reporting the hate speech if they are “ acting in good faith”, there’s nothing to stop future commissioners from taking a much hasher stand. “T he law is not clear; it could be used to crack down on the media”, said one Kenyan journalist. NCIC’s Kibunja reiterates however, that he has no plans to try to force media to cooperate, instead journalists will see is as their “civic duty”.

➤ **Research Methodology**

The research information is based on oral use information -like interviews, collected data sources, books and newspaper reports with the following aims and objectives:

1. To improve the process of democratic governance in the journalistic practice.
- 2) To raise the standards of media ethics and its practice- in relation to the new constitution.
- 3) And to generally enlighten and advocate the masses be conversant with laws governing them in so far as rights and freedom of speech are concerned.

➤ **Findings**

It has been established that the underlying factor that results in hate speech is bad governance in journalistic practices in this country, which are historically, based on negative ethnicity and political marginalization since colonial period to-date.

Kenya's new constitution with the media role coned enlightens the citizenry on the need of nationalism while shunning hate-speech as a setback.

➤ **One such example, include this:**

Hassan Omar, wrote on the standard on Sunday of November 27, 2011

Entitled “the unacceptable institutionalization of ethnicity” He had reminded Kenyans of tribalism in public job appointments. He had written in one of the opinion page of a local newspaper that kikuyu will not be the next president of Kenya.

Questions arise: How do these amount to hate speech? How can Hassan be attacked, condemned and vilified for telling the truth?

Many through the media the media reacted to his position. Omar Hassan is being accused of making utterances likely amount to hate speech, which others wondered whether the team was just put up on top to make Kenyans shut up their mouths while our leaders engage not in hate speech but “hate acts”- the causes of hate speech rather than just product of it. Impunity, tribalism, land question and apartments of less deserving people to public offices in Kenya perpetuated by leaders’ amount to “hate action”.

“**Justice in the extreme is often unjust**”- the words underlined by team Racine, a French playwright having been born on december21, 1639. This is sentence is apt to attacks on Hassan Omar Hassan. His details were factually correct and that and that the attacks on him are by persons who are thronged by truth of facts he gave.

In fact, the details of his article were facts and opinion based on public interests contrary to merchants of hate and violence that must be isolated by all means. That is why in Kenya there is a thin line between hate speech and individual freedom of expression.

No wonder, Omar Hassan had to say in his summary; “In the history of great nations, a “chosen” generation is faced with the duty to rise up to the challenges of nationhood. Kenyans can no longer commit treason by concealing or disregarding the truth”

➤ **Obstacles/limitations/ problems**

1. Negative ethnicity – so much and deep rooted imitation in all sectors of life in Kenya to the level that the media in itself has become a medium of hatred: news headlines, opinion pages and in letters to the editors and in radio programmes that are hate pronouncements.

2. political ethics- the recycling of old fashioned politicians who majority belong to provision regimes are busy fighting reforms- they are in for status quo.

Generally, they belong to wealthy lot and manipulating into non-implementation of new law finally in Kenya.

3. Ignorance of the masses – the Kenyan performance still is consent with the content of the New Constitution.

➤ **Is hate speech in international law?**

Hate speech generally seems to be outside law. However, in some countries, a victim of hate speech may seek redress under civil law, criminal law or both. There has been debate over how freedom of a speech applies to the internet. A website that uses hate speech is known as hate-site and most of these sites contain internet forums and news briefs that emphasizes a particular viewpoint.

Conferences concerning such sites have been sponsored by the United Nations High Commissions for Refugees (UNHCR). The International Covenant on civil and Political Rights (ICCPR) also states “any advocacy of national, social or religious hatred that constitutes incitement to discrimination, hostility or violence shall be prohibited by law. ‘Convention on the Elimination of All Forms of Racial Discrimination as well prohibits all incitement of Racism.

On May 3, 2011, Michael O’Flaherty with the limited Nation Human Rights Committee Published General Comment. No. 34 on the International convent that many forms of “hate speech” also not meet the level of seriousness set out in Article 20.

➤ **The American example**

Hate is not new to Americans. During the electioneering, years of tough presidential candidates like Washington and Thomas Jefferson, negative campaigns against them aligned- either politics of the US is messed by partisan campaigns with election and personally nasty.

Scare tactics worked for an increment and his party. Here were regimes that liked power, and wanted to keep it. There was introduction to the law- that the ruling party Passed- The Sedition Act to punish the very kind of speech against his followers.

The sedition Act made a crime in the 1800 election- punishable by up to two years in prison-of uttering or publishing “any false, scandalous and malicious writings against the government of the United States, or either house of the congress of the United States, or the president of the United States, with intent... to bring them or either of them, into a contempt or disrepute; or to excite against them the hatred of the good people of the United States.

This potentially unconditional law expired at the end of Adams single term in office, and by Jefferson’s second year as president, the very sort of personal invective that permits today’s political discourse was in full swing- against him.

In the recent times, conservative picketers responded with such charming slogan as “Get a job!” and “union things go home!” That speech rude but certainly within the bounds of legitimate protest, but the man who sported the sign “Death to Obama” and “Death to Michelle and her two stupid kids” unnerved the crowd and someone called the cops. The holder of the offensive sign, unidentified by authorities was detained by sheriff’s officers and twined over to the US Secret Service for questioning. It is after all, illegal to threaten the life of a president.

It is easy to dismiss the person as an obvious nut, but that is not really the point. Her is the point: Unhinged political extremists can be galvanized into action by the words of others; they can aim themselves; and they can act on their delusions. It’s happened twice secretly, one in a Lutheran Church in Wichita, Kansas, where George Tiller, a Physician who performed abortions, was

murdered in a Sunday services; and two weeks later at the Holocaust Memorial Museum, which a virulent 88 year old while supremacist shot dead Stephen Tyrone Johns a heroic and quick-thinking African American Security guard.

During the times of President Bill Clinton when he tried to pin the devastating 1995 Oklahoma City bombing when he denounced it as “hate-talk radio”. It is demozens, the president said, are “purveyors of hate and division” who leave the impression by their very words, that violence is acceptable.

In US, the problem is partisanship of hate, which is so entrenched that it is reflexive and unreasoning. The hate-tinged snipping at “red America” by “blue America” and vice versa. More assembles the turf was of the L.A based street gangs the ships (blue bandanas) and the Bloods (red bandanas) than any kind of deeply principled philosophical difference of deeply of opinion.

Anything had said about my said about the other guy is obvious truth, or free speech or you know, just satire.

Glenn Beck Fox television talker had claimed that the nation’s first African American president is “racist” who “has a deep-seated hatred of white people or the white culture”. That is truly odd, not to mention hateful, thing to say, especially considering that this implies that Barack Obama hated his own mother. However, among those who proposed method of discourse is the diatribe, logic is rarely the common currency. In addition, the extreme practitioner is probably a right-wing blogger from New Jersey named Hal Tuner.

### ➤ **RECOMMENDATIONS**

1. Kenyans can no longer commit treason by concealing or disregarding the truth-we must at all times bear our allegiance to **must at all times** ear our allegiance to nationhood and liberate our country from fear that would set us all free.

2. Journalists, like other citizens and policymakers-to ensure that future generations read a history that credits citizens with the media in the face of political onslaught in our country. That if we do not act now, our children may not be able to discern a news story from a sneaker ad, and hard copy may come to represent the standard for investigative reporting generations to come.
3. If Kenyans will be incited by hate speech and pieces of opinions the resolution is not to interrogate and harass the author. The solution is to petition the president politely and ask him to make his office and other government organs to have more representatives of tribes of Kenya.
4. Until we stop applying the law selectively, we shall never be able to tackle this problem of hate speech being a catalyst for national division. We must all have the will to apply the law without fear or favor exercise the freedom of expression but descend but descend to hate speech and peddle falsehoods, the crowds cheer and journalists interpreted and misinterpreted as we massive at being our own worst enemy. Therefore, what forgiveness or recommendations are we talking about through NCIC or the church to own communities?
5. Unless the media, politicians and even the religious institutions come together, hate speech cannot be countered.
6. Kenyans must take matters of hate speech seriously. We have been warned by people of all sorts-clergy, civil society, former president and even International Criminal Court to desist from engaging in such speeches that violate not only the constitution but also internationally accepted human rights-individual and group's rights. This is because in Kenya almost all politics is tribal.
7. Celebrate diversity- moving forward to teach children in school religious institution (churches, temples and mosques) and more so as home means seeking a common ground that draws strength from diversity. The division between the ethnic press and alternative media can be fought with all efforts.

Diversity is a necessary to our media system as it is to any ecosystem. Fighting homogeneity of ideas and new forms of media may require seeking out new forms of media-whether its zones talk radio the web, the community presswork anything out of your usual sanative. Besides, its fun-if we accept a fraction of arguments made in strengthening advocacy media.

8. Kenyans will have to device a way of identifying what constitutes intolerant hate speech, as wells learn to endure practice or ideas which one is apposed to as an individual or group when expressed by others. Perhaps a Kenyan university should be introduced as an institute of Ethnic Relations to study on the discipline bordering hate speech and freedom of expression.

## **CONCLUSION**

As indicated earlier, without freedom of expression, it is impossible to secure realization of other rights.

Arriving at what exactly constitutes hate speech remains a challenge to all societies living in Kenya and the world over.

Excessive tolerance might lead to disaster since too much control, has the potential of strangling the market place of ideas.

Freedom of expression is of paramount significance when it comes to individual self-fulfillment.

There is no way that the cry by certain lot for protection of their constitutional rights in order to violate the constitutional rights of the others neither should arise in the future.

- Each case of the hate speech verses freedom of entitlement to opinion and that of factual truth should be handled with its own circumstances and deserves to be debated on its own merit. The debates would be open and that the media practitioners would feel free to exercise their professional news judgment which NCIC would not sermon any journalist, a politician or any other Kenyan over hate speech used while suppressing free speech.

- All in all, the state should in most cases ignore some utterances whether by media practitioners or politicians because it is not easy to define clearly in law all that borders on hate speech because attempting to vigorously enforce the law on hate speech would impact negatively on freedom of opinion, expression, and information.

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### **L2012-08: Governance and Ethics: A Philosophical Perspective**

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#### **Abstract**

Broadly speaking, governance can be perceived to refer to the competent management of public affairs in a government. Governance therefore is the act of governing. It relates to decisions that define expectations, grant power or verify performance. It consists of either a separate process or part of management or leadership processes. These processes and systems are typically administered by a government. On the other hand ethics is mainly held as a characteristic way of life of some people. Ethics generally prescribes what ought to be done in a given social system, a prescription that always reflects a characteristic and acceptable way of behaviour of some group. It is therefore a set of standards that society places on itself and which helps guide behaviour, choices and actions with an envisaged goal in view. Ethics and governance is a very important area of study in today's world where governance poses a great challenge to many states. It is also an area that provides its candidates with the analytical and decision-making skills and knowledge to identify and resolve professional and ethical issues. The skills and knowledge obtained are also important for segments that specialise in the functional disciplines. Many governments have struggled to achieve good governance, and especially free from corruption. Corruption is an important manifestation of the failure of ethics. The word 'corrupt' is derived from the Latin word corruptus,

meaning ‘to break or destroy’. This hence implies lack of appropriate governance. However, good governance is not necessarily ethical. The main objective of this paper is therefore to inquire into whether it is possible to come up with the objective ethic of governance. This paper shall adopt philosophical methods of inquiry, and especially the Socratic critical method. This is a method of persistent inquiry by constant question of any nature until one finds reasonableness in a question at stake. The main hypothesis of this paper is that the competent management of public affairs need not occur only in popular and preferred forms of government like democratic governments, but also in other forms of governments.

### **L2012-11: Factors that Influence Adoption of ISO 9001; 2008 Quality Management Standards in Legal Practices**

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#### **Abstract**

Many Organizations invest considerable amount of time and resources in obtaining certification to the ISO 9001; 2008 standard. Although ISO 9001 has many benefits legal practices in Kenya have yet to adopt it. This research through three case studies examined the factors that influence the adoption of ISO 9001; 2008 management standard. The data collection methods included interviews using semi-structured questionnaires. The findings from the research reveal that external benefits are deemed more important in for the adoption of ISO 9001 than internal benefits. This benefit is associated with the prestige of obtaining the ISO certification. This gives the legal practice publicity and enhances its branding. Commitment by the Partners was identified as a critical factor influencing the adoption. The choice of three legal practices limits the applicability of the findings to other legal practices in Kenya.

Key words; *ISO 9001; 2008 standard, Quality Management, Legal Practices, Critical Success Factor*

### **L2012-12: Greed, Knowledge Management Practices Corruption**

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#### **Abstract**

Given the ethical and moral issues that surround greed and the need to prevent corruption which it proceeds, it is suggested that greed and corruption propensities and their relationship in organizations be investigated together with the moderating role of knowledge management practices namely knowledge exchange, socialization and internalization. It is anticipated that measures of these propensities and the moderating role of knowledge management will be determined in order to help organizations manage their greedy tendencies hence reduce corruption.

Keywords: *Greed, Corruption, knowledge management, organizations*